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Smart City Strategy of Dubai

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Introduction

The United Arab Emirates (UAE) comprise seven emirates: Abu Dhabi, Ajman, Dubai, Fujairah, Ras Al-Khaimah, Sharjah, Umm Al-Quwain and are located along the southeast coast of the Arabian Peninsula. The seven emirates combined cover a surface of 84'000 km^2 (Efthymiopoulos, 2016, p. 3). Recently, Dubai has shown through innovation, strategic investment and keenness to globalization that it was able to become a top metropolis in the world even though Dubai lacked of important resources in the past (water, oil, …). While becoming a global hub between the western and eastern civilizations, Dubai gives opportunities to those who look for investments and innovation, and also respects its local culture, religion and heritage. The recent discoveries of big oil reserves help the further development of the city (Efthymiopoulos, 2016, p. 3). The deployment of a modern urban space is used to find a balance between economy, technology, society and culture (Lombardi *et al.*, 2011, p. 2). The rapid development of the city made the use of innovation not only a will but also a necessity. Indeed, the population of Dubai grew from 0.5 million inhabitants in 1990 to 2.9 million in 2020. Dubai is one of the new "lands of opportunities" in emerging countries and fits perfectly in the present world, which is globalized and multi-cultural. Innovation and luxury are both the main features of the city of Dubai focusing on high value creation.

Smart Dubai 2021

Dubai has initiated and implemented smart city projects in the recent years (Khan *et al.*, 2017, pp. 6-7). In order to use and evaluate this huge amount of data available, Dubai develops 2 different indexes: the Smart Dubai Index and the Happiness Meter Index. The Happiness project, which is part of Smart Dubai, is different as it is not solely oriented towards productivity, livability and sustainability (Khan *et al.*, 2017, p. 9). This Index measures the level of satisfaction for a wide range of services provided by the different government entities of Dubai (Khan *et al.*, 2017, p. 10).

[1] This Report is mainly based on Luc Stalder (2019), Smart City: the case of Dubai, Center for Competitiveness of the University of Fribourg.

Smart Dubai vision started with the Ruler of Dubai. According to Sheikh Mohammed bin Rashid AlMaktoum, innovative governments need to "attract talent, perform efficiently, and continually upgrade their systems and services. They empower citizens to cultivate their collective energy and develop their potential, and thus become drivers for their countries' growth and advancement in the world arena" (Gulf News, 2015).

The project "Smart Dubai" officially started in March 2014. However, the history of Dubai is linked with digital projects since far before 2014. Indeed, foundations of what would be later considered as smart Dubai can be found as far as in 1999. Table 1 presents the different steps taken in order to launch the Smart Dubai project in 2014.

Table 1: Different steps prior to Dubai Smart City

Year	**Event**
1999	Dubai ICT Strategy is initiated.
2000	Dubai e-government initiative is announced.
2009	Dubai e-government department is open.
2013	Smart Dubai Higher Committee and Higher Committee for the implementation of Dubai Smart City are formed.
2014	Smart Dubai Executive Committee and Open Data Committee are formed.
2015	Dubai Data Law is announced and Smart Dubai Office is open.

Note: ICT: Information and communication technology.

Source: Khan *et al.* (2017, p. 6).

Dubai's smart city concept is based on 3 main principles: communication, integration and cooperation (Dassani *et al.*, 2015, p. 8). The "final goal" of all of these initiatives is Smart Dubai 2021. It introduces a new framework that looks like what occurs in the management of customer relations in the private sector, but will be in this case between inhabitants and the government. One of the aims of this project is to unify all the different government entities into a single body in order to provide services that are adjusted to the needs of every citizen in a more precise and more efficient way. It is happening mostly through smart applications and devices in Dubai (The Government Summit, 2015, p. 52).

The Smart Dubai 2021 plan is led by Smart Dubai Office and has the main goal to change Dubai into a model smart city, transforming completely how government services work and how they are delivered to people. By launching over 100 smart initiatives and more than 1000 smart services by more than 20 government bodies and the private sector in a short period of time, Dubai wants to achieve its goals and has already received some of its benefits as the city happiness has increased of

3% in the past 3 years (Smart Dubai Office, 2019). As the ultimate success indicator, happiness is measured cautiously with the help of the technological tools in order to celebrate the emirate's jubilee in 2021. Four main pillars structure its goals: seamless, efficient, safe and personalized. In addition to that, 3 axes of work have been targeted: customer happiness, economic growth and infrastructure resilience.

Smart Dubai strategy is exposed below according to the 6 "traditional" smart city dimensions usually used in the economic literature: smart economy, smart governance, smart environment, smart people, smart mobility and smart living (Giffinger *et al.*, 2007, p. 10). Smartness is a multidimensional concept. Many projects have incidences and ramifications in other areas related to the development of the smart city. Therefore, it is sometimes difficult to select these dimensions and place them in selected "boxes". It is also important to consider that there are correlations among the pillars (De Santis *et al.* 2015, p. 18). Table 2 – based on a study on smart cities - provides indications regarding the correlations between the pillars.

Table 1: Correlation matrix between the 6 pillars

	Economy ECN	**Environment ENV**	**Governance GOV**	**Living LIV**	**Mobility MOB**	**People PEO**
ECN	1.000	0.259	0.522	0.636	0.532	0.398
ENV	0.259	1.000	0.416	0.390	0.272	0.555
GOV	0.522	0.416	1.000	0.467	0.635	0.580
LIV	0.636	0.390	0.467	1.000	0.553	0.512
MOB	0.532	0.272	0.635	0.553	1.000	0.431
PEO	0.398	0.555	0.580	0.512	0.431	1.000

Source : De Santis *et al.* (2015, p. 18).

For most of the variables, a moderate correlation is found. However, strong correlations can be observed between smart governance and smart mobility, and between smart living and smart economy. On the other hand, correlations between smart economy and smart environment, and between smart economy and smart people are weak. According to De Santis *et al.* (2015, p. 17), the lower correlations of smart environment with other dimensions could imply a polarization of smartness on some dimensions rather than on others.

Dubai Smart economy

Dubai has become a major business center that got a dynamic and diversified economy over the last three decades. According to Mishrif and Kapetanovic (2018, p. 90), Dubai transformed itself into a global city thanks to "its small, open and well-integrated economy into the global economic and financial system". Thanks to its strategic location, Dubai serves as the biggest re-exporting center in the Middle East as the costs related to doing business are very low. Throughout the time, Dubai became a key player for a number of growing and profitable economic sectors according to Smart

Dubai Government (2018) such as: Meetings, conferences, exhibitions; Tourism; Corporate regional headquarters; Regional transport, distribution and logistics centers; Banking, finance and insurance; Business and industrial consulting; ICT, and Light and medium manufacturing.

The Higher Committee for Smart Dubai defines the smart economy as "*smart companies and port services, smart stock exchanges, and industries that support the knowledge-based economy*" according to Eid (2015). In order to efficiently meet these goals, Smart Dubai is mainly basing its strategy on the Internet of Everything (IoE), which is the connection of people through networks, processes, data and connected objects. In order to effectively implement the IoE, sensors put in millions of connected objects across the city generate data through the Wi-Fi that can be used by mobile apps and organizations to make daily lives and businesses better off with a wide range of services from tracking utilities to reducing supply chain inefficiencies (Eid, 2015). In addition, the Smart Dubai Office has come to an agreement for an alliance with the ArabNet Digital Summit to enhance digital transformation in the public and private sectors and to use the full potential that the smart economy can offer (GDN Online Desk, 2016). The partnership will help to deliver government-as-a-service, which will make the city's connectivity and data more available for businesses and entrepreneurs in order to create innovative services through this platform. As the private sector is expected to provide for around 80 percent of smart services, this alliance will unify the different stakeholders in order to connect and exchange ideas to make the smart economy in Dubai better off (GDN Online Desk, 2016). The ArabNet Summit typically includes a variety of subjects such as "smart cities, machine learning, internet of things, big data, corporate investment in innovation" for example (GDN Online Desk, 2016).

Dubai has adopted several measures to attract and ease processes for small business and start-ups. The Business to business (B2B) online portal Tejuri offers low startup costs for new businesses and they are henceforth supported through the integrated social media to interact and promote their businesses to potential customers and partners. The platform is also fully integrated, including payment solutions, logistics and shipping providers, marketing solutions and other services that might be necessary for young businesses (Sutton, 2016). Another tool that is developed to help young businesses to succeed is IBM Watson artificial intelligence engine. It provides "an interactive source of information on all procedures, processes and requirements for starting up a business in Dubai, so that entrepreneurs can get everything they need from a single source" (Sutton, 2016). The government also developed solutions such as DED Analytics, which provides to different ranges of businesses the ability to create their own reports and dashboards for personalized data and analysis that can be shared across the different bodies of a company. The DED Analytics is also available on cellphones granting top management of companies the access of key information very quickly on their cellphones without needing hard infrastructure (Sutton, 2016).

The department of economic development in Dubai has foster the development of innovations in ICT in order to create a global and digital competitive economy. The Dubai government encourages initiatives to promote entrepreneurship through high R&D investments, new technologies, the data sector and increases in terms of patents granted (Al Qamzi, 2018). Smart initiatives related to economy in Dubai include the personal assistant RASHID and the business dashboard, which help to accelerate the transition of Dubai regarding smartness (Al Qamzi, 2018). Moreover, another initiative has been conducted that automates and simplifies business registration and licensing procedures (Al Qamzi, 2018). Consequently, they are now more efficient and take less time than previously. Finally, the department of economic development has also adopted the Global Star Rating System for services in commercial establishments in Dubai. It is one project among others to serve as "a model to improve services and achieve customer happiness" (Al Qamzi, 2018).

Tourism is a major resource of income for lots of countries around the world. Thus, smart tourism, as part of smart economy, uses many smart city concepts and promotes tourism through the extensive use of ICT (Dassani *et al.*, 2015, p. 22). As Dubai was the fifth most visited city in the world in 2014 with 11.95 million visitors, the further development of the tourism sector is therefore crucial for the economic development of the city. Moreover, it plans to welcome 20 million visitors by 2020 (Dassani *et al.*, 2015, p. 23). In order to satisfy the increasing demand, smart concepts related to tourism have been developed. For example, the tour guide system Nahaam, developed by the Roads and Transport Authority (RTA), gives information to tourists about landscapes and routes. Additionally, the smart gate system at the airport has significantly shortened the time related to immigration and passports through electronic identification. The Dubai department of Tourism and Commerce Marketing has also developed e-Permit and e-Ticketing in order to further develop the events sector, which is a key factor in the strategy for the development of Tourism for 2020. E-Permit is an online centralized system where all "procedures related to the application, processing and licensing of event permits are operated" (Dassani *et al.*, 2015, p. 23). E-Ticketing is "a centralized platform for the sale and distribution of tickets for all events in Dubai". The main advantage of both platforms is that it accelerates and simplifies the entire process from the application for a permit up to the selling of tickets (Dassani *et al.*, 2015, p. 23). In addition to the advantages related to the creator, seller and buyer of events, Dubai's government is able to collect data that can be used for city planning and crowd management during the events (Dassani *et al.*, 2015, p. 23).

However, such a strategic orientation directed toward the use of data and analytics requires tremendous efforts in terms of security, which is also a big asset when attracting businesses and people from the 2.0 world in Dubai. This is why Dubai is now embracing blockchain technology (Cohen, 2018). Indeed, Dubai has developed 20 projects related to the use of this type of technology. Typically, one of these projects is the complete elimination of the use of paper for government services, which requires enormous needs in terms of security. This issue can be satisfied with the

use of the blockchain technology. With annual savings that could be up to $1.5 billion per year, these funds could be allocated elsewhere, which would increase the competitiveness of the city (Cohen, 2018).

Ease of doing business has been a focus of Dubai. UAE established UAE competitiveness entity that works to enhance the competitiveness of the country in several aspects. UAE federal council of statistics and competitiveness established local teams to work with local governments and private companies to make cost and process of doing business easier in Dubai through government reforms programs. UAE ranked 16th worldwide in ease of doing business in 2020 thanks to these efforts (The National, 2019).

Lack of affordable housing is one of the key challenges facing Dubai policy makers' efforts to achieve Emirate's sustainable development objectives. Dubai's diversification strategies to build a competitive economy independent of oil have succeeded to a large extent with oil accounting for less than 2% of GDP as of 2014[i]. Economically, the city's GDP has grown from $11 billion as of 1995 to $105 billion in 2016 accompanied by growing population from 690,000 to 2.5 million in the same period (Elburai, 2019). What is unique about Dubai's affordable housing challenge is the fact that 91% of its population is expatriates who have seen Dubai as a country of hope (Elburai, 2019).

Speculators had driven homes' prices by 500% for villas and 300% for apartments from 2003 to 2015, thus making it impossible for residents to own their homes (Elburai, 2019). According to Craig Plum of JLL (Jones Lang LaSalle investment and consultancy company) "only 20% of all products that was being built was affordable "although" the demand for affordable sector was 40% of the demand" resulting in a gap of affordability of 20%. This affordability gap created other challenges to the city urban structure as one third of its daily population live in neighboring emirates creating congestion in major highways (Elburai, 2019).

Dubai Smart governance

Smart Dubai Government Establishment (also known as Smart Dubai Gov) is the technological arm of Smart Dubai and one of its departments. Being under the supervision of the Smart Dubai Office, Smart Dubai Gov is aligned with the global goal to make Dubai the happiest city on Earth. Smart Dubai Gov is the official supervisor of the implementation of electronic and smart transformation in the Dubai government (Dubai Government, 2019). The main mission of Smart Dubai Gov is to deliver high standard smart services and infrastructure in order to generate more happiness. Historically, Smart Dubai Gov started in 2000 as the Dubai eGovernment umbrella initiative before changing into its actual shape (Dubai Government, 2019).

One of the main objectives of Dubai's government is to go paperless by 2021. Nowadays, more than 1 billion papers are used every year for government related activities according to Bin Bishr (p. 6). His Highness Sheikh Hamdan Bin Mohammed Al Maktoum has charged the Smart Dubai Office to reach the goal of having the last paper transaction in 2021. This means that transactions related to the customers or that are internal will be 100 percent digital. Indeed, by 2021 the government of Dubai will not issue official documents in the paper form anymore. Moreover, employees will also not emit papers anymore, even if it remains internal (Bin Bishr, pp.9-10). The consequences of this abolishment are very positive as 130'000 trees will be saved and it will represent 40 more hours of free time for each employee by not dealing with paper anymore (Khan, 2018). In order to reach this goal, the initiative is based on 3 pillars according to Bin Bishr (p. 11):

- Technology: technology and data needs should be satisfied and of the last generation in order to ensure that all transactions and processes can fully be paperless.
- Legislation: the required legislators and laws should be solicited in order to enable the development of paperless transactions in different entities.
- Culture: it is also important to educate people by addressing the entities' and customers' cultural barriers to the adoption of 100 percent paperless processes and transactions.

Nevertheless, such dramatic changes take time and have to be progressive. This is why Dubai tries to motivate its government bodies to take steps prior to 2021. As a good example, 6 government entities (Dubai Police, Dubai Electricity and Water Authority, Land Department, Dubai Tourism, Dubai Economy and Roads & Transport Authority) already reduced their use of paper by 57% (Bin Bishr, p. 13).

Dubai plans on using the blockchain technology to secure its transactions, artificial intelligence, RASHID (the city's virtual assistant) and more digital services in order to replace paper (Bin Bishr, p. 17). 56 government entities are participating in this ambitious project. Moreover, Dubai enhanced the Global blockchain challenge and awarded $45'000 prize money to teams for the development of its strategy (Bin Bishr, pp. 19-20). Projects related to the blockchain technology are already emerging as the blockchain enabled retail payment app DubaiPay has recently been launched with the collaboration of the Smart Dubai Office and the Department of Finance. DubaiPay supports 40 government and non-governmental agencies and collected $35 million in 2017 (Khan, 2018). Moreover, Dubai Tourism has also started to use the blockchain technology by introducing a virtual market place. Dubai's Roads and Transport Authority will introduce vehicle management system in 2020. Recently, the Prime Minister of the United Arab Emirates presented the UAE Blockchain strategy 2021 which is based on 4 pillars such as residents' happiness, government efficiency, advanced legislation, and global entrepreneurship (Khan, 2018).

In addition, Dubai has also launched its own blockchain-based cryptocurrency called emCash. It can be used in order to pay for government and non-government related services as it got the advantage to have faster processing, improved delivery time, less complexity and is less costly. The goal of this cryptocurrency is to improve the ease of doing business and the quality of life in the city. Many startups involved in cryptocurrencies such as ArabianChain, CrossVerify, Loyyal, Luther Systems, Otonomos and RSK Labs have been "hired" in order to further develop the use of blockchain. Recently, the Dubai government got an agreement with the startup ObjectTech in order to bring blockchain based security at the Dubai International airport in order to develop the concept of digital passports and the elimination of manual security checks. Even though many startups are involved in the process, the IT giants such as Microsoft, SAP, Cisco are in the mix as they are part of the Global Blockchain Council, which unites 32 government bodies and private actors to develop the use of blockchain applications in Dubai that can contribute to the Dubai economy (Dutt D'Cunha, 2017).

The Dubai Government launches the Dubai Pulse portal. In this portal, Government bodies and citizens will be able to create their own dashboards. For instance, public sector managers will have access to real-time data about the satisfaction of citizens about public services through the information coming from social media, and consequently make the adjustments needed. Moreover, future developments of Dubai Pulse could also be developed in order to help consumers find the closest parking spots to their favorite stadiums, shopping malls, etc. The portal could also be used in order to avoid traffic jams with the real-time data and could propose alternative routes. With this kind of initiatives, the Dubai government is saving around $97.5 million per year due to gains in efficiency (Hewlett Packard Enterprise Development LP, 2019).

The government introduced RASHID that is the artificial intelligence powered smart city advisor. RASHID is available to answer questions and requests from users, typed or voice commanded, allowing them to access high-quality information and services directly on their smartphones. More than simply giving advices, it can also do tasks requested by the user. Instead of being available only for public services, RASHID also proposes now the services of private actors.

One of the main challenges related to the use of the digital technologies relates to the safety of data. Several measures have been undertaken such as the foundation of the "Dubai Center for E-Security" in 2014 (Efthymiopoulos, 2016, p. 10). The goal of the center is "to protect information, communication networks and government information system in Dubai" (Efthymiopoulos, 2016, p. 11). Concretely, the center provides the technical tools and more efficiency in logistics to all government bodies in Dubai, while also protecting the inhabitants and tourists in Dubai at the same time.

Dubai Smart environment

Dubai has the goal of reducing carbon emissions by 30 percent (Khan *et al.*, 2017, p. 8). Besides this objective, Dubai also aims to improve the air quality, water quality (marine and non-marine water), soil quality and waste management according to Khan *et al.* (2017, p. 8). In order to properly optimize energy use, the Dubai Electricity and Water Authority encourages the residents to use solar energy, saving it as much as they can through the use of smart grids, and selling back the surplus to the government. Regarding the tourists, Dubai is transforming its parks and beaches to become smarter as they will provide in the near future information related to safety instructions, weather and sea conditions, temperature and more (The Government Summit, 2015, p. 51). On a larger scale, the creation of the International Renewable Energy Agency, which has its headquarters in Abu Dhabi, is part of a more global effort in the Emirates to satisfy to the requirements of the United Nations sustainable development program (Efthymiopoulos, 2016, p. 7).

A major topic where energy consumption can be reduced is buildings. Indeed, buildings accounted for 32% of global energy consumption and for 19% of all carbon emissions in 2010 (Dassani *et al.*, 2015, p. 18). This is why the city of Dubai introduced a set of rules that promotes the use of energy saving systems, natural lighting systems and green building materials. More generally, the Dubai's Integrated Energy Strategy has the goal to reduce energy and water demand by 30% by 2030 (Dassani *et al.*, 2015, p. 19). One of the main topics of this reduction is in the cooling requirements of buildings by the Dubai Electricity and Water Authority (Dassani *et al.*, 2015, p. 19). Moreover, the Authority has other plans in order to make Dubai more sustainable and efficient in energy consumption according to Dassani *et al.* (2015, p. 21):

- It plans to install 250'000 smart meters in residential, industrial and commercial properties by 2018.
- It will deploy smart-grids in order to automate grid-control decisions that will allow citizens to automate and control their power consumption.
- It also plans to implement solar power in houses as it is the main resource of the city. The city is also developing smart apps, building and charging infrastructure for electric cars.
- Agreements with specialized private actors such as IBM have also been signed in order to collaborate on smart grid technologies, innovation centers and R&D.
- The role of information is also very important: the development of mobile apps that inform people on their daily energy consumption that gives rewards to "efficient" citizens is in the pipes in order to preserve energy and water.

The Dubai Green Mobility Strategy 2030 also wants more electrical cars on its roads in order to ameliorate sustainability, air quality and fuel efficiency. This is why Dubai wants government bodies having at least 10% of annual leased or bought car to be electric or hybrid. It started in 2016 and the

goal is to have 2% of hybrid and electric cars by 2020, and 10% by 2030 in order to reduce the carbon footprint of the emirate (Utilities Middle East Staff, 2018).

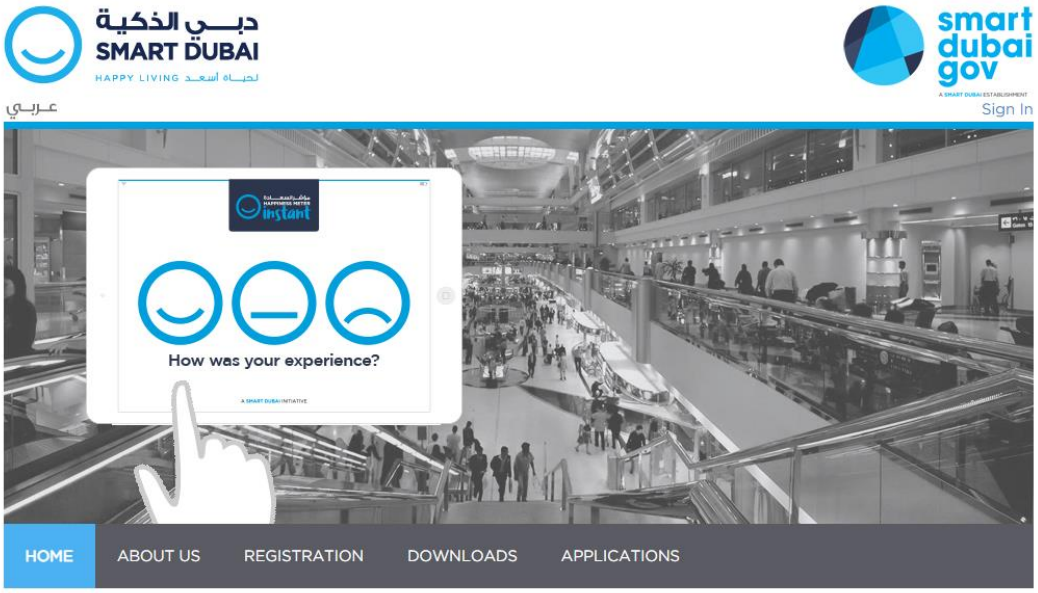
Clusters buildings have been an important strategy used by the government to make it easier for FDI to flow in, businesses to locate and talents to choose Dubai as home. Dubai Internet City (DIC) is one of the first clusters in the city. DIC has managed to attract AED 7.8 billion in investments, more than 1600 technology companies and more than 24'000 people from 150+ nationalities (Emirates News Agency, 2018).

Dubai Smart people

The Happiness Meter Index measures the level of satisfaction of people for many services and other areas related to the city of Dubai. As part of the Smart Dubai project, it is not only oriented towards productivity, efficiency, livability and sustainability but mainly on people and their feedbacks (Khan *et al.*, 2017, p. 9). The measurement of these feedbacks and evaluations is done by smart online devices installed in the headquarters of the government bodies and also connected to a central data center that monitors and analyzes the real-time performance of the services judged. Afterwards, reports are generated and sent to policy makers in order to change things that have been considered as less satisfying by people. The system is large as over 1 million interactions were reported in 2016 among 31 different government entities (Khan *et al.*, 2017, p. 10). The initiative is even more impressive as, instead of focusing on one specific area of improvement, Dubai places the people's happiness as the heart of its strategy (Hewlett Packard Staff, 2016). The principle of the Happiness Meter is pretty much simple (cf. figure 1): users have simply to rate services between 1-satisifed, 2-neutral and 3-dissatisfied. Therefore, it generates valuable data and paths for improvement for services devoted to people. It can be used through cellphones or computers (Smart Dubai Government Est, 2019).

On a more general side, Dubai created the National Program for Happiness and Positivity in 2016. The program covers 3 areas: Inclusion of happiness in the policies, programs and services of all government bodies and at work; Promotion of positivity and happiness as a lifestyle in the community; Development of benchmarks and tools to measure happiness.

Figure 1: Happiness Meter Index portal



Source: Smart Dubai Government Est (2019).

Finally, as the city considers that happiness can be measured, the study "Happiness Snapshot" collects worthy data about beliefs and motivations of the Dubai's inhabitants. Consequently, these data will be used by the city's leaders to help them in the decision process regarding new projects and policies in order to influence positively the happiness of the Dubai's population (Dubai Corporation of Tourism & Commerce Marketing, 2019).

Education is another major aspect of the smart people dimension. In Dubai, a smart e-services portal for universities has recently been introduced. Additionally, an updated system that reunites all schools and training institutes allows the customers to connect directly with the education authority of Dubai (Dassani *et al.*, 2015, p. 25). Furthermore, Universities have online registration for both students and employees and services such as certificate attestations and permit renewals. Moreover, the smart learning project was implemented in 2012 in order to shift classrooms into an e-platform that reunites teachers, students, parents and administrators. The goal of this was to introduce the concept of smart classes in all public schools, providing every student with a tablet with 4G internet access. By doing so, students, parents and teachers interact on every aspect of the learning process (Dassani *et al.*, 2015, p. 25). Finally, Dubai founded the smart city academy, which is "the world's first open platform for decentralized education and skill development of the blockchain" in collaboration with the RIT and the University of Surrey (Bin Bishr, 2019, p. 21).

To attract talented people, UAE recently introduced 10 years residency visas for scientists, PhD holders, doctors, engineers and distinguished students (Khaleej Times, 2020). This is expected to enhance caliber of people living in Dubai as it is departure of traditional short-term focus of the city.

Furthermore, several unicorns were born in Dubai such as Souq.com and Careem that were sold later to Amazon and Uber. Such unicorns started with expatriates' executives.

Dubai Smart mobility

Recently, Dubai has made a tremendous progress in the smart mobility sector. Smart systems that include smart parking, smart taxi service, smart toll system and smart drive have been recently developed. More ambitious and shinier projects are also in the pipes in order to put Dubai on the map of smart cities (Khan *et al.*, 2017, p. 9). Even though Uber was planned to launch the first air taxi in Dubai, Volocopter (from Germany) has actually been chosen. The Autonomous Air Taxi is part of the Autonomous transportation strategy that wants to have 25% of all transportation in Dubai to be autonomous by 2030. The air taxi is electricity powered and can reach a speed of 100 km/h. The use of drones is also planned in order to deliver Emirates ID cards by 2018 (United Arab Emirates, 2019). The RTA signed the contract with Volocopter and the first tests started in 2017. Prior to being in service, the planning of air routes, take-off and landing points and the logistics of these projects are needed (Logistics Middle East Staff, 2019).

Figure 1: Volocopter air taxi

Source: Logistics Middle East Staff (2019).

The second noticeable project is the Dubai Loop Train. The goal of this Hyperloop (based on the project of Elon Musk) is to link Dubai and Abu Dhabi faster than what has previously been achieved. It will be on service for Dubai2020. The duration of the trip will only be of 12 minutes for an approximate length of 140 kilometers (Khan *et al.*, 2017, p. 9). Another project is related to the airport of Dubai. The goal of the Smart Tunnel at Airport Immigration is to allow passengers to pass through the whole entry procedure within 15 seconds by simply walking in the tunnel that contains no passport stamp or any human intervention (Khan *et al.*, 2017, p. 9).

The smart mobility in Dubai is oriented between 5 different areas of action: transportation, traffic management, roads infrastructure, sustainable public transport modes and non-motorized modes (Al Bastaki, 2017, p. 5). In addition to these aspects, it is also important that the Dubai system is fully integrated between the different services, safe and secure, rich by the information it provides and also multi modal. When speaking about the multimodality, it is understood that the transport network as a whole is concerned. Integration and information are central and should be no different if the user takes the car, bus, metro, tram, bike, boat or walks. The major points related to the user that have to be continuously improved are the accessibility, the affordability, the safety and security and finally, the health and lifestyle should also be considered (Al Bastaki, 2017, p. 6). In order to effectively measure the smart mobility in Dubai, many Key Performance Indicators and their target scores have been determined such as:

- RTA Happiness Index with a 53% target,
- Increased efficiency of RTA processes with a 20% target,
- Share of public transportation with a 20% target,
- Share of optimized asset performance with a 98% target,
- Number of major security incidents per 100'000 passenger journeys with 1 as a target,
- Number of greenhouse gas emissions per passenger with 1.16 kgCO_2/passenger,
- Share of compliance with Dubai Data Law with a 100% target,
- Share of new digital solutions where RTA is a pioneer with a 53% target,
- Share of smart transportation with autonomous systems with a 12% target.

All of these targets have to be reached by 2020 or 2021 depending on the Key performance indicator (KPI) chosen (Al Bastaki, 2017, p. 8). By 2030, transportation with autonomous vehicles should reach 25 % of total transportation (McMurray, 2018). In addition to that, it is also important to focus on what are the smart projects concretely made of. They include features such as bus lane enforcement, smart pedestrian crossing, smart parking, smart vehicle, smart lighting, the launch of the Dubai Integrated Mobility Platform, smart yard, smart Nol (the use of the handset of the cellphone to pay fares for public transportation), vehicle safety services and smart bus shelters (Al Bastaki, 2017, p. 11). Nevertheless, one of the first major steps taken in order to have smart mobility solutions was the Dubai Metro. Indeed, it is the longest driverless metro in the world, which moves more than 600'000 passengers per day (Gulf News Staff, 2017).

The RTA has also recently launched a service to optimize the selling of cars. The process, from the visit of a showroom to the registration for plates and transfer of possession, is now all online. With the help of the Emirates ID, the sales transactions can be achieved more effectively in addition to other services related to buy a car such as insurance, plates and so on (Government of Dubai, 2016, pp. 20-21). Cars have a special place in smart initiatives related to mobility in Dubai as they almost doubled in the city growing from 740'000 in 2006 to 1.4 million in 2014, which make annual

increases to be in the highest in the world (Dassani *et al.*, 2015, p. 14). The orientation given to smart mobility has also been oriented toward the cellphone. Indeed, 173 services of the RTA are now available on the smartphone. Apps such as Smart Drive, Wojhati (trips planner), Smart Salik, Smart Parking, Smart Taxi, Drivers and Vehicles, Public Transportation, Corporate Services and RTA are now available. In addition to that, the RTA has developed a project that includes 900 kilometers of bike lanes. The plan is to connect these lanes in the transportation system for greater integrations between every type of vehicles (Dassani *et al.*, 2015, p. 15). Another project that is holistic in its approach is the smart mall concept. It enables the Dubai metro passengers to shop "via an interactive, high-definition 3D digital screen spanning nine square meters" while they wait at a stop. They can add products in a virtual cart, make their payment via credit card and choose where and when the goods are delivered. By doing so, it helps the people to do their shopping while they wait instead of allowing a specific time frame for shopping (The First Group, 2019). Moreover, Dubai also launched electric-powered autonomous cars that can include 10 passengers. It goes at a speed of 10 km/h and is remarkably safe as it includes a four-directional GPS and uses laser sensors to help cars to spot any object that is 40 meters far from the vehicle. People have completed a 94% satisfaction rate (The First Group, 2019).

But next to autonomous transport means, one of the other important aspects of smart mobility is sustainability. Thus, the government provides incentives to own electrical vehicles. These incentives include free charging of cars to the end of 2019, an extra 3 years warranty for electrical vehicles in Dubai, savings of $6'000 on total cost of ownership, free registration and free parking. The goal of this is to bring 270'000 electrical vehicles by 2030 (McMurray, 2018).

Dubai's Autonomous Transportation Strategy has 3 main goals: first, cut transportation costs by 44%, which means up to $245 million per year of savings. Second, the decrease in pollution by 12% will lead to a saving of $408 million per year. Finally, the increase in the economic growth and in efficiency in transportation will generate $9 billion annually in economic returns (Albawaba Business, 2018). In addition to that, Dubai Autonomous Transportation Strategy has other less economic goals such as reducing traffic accident losses by 12%, which will represent savings up to $544 million. Finally, an increase of productivity by individuals of 13% will occur, which means that 396 million hours on transportation will be saved (Dubai Future Foundation, 2019).

The city faces many challenges when it comes to transportation including congestion, high car ownership, low public transport ridership, and pollution (Chaudhry, 2012). One of the negative consequences of its explosive urban growth is its widening sprawl making the city car dependent as well as highly polluted. The city has one car for every two residents making it one of the highest worldwide, while congestion index is one of the highest as well (Ministry of Environment and Water, 2014). Moreover, Public transport use in Dubai of 16% is much less than other similar cities like 65% in Singapore and 87% in Hong Kong making the city prone to congestion problems

(Chaudhry, 2012). In addition, number of cars is expected to reach 1.5 million by 2020 (Ministry of Environment and Water, 2014).

According to government sources, road transport contribute to 75-70% of air pollution in the city (Arabian Business, 2007). It is also estimated that hydrocarbon emissions' in Dubai is of 800 ppm, which is much higher international averages of 200-300 ppm (Chaudhry, 2012) . To deal with this challenge, the city plans to have 20% of trips on public transport by 2021 and 30% by 2030, compared with 16% today. The city needs to transform itself from car city to public transit by 2030 making half of trips through public transport. This huge transformation requires system thinking and change management to create interest for public transport use as the mode for future growth.

Dubai Smart living

As the Dubai population is already technology prone and highly connected, the objective is to propose solutions to the majority of inhabitants' needs through digital services instead of proposing traditional ones such as paper documents and so on. Such services include "healthcare, education, culture, housing, entertainment, community, and volunteering services among others". It is also a goal of Dubai smart strategy 2021 to use data as a strategic asset that will benefit to the public as well as to the different government bodies and their customers. Moreover, the Dubai Data Establishment has been implemented in order to ameliorate the exchange of data between different government entities, government and private actors, government and their customers. All of this is happening with the goal of making the lives of people better off and more comfortable (Telecom Review Staff, 2017).

In Dubai, a steady growing population means that the city has to build additional healthcare infrastructure that will be equipped by smart healthcare projects. In 2013, the city elaborated a smart city project based on 3 factors: smart applications, smart operations and smart hospitals (Dassani *et al.*, 2015, p. 16). Moreover, Dubai has implemented Electronic Medical Records and a Hospital Information System in 2015. By doing so, the easiness to access patients' files is better off as all details of patients related to health status (results of tests, x-rays, records of doctors' visits) are available to the whole medical body in Dubai on a single file. Moreover, the system also allows doctors to send instructions and medical goods to other sectors of the hospital like laboratories and pharmacies as the system unifies all services of the hospital into one single entity. Consequently, the system eliminates paper work, reduces patient waiting time, provides additional relevant data of the patient treated and cuts the time for procedures by 50 %. In a close future, the Dubai Healthcare Authority is also exploring to implement telemedicine projects. This would help patients get indications about what their problem is, and finally also let them benefit from e-consultations. As a consequence, it could reduce waiting lists in hospitals, increase patient satisfaction and improve the time allowed to each patient (Dassani *et al.*, 2015, p. 17). Similarly, parents and children should

have the opportunity to look for education and schooling information online, but also get the registration and the payment for classes online, and interact with other participants online (Telecom Review Staff, 2017).

Safety is a major component fostering smart living. The Dubai police app has become highly successful and is one of the most popular among other government apps. The app includes many key online services of the police force that can be accessed on the mobile phone. The app includes fines, which can be accessed and paid through it, the application to good conduct certificates, the report of traffic violations or crimes, a list of pharmacies that are open, and general traffic services (Dassani *et al.*, 2015, p. 27). In terms of public safety, the use of Google glasses by police officers and the launch of the first intelligent robot officer go in the right direction. The robot provides Dubai police services in 6 languages, communicates, provides information to the general public and is linked to a non-emergency call center (Dassani *et al.*, 2015, p. 27). The main benefit of the app remains in the fact that people can make reports or enquiries without having to go to a police station, which saves a significant amount of time for people (The Government Summit, 2015, p. 52).

The smart living experience in Dubai homes goes mostly through the solutions provided by the state telecommunications enterprise Etisalat. In 2015, Etisalat partnered with Homengine Technologies in order to introduce the Fibaro Home Automation System for the residential customers of the company in Dubai. The Fibaro System allows home monitoring, security and air conditioning management. The smartness in this program relies in the fact that the users have the ability to monitor, automate, secure and control their homes from anywhere at any time using devices such as cellphones, tablets or computers (Basit, 2015). In addition to that, customers can combine such packages with additional devices such as cameras, thermostats, sensors or wall plugs in order to fully benefit from the features of the system at an affordable price. To encourage people to use it, Etisalat provides also free delivery, free installation and free training to the inhabitants of Dubai (Basit, 2015). More recent connected objects for daily life are also appearing such as Cota, which has been developed in collaboration with Etisalat. It is a wireless charger for electronic devices that uses radio frequency waves to charges objects. In a close future, wireless chargers will be in every home in Dubai. Sunflower, from a US startup, is a charger that automatically seeks the sun in order to charge objects. It comes with Bluetooth and Wi-Fi connectivity and can be controlled on a cellphone trough an app. The company has deliberately chosen Dubai as a hub because of the technology-prone environment (Sadaqat, 2017).

In order to launch new products and confront the Dubai inhabitants to novelties related to smart living, the Dubai government hosts the Shopper Smart Living event every year. It includes the presentation of goods in domains such as: Luxury and lifestyle appliances; Large domestic appliances; High end consumers electronics; Home automation technology; Studio kitchens; Smart lighting; Smart security systems; Energy conserving products (YesGulf, 2016).

Overview of the Dubai Smart Strategy

Smart cities have common characteristics that form their core in order to accomplish the objectives allowed to them. These characteristics include: the effective ICT, an effective use of the data generated among the stakeholders and platforms that allow stakeholders going from an idea to concrete solutions (Khan *et al.*, 2017, p. 3). According to Babar (2016, p. 19), "a smart city embodies innovative solutions enabled by digital technologies for effectively and efficiently creating and sustaining livable and vibrant infrastructures and ecosystems for socio-economic benefits of involved stakeholders including communities, enterprises, and governments in the 21st century". These different parameters are found in the many definitions of smart cities. Whichever definition is chosen, it is clear from this report that Dubai is one of the most illustrative examples of a city's smart development.

Smart Dubai strategy aims at utilizing technology in achieving three types of impact (Smart Dubai Office, 2021):

1. Customer impact: focus is made on government services to utilize technology in a way that delivers customers a smooth and efficient journey. Customers can be individuals and businesses and the way to measure this is using happiness metric.
2. Financial impact: Efficient services are believed to lead to more competitive business environment. Data can help enhancing the innovation ecosystem of the city while delivering value. According to Smart Dubai office, open data will lead to $2.8 billion to Dubai economy by 2021 (Smart Dubai Office, 2021). The city is saving 5.6 dollar for each dollar invested in ICT infrastructure (Smart Dubai Office, 2021).
3. Resource and infrastructure impact: making city's infrastructures more sustainable and resilient is believed to lead to healthier environment.

The Annex A provides a summary of the main smart actions and programs undertaken in Dubai according to the 6 dimensions. The "happiness factor" is at the core of Dubai smart city. Many initiatives have been put in place in the context of Dubai 2021. While some actions have measurable goals, others have so far been limited to intentions that need to be clarified in order to identify measurement indicators. Annex B summarizes the main measures adopted and sets out the criteria for the measures adopted. It is disputed that important measures – such as those linked to smart economy - do not currently have quantifiable objective and criteria. Some pillars already have quantitative and measurable objectives such as smart mobility, however, some others do not. For example, the Dubai Autonomous Transportation Strategy clearly sets its goals to reach in the future. By doing this, the strategy becomes more concrete. The smart mobility key is the one that has the more numerical goals. Therefore, it helps to understand the orientation wanted by the government of Dubai and its implications.

Conclusions

Dubai has proven to be a unique city that managed to transform itself from desert into a global city. Visionary leadership has been an important engine behind this success and transformation. Happiness agenda of the city has been integrated in policies, services and strategies of different local government agencies. However, what is needed to be focused in future steps is involving private sector in Dubai's efforts to climb the ladder of smart cities as opposed to entirely government's led and executed agenda. In addition, supporting infrastructure of legal facilitation and data sharing as well as management platforms is crucial to build efficiency and competitiveness.

On another hand, the city is car dependent and continue to be unsustainable in terms of resource consumption. Thus, linking smart city strategy to the 17 SDGs of UN can be a smart move to reinforce the need to be sustainable in order to be smart. Although the city managed to attract variety of skilled talents from all over the world, strengthening education and health sectors are important areas the city needs to focus on to enhance the quality of life. Building long term economic and social models are needed in such expats dominated city to build a more resilient city facing shocks and uncertainty.

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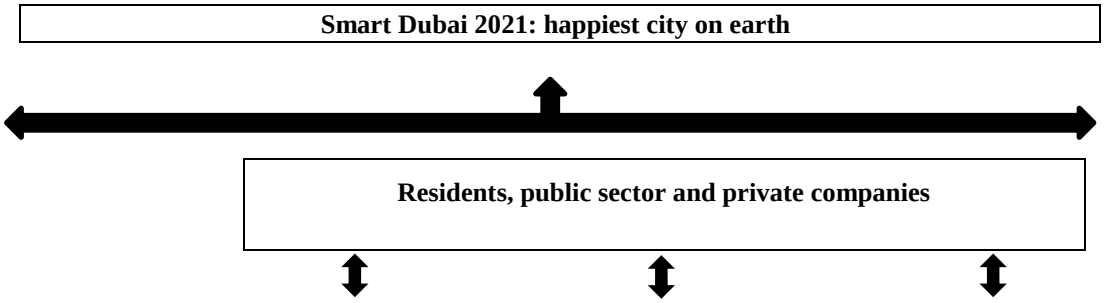
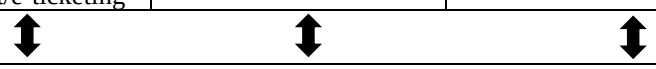
Annex A: Smart Dubai Summary of interactions



Efficient **Seamless** **Safe** **Impactful**	**Smart living** - Dubai Data Establishment - Electronic Medical Records - Hospital Info System - Telemedicine - Fibaro Home Automation System - Cota/Sunflower chargers - Shopper Smart Living event - Dubai digital certificates - Dubai crowd initiative - Smart Cities global network - Dubai Police app	**Smart environment** - Solar energy smart grids - Live information related to weather conditions - 250'000 smart grids - Integrated Energy Strategy - App related to the daily consumption of energy - Increase of electric/hybrid cars - Robot police officer	**Smart mobility** - Smart parking - Smart taxi service - Smart toll system (Smart Salik) - Smart trip planner (Wojhati) - Air taxi (Volocopter) - Use of drones for delivery - Hyperloop - Airport smart tunnel - Smart public transport - Smart mall concept - Electric autonomous cars - Dubai Autonomous Transportation Strategy
Personalized	**Smart economy** - IoE - Arabnet Digital Summit - B2B online portal Tejuri - IBM Watson AI engine - DED Analytics - Global Star Rating System - Nahaan - e-Permit/e-ticketing	**Smart governance** - Paperless government - emCash cryptocurrency - smart devices & phones - RASHID - DubaiPay	**Smart people** - Happiness Meter Index - National Programme for Happiness - Happiness Snapshot - Smart e-services portal for universities - smart city academy



Blockchain technology
Dubai Pulse (data)
Smart grids, personal devices, Wi-Fi

Source: own elaboration based on Khan *et al.*, 2017, p. 19.

Annex B: Synthesis of the smart measures and projects in Dubai

Smart keys	Projects and measures	Results
Smart environment	Live information related to weather conditions	-
	Solar energy smart grids	Reduction of energy and water demand by 30% in 2030
	250'000 smart grids	
	Integrated energy strategy	
	App related to the daily consumption of energy	
	Increase of electric and hybrid cars	Government cars to be at least 10% electric and have a global 10% of all cars to be electric by 2030
	Robot police officer	Gain in efficiency
Smart living	Dubai Data Establishment	Dubai digital wealth will worth $6 billion in 2020. The IoT will worth $4.79 in 2020. The data will add $2.83 billion to the GDP in 2021. Blockchain applications will add $1.5 billion to the GDP by 2020.
	Electronic medical records	Reduces the time for procedures (waiting time, paper work, interaction of services) by 50%
	Hospital Info System	-
	Telemedicine	Reduction of waiting time at hospitals
	Fibaro Home Automation System	-
	Cota/Sunflower chargers	-
	Shopper Smart Living event	-
	Dubai digital certificates	Increased safety and security
	Dubai Crowd initiative	Better management of big crowds during events
	Smart cities global network	Increased prestige abroad
	Dubai police app	Saving of time as enquiries and reports can be done through the app (no need to go to a police station)
Smart mobility	Smart parking	These are some of the 173 services available on the smartphone that are parts of the Roads and Transport Authority of Dubai
	Smart taxi service	
	Smart toll system (Smart Salik)	
	Smart trip planner (Wojhati)	
	Air taxi (Volocopter)	-
	Use of drones for delivery	-
	Hyperloop	Link Dubai and Abu Dhabi in 12 minutes (140 kilometers) in 2020
	Airport smart tunnel	Whole entry procedure in Dubai to last 15 minutes (no human intervention)
	Smart public transport	Share of public transportation to become 20% of all traffic
	Smart mall concept	-
	Electric autonomous cars	Speed of 10 km/h. satisfaction rate of users of 94%

	Dubai Autonomous Transport Strategy	25% of all transportation in Dubai to be autonomous by 2030, 12% to be reached in 2020. The final goals are to cut the costs of transportation by 44% ($245 million of savings), decrease of the pollution by 12% by 2030. 12% reduction of traffic accident losses ($544 million saved)
	Bike lanes	Creation of 900 kilometers of bike lanes
	Electric cars	Bring 270'000 electric car on the road by 2030 with the help of incentives such as free charging, free parking and free registrations
Smart people	Happiness Meter Index	Over 1 million interactions reported in 2016 among 31 different government entities
	National Programme for Happiness	-
	Happiness Snapshot	-
	Smart e-services portal for universities	Provides a tablet with 4G internet access to every student
	Smart city academy	-
Smart governance	Paperless government	Last paper transaction to take place in 2021 in the government, it translates into 130'000 trees saved per year.
	emCash cryptocurrency	-
	Smart devices and phones	-
	RASHID	The city virtual assistant includes the services of 27 entities and offers 59 services to the 750'000 customers that have downloaded the app
	DubaiPay	Retail payment app that supports 40 public and private entities. It collected $35 million in 2017.
Smart economy	Internet of everything	-
	Arabnet digital Summit	-
	B2B online portal Tejuri	-
	IBM Watson AI engine	-
	DED Analytics	-
	Global Star Rating System	-
	Nahaan	-
	e-Permit/e-Ticketing	-

Source: own elaboration from Al Bastaki, 2017; Albawaba Business, 2018; Al Qamzi, 2018; Basit, 2015; Bin Bishr; Cities Today Staff, 2018; Cohen, 2018; Dassani *et al.*, 2015; Dubai Corporation of Tourism & Commerce Marketing, 2019; Dubai Future Foundation, 2019; Eid, 2015; GDN Online Desk, 2016; Gulf News Staff Report, 2017; Khaleej Times, 2018; Khan, 2018; Khan *et al.*, 2017; Logistics Middle East Staff, 2019; McMurray, 2018; Sadaqat, 2017; Smart Dubai Government Est, 2019; Sutton, 2016; The First Group, 2019; The Government Summit, 2015; Telecom Review Staff, 2017; United Arab Emirates, 2019; Utilities Middle East Staff, 2018; Volkwyn, 2017; YesGulf, 2016.