

# **Assessment of Smart Cities: The Case of Dubai**

**Bardya Maleki**

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Prof. Dr. Ali Hakan Ulusoy  
Director

I certify that this thesis satisfies the requirement as a thesis of the Master of Science in Urban Design.

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Prof. Dr. Resmiye Alpar Atun  
Chair, Department of Architecture

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as thesis for the degree of Master of Science in Urban Design

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Asst. Prof. Dr. Müge Rıza  
Supervisor

---

Examining Committee

1. Assoc. Prof. Dr. Buket Asilsoy

---

2. Asst. Prof. Dr. Pınar Uluçay Righelato

---

3. Asst. Prof. Dr. Müge Rıza

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## ABSTRACT

The concept of smart city dates back to 1980's and can be followed from the work of Hall (1988), Rayman (1988) and Lipman et.al (1986). Smart city can be explained as the city that combines technology offered by web and ICT to promote the socialization of individuals and aims to make their lives more efficient. There is no exact definition for smart city because it is constantly evolving in time. Many authors and scholars discuss the concept of smart city and its dimensions which are mentioned in depth in following chapters. Yet, each author possesses a different perspective about dimensions of smart city.

In the world we live in now, there are many smart cities such as New York, Barcelona, and Amsterdam of which the main target is to create cities that are more sufficient to serve citizens. Each city's approach to smartness is different yet they gather around a common goal: creating a more efficient and reliable environment for better living.

Based on the literature review in chapter 2, the case of Dubai is evaluated as an example of smart city. Dubai is a highly populated city which is famous worldwide due to its technological advancements. Dubai applies smart city approaches and methodologies which are the main focus of this thesis. These approaches are critically reviewed in order to state whether the application of smart city concept in Dubai has been successful or not. Based on the results of the evaluation, the city of Dubai can be considered as a successful smart city example.

**Keywords:** Smart city concept, Smart Dubai, Sustainability, Urban development

## ÖZ

Akıllı şehir kavramı 1980'lere dayanır ve Hall (1988), Rayman (1988) ve Lipman ve arkadaşlarının (1986) çalışmalarından takip edilebilir. Akıllı şehir, bireylerin sosyalleşmesini teşvik etmek ve hayatlarını daha verimli hale getirmeyi amaçlayan web ve BİT tarafından sunulan teknolojiyi birleştiren bir şehir olarak açıklanabilir. Akıllı şehir için kesin bir tanım yoktur, çünkü zaman içinde sürekli gelişmektedir. Birçok yazar ve akademisyen akıllı şehir kavramını ve ilerleyen bölümlerde derinlemesine belirtilen boyutlarını tartışmaktadır. Yine de her yazar akıllı kentin boyutları hakkında farklı bir bakış açısına sahiptir.

Şu anda yaşadığımız dünyada New York, Barselona ve Amsterdam gibi ana hedefleri daha mutlu insanlar yapan şehirler yaratmak olan birçok akıllı şehir var. Her şehrin akıllılığa yaklaşımı farklıdır, ancak ortak bir hedef etrafında toplanırlar: daha iyi yaşam için daha verimli ve güvenilir bir ortam yaratmak.

Bölüm 2'deki literatür taramasına dayanarak, Dubai örneği akıllı şehir örneği olarak değerlendirilmiştir. Dubai, teknolojik gelişmeleri nedeniyle dünyaca ünlü, oldukça kalabalık bir şehirdir. Dubai bu tezin ana odak noktası olan akıllı şehir yaklaşımlarını ve metodolojilerini uyguluyor. Bu yaklaşımlar, akıllı şehir konseptinin Dubai'de uygulanmasının başarılı olup olmadığını belirtmek için eleştirel olarak gözden geçirilmektedir. Değerlendirme sonuçlarına dayanarak, Dubai şehri başarılı bir akıllı şehir örneği olarak düşünülebilir.

**Anahtar Kelimeler:** Akıllı şehir, Akıllı Dubai, Sürdürülebilirlik, Kentsel gelişmeler

# **DEDICATION**

To my family

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## **LIST OF ABBREVIATIONS**

ACE	Accelerated Protection and Efficiency Program
AMR	Large-Scale Automatic Meter
BMT	Barcelona Metropolitan Transportation
CAGR	Compound Annual Growth Rate
DEWA	Dubai Electricity and Water Authority
GBC	Green Building Council
IBM	International Business Machines
ICT	Information and Communication Sciences
IOT	Internet of Things
ITS	Intelligent Transport System
ITU	International Telecommunication Union
JICS	Japan International Corporation System
KPI	Key Performance Indicators
LEED	Leadership in Energy and Environmental Design
LLC	Limited Liability Company
NOTI	NYC Office of Technology and Innovation
ODC	Open Data Committee
OECD	Organization for Economic Co-operation and Development
PPP	Public-Private Partnerships
RTA	Road Transportation Authority
UNDESA	The United Nations Department of Economic and Social Affairs
UNITAR	United Nation Institute for Training and Research
URENIO	Urban and Rational Innovation Research

WANA      West Asian and North Africa

# Chapter 1

## INTRODUCTION

Even though the smart city concept developed in late 1980's, the idea has gained increasing attention over the years as a city branding strategy, sitting to the current agenda of many cities around the world. The smart city concept covers a wide range of settings for smart living and new technology authorships to create more sustainable cities and support the urban economy using ICT. In short the smart city concept focuses mainly on the well- being of the citizens by using and optimizing current technological tools. It uses ICT and several other tools related to the Internet of Things (IOT) network to optimize the performance of municipal functions and services and to connect with citizens. Smart municipality technology allows city officials to connect immediately with the community and monitor urban infrastructure such as streets, tunnels etc. for safety reasons (Hall, 2000). In addition, it helps them to have well organized performance and interaction of utilities, minimize costs and increase communication between residents and the local institutions. The functions of smart cities are designed according to urban flows and provide real-time responsiveness. Therefore, a smart metropolis may be more ready to meet challenges than a simple "transactional" relationship with its citizens (Venkat R. P., 2017). However, the term itself is unclear about its specifications and is therefore open to many interpretations (Mclaren, 2015).

While several literature is available relating to smart cities in Europe, United States and Asia, there is a lack of smart city development research in Middle Eastern countries. The focus of this research is on the smart city of Dubai, United Arab Emirates, located in the Middle East where trends, approaches and applications of smart city concept will be explored in depth to arrive at some conclusions for Middle Eastern countries.

The city of Dubai is currently developing a strategy to become the world-leading smart city by 2021. In order to achieve this aim the government is undertaking investment in smart city technologies and infrastructural changes. Many of these changes have a direct impact on the urban environment and its users. The idea of Smart Dubai is an integrated strategy grounded on three main issues: integration, communication and collaboration between government and all other stakeholders. The main focus is on technology driven Dubai while enhancement of economy and through more productivity, collaboration with administration and well-being of its citizens are the main goals. Dubai Smart 2021 is presently the city's guide for Dubai's future (Khan, 2017).

The smart city concept originally came from USA and European countries as the first smart cities. The reason of choosing Dubai is, Dubai is known as a first Arabic smart city. In before around 15 years ago Dubai is known as normal Muslim city with too many deserts but from 1999 until current time, government by investing huge amount of money changes the city to a one of the smartest cities in the world.



As E.Mouir in 2014 says smart city is concept of future cities. There is other branches as eco city, digital city, creative city etc. as well. The main focus of thesis is about smart city.

## **1.1 Research Questions, Aims and Objectives**

1. What is a smart city? Why do we need a smart city?
2. What are the attributes of a successful smart city?
3. What are the impacts of smart strategies on the urban environment and its users?
4. What are the smart city strategies for Dubai?
5. How does the smart city concept of Dubai contribute to the improvement of urban environment?

This thesis is focusing on smart city strategies, its implications and impacts on the urban environment with a focus on successful smart city applications. The main aim is to understand how smart city application creates successful urban environments and how these applications are evaluated to draw conclusions. The aim is to point out positive attributes of a city and dimensions that should be improved or added to turn into a more successful smart city. In this thesis, the city of Dubai in United Arab Emirates will be used as a case study to understand what dimensions of smart city has been taken into account to create a successful example. The smart city strategy and its applications in Dubai are going to be evaluated according to a guideline developed from the literature review. As a result, it would be possible to evaluate the strategy of Dubai and its achievements compared to other smart cities. The results and findings of this thesis could be beneficial for municipalities and other researchers who wish to focus on the assessment of smart cities and wish to contribute to their developments.

## **1.2 Research Methodology**

This thesis is grounded on qualitative research method. Qualitative method involves literature review including books, articles and internet research on smart cities. The literature covers especially definitions, development, purpose and dimensions of smart cities. Moreover, existing examples from several cities and best practices gathered through literature study will be compared and analyzed. As a result, a guideline for smart city strategies will be developed. A literature review on existing strategies for the city of Dubai will be examined and considered in the case study. In addition, this method is used in the form of physical observations of Dubai city to follow the impacts of smart attributes to the city. Finally, the gathered outcomes will be used in the assessment of the city of Dubai as smart city.

## **1.3 Limitations**

The thesis is limited to the development of city of Dubai due to the extensive literature available on this example. Main concern of the thesis is how various dimensions of smart city concept impact on the city of Dubai, and whether these dimensions are successful or not. This thesis will focus on living environment, mobility and human dimensions in Dubai. As the concept of smart city emerges in late 1980s and most of the data collected is from the years between 1990 and 2019 the data collected for this thesis involves the decade in between 1990 and 2019.

## **1.4 Research structure**

The thesis main argument is about the case study as a city of Dubai is successful smart city or not. According to details and dimensions that founded, Dubai supports all the dimensions by the evidences and life of people in the city.

By the successful examples as smart city and their main dimensions, when we use this dimensions for Dubai we can see that this idea are supported by the government to make the city more livable and improve life for their citizens.

In the first chapter it discussed about introduction of thesis that gives information about history of smart city. Also it talks about limitations methodology and gives research questions about thesis.

The second chapter gives information about concept of smart city. What is the meaning of smart city and what are the aims of smart city? Also it discussed about strategies of smart city that gives details how we have to analyses the problems and reduce them. Next it gives information about impacts of smart city. In which part and how it will impact. Also in this chapter it will review on some successful smart city examples.

Why this city known as successful smart city and what are the impacts. In third chapter it will mainly focus on case study as Dubai city. The overall view and history of Dubai that what are the properties of city and what are the city attractions. Also it focuses on movements on city as general from when this idea in Dubai comes etc. and evaluation of dimensions in Dubai as are the successful or not. And final chapter is about what we understand from this thesis as conclusion.

## **Chapter 2**

# **THEORETICAL FRAME WORK: AN OVERVIEW OF SMART CITY**

According to Agymen (2015) in smart city urban areas different types of electronic internal data is used to manage resources, assets efficiently.

Smart Metropolis is an urban neighborhood that uses a wide variation of statistical sensors to provide sufficient statistics to manage resources. This involve facts collected from people and the means used to control transportation systems and visitors, water networks, waste management, the facts system, schools, universities, hospitals, and more (McLaren, 2015).

The Smart City utilizes the most present day sciences to convey administrations to individuals on to their expectations and concerns. Smart City is a free and cooperative city based on the utilization of science to make life increasingly important for people. Smart City is the acknowledgment given to the city for utilizing data and imparting innovation for improving the presentation and avoidance of urban plan recommendations, for example, transportation, science, vitality, and basic data costs. The principle objective of Smart City is to advance first level lodging for residents. Keen city is a change of urban regions and urban areas by means of the update of innovation to give novel and intelligent colossal town benefits; it is a digitalization of neighborhood zone which is utilized to lightening

trademark and exercises that taking region inside substantial space of city (Romualdo, 2013).

## **2.1 Definitions of smart city**

There is no comprehensive definition for smart city until now as with the improvements in technology definitions are varying and broadening.

As Harrison (2010) said smart city is the city that by using sensors, personal devices etc. data's will collect and analyze for allowing communication through city services. Intelligent coverage the complex analysis, optimization and modeling for making better decisions.

According to Ballas (2013) in field of urban design smart city is the city that governance and public policies by using technological instruments and programs they will try to make cities more sustainable and smarter and improve the better quality life for people.

Wahsburn et al (2010) says smart city is the city that by applying ICT to the services and critical infrastructure, the city can improve and it can increase quality of life. Alawadhi in 2012 explains smart city as the city that have combination of ICT and modern technology and infrastructure with the city and urban to make them more smart and have more quality around the city.

As Perez. B (2016) says smart city is the city that connected ICT to IOT network for delivering city services to people and increase their quality of life.

As Guan in 2012 says smart city is the city that by the changes in economic growth and social trends with technological improvements the quality of life and happiness for people will increase.

In Table 2.1 there are other definitions that explain more about smart city.

Table 2.1: Smart city definitions

Definition	Author
Smart City is used for connection between people and city elements by technology for increasing quality and sustainability.	Bakıcı 2012
Smart city is the city that that provides a happy community by thaw challenges that economic and social trends will bring	Guan 2012
Smart city uses all available Technologies for developing urban centers that more habitable and sustainable	Barrionuevo 2012
A city that connected physical, IT and social infrastructure to make intelligence inside the city	Harrison 2010
Smart city explains as the city that people by learning and innovation and creativity in built-in and digital	Komminos 2011

<p>infrastructure they can improve their quality of life.</p>	
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As general smart city is the city that connected people and city with high technology and smart movements that makes life for people more comfortable and faster and also reduce hazards in city and increase security and privacy.

## **2.2 Smart city concept**

According to E.Moir (2014) as a general there is many branches for FUTURE CITIES. Smart city is one of the branches of future city. Smart city can use geographical spaces to manage resources like human, infrastructure, buildings etc. (A. huerta,2013).

As E.Moir in 2005 says there is other branches for future city as Digital city that is different than smart city. This concept is one of the most useful concepts in 90s. it's used with the connection between growing information, communication and large amount of information. There are other concepts for future city in table below but our main concern is smart city.

Table 2.2: Concepts of future city (taken from E. moir,2014)

<b>Concepts</b>	<b>Trends</b>
Smart city	Fluctuating interest
Digital city	Stable, after decreasing interest
Eco city	Stable
Livable city	Rarely used
Green city	Stable

Smart city concept is the way to improve the life for the individuals in enormous urban communities for the length of the 80s and 90s. This development drove the individuals to towns from enormous urban areas for living, working and examining (Caragliua, 2011).

In 2005, the pioneer of US Bill Clinton, through his foundation, moved Cisco to improve imaginative skill to make the town progressively supportable. For the remainder of the result, he spent like 25 Million Dollars in 5 years on programming called associated urban headway. In this period, he tackled adventures for pilots with the urban regions like San Francisco, Seoul and Amsterdam to check the advancement. After that in 2010, he promoted the organization and thing to make in this item through its correspondence division. In 2008, IBM started to manage a practically identical vision to make an increasingly splendid planet action; IBM begins to focus on an explanatory estimation to appreciate information's and substances to accumulate on consistently premise (Smart cities readiness guide, 2015).



According to Boyd.C (2015), he explained 3 different generations of smart city as:

- Smart city 1: Innovation driven Vision of Smart Cities Guided by Technology Companies to Create Efficiency, Innovation of cities.
- Smart city 2: use of technological solutions for quality of life by government.
- Smart city 3: vision of using of people from smart cities to improve the life quality.

### **2.3 Smart city dimensions**

Keeling and Dirks (2009) according to importance of smart city they find dimensions of smart city as: energy, transportation, healthcare, education, food, water, safety and physical infrastructure.

Komninos in 2012 says for the smart city the first dimension is about digital infrastructure and technology ca created knowledge based city. The second dimension is how to transform life and work by technological information. Third one is embedding city infrastructure by ICT and last one is combining ICT and people to develop and improve the city.

Griffinger in 2007 found and identified four smart city components as: education, industry, technical infrastructure and participation. But this component expanded in six main dimension by center of regional science of Vienna university as: smart living, mobility, economy, environment, governance and people.

As Nam and Pardo in 2011 says the main dimensions of smart is people and technology. People can be more creative and gives many ideas for improving and also they can use for policies and governance issues. People must combine all this aspects with technology to making cities smarter and increases the quality of life for

people. According to many authors and scholars there are many dimensions of smart cities. Table 2.3 shows some of them.

Table 2.3: Dimensions of smart city

Dimensions	Source
1.life quality 2. development of sustainable economy 3.similarities of environmental goals and social 4. natural resource management	Thuzar 2011
1.Education of information technology 2. information technology of infrastructure 3. life quality 4. economy of information technology	Eger 2009
1.Management and organization 2. governance 3. technology 4.infrastrucue for built 5. community and people	Chourabi 2012
1.Economy as strength of sector 2. humans as talent and authorship 3. social as religion, habits and family 4.organization as election, engagement of civic	Barrionuevo 2012

1.Man power task of force skills	Nijkamp 2012
2. fundament capital as facility of communication	
3.capital of social as network linkage	
4. capital of financial as business activates	

All these dimensions are important as they reflect the views of various authors.

Griffinger (2007), summarizes the main dimensions of a smart city as follows:

Table 2.4: Main dimensions of smart city (adapted from Griffinger, 2007)

Dimensions	Main use of dimension
Smart People	Mostly used in education
Smart living	Mostly used in quality and security
Smart mobility	Mostly used in fundament and logistic
Smart governance	Mostly used in democracy
Smart environment	Mostly used in adaptability and sustainability
Smart economy	Mostly used in industry

Each of these dimensions is explained by different scholars as:

1. Smart economy: urban regions need to have high proficiency by methods for data and have a fixable market. Two Economies are more likely than not been depicted with the guide of the use of dynamic options two and adaptions to exchange occasions (Stawasz, 2012).

According to Niaros (2016) process of smart economy focuses on specific aims to achieve opportunities caused by independent choice for a way of life learned by the economic dimension. A smart city economy as Cohen (2016) says is a process used for improvement in business and economy for urban life participation. It is the process for receiving information to adding in city developments.

2. Smart mobility: by ICT, urban regions become a colossal arrangement of talks between all sources. Propelled talk and regular transportation should be established on developments that normal to use the present establishment (Stawasz, 2012).

As Geotab (2018) says smart mobility is a new innovation for reducing emissions and accidents to zero. Smart mobility innovates new ways of transportation to decrease the amount of traffic and pollution in cities.

According to the planning tank (2018), smart mobility is the major key to a smart city that will create broadloom development for making more flexible and sustainable with zero emissions for transportation.

3. Smart environment: smart city, the usage of boundless force sources and different gadgets, upgrade essentialness sources, endeavors to control the releases as demonstrated by insurance plans of supportable improvement (Stawasz, 2012).

In 2005, Das says that a smart environment is like a world that all other smart devices try and work to make life easier and more comfortable for people. As Weiser (1991) says, the smart environment is a movement to make everything digital and computers in a big range embedded in all objects in the physical world.

4. Smart people: thinking about the system, all of the changes in the city must be balanced by ideal particular help for essentialness use and diminish the air tainting to improve the first class of life (Stawasz, 2012).

As Nam.T (2011) talks about smart people, it is a starting key for making a smart city. Human fundament is the key access for developing cities. People by increasing their knowledge, creativity and learning will develop cities to make more efficient and flexible. According to Harish.k (2017), people must be more creative and open-minded to make cities more flexible and useful and also have to participate more in public life to see the environment and be more creative. Creativity is the key element of a smart environment.

5. Smart living: precise and welcoming surroundings in unequivocal parts like commitment colossal access to open organizations, guarding space and fresh thought (Stawasz, 2012).

According to Laurent.p et al (2014) smart living gives a chance to the people to have the opportunity for using new ways in their living life. This way includes the main solutions for being more economical, more controlling and sustainable. The smart living allows people to understand more about combining feeling with physical actions, analyses of social behavior and data's, engineering and technology (Andreas,2004).

6. Smart governance: improvement in this area needs a fit organization system. This improvement requires the joint effort of near to authorities and the use of most present day applied sciences in urban zones (Stawasz, 2012).

As Dewi.M et al in 2018 explains smart governance as by using technology it increases the planning support and decision making. It is used to make a better democratic process to give better services to the people. It can include mobile networking and electronic government. Smart governance used to make a better decision for people's living. This dimension participates in better decision making by using electronic government and ICT public services are delivered to people.

By these ideas and definitions best explanations for these dimensions are summarized in the table below:

Table 2.5: Definition of dimensions for smart city

Dimension	Definition
Smart economy	This process is used for improving the economy by producing more jobs, factors of production and accessing to technology
Smart mobility	This dimension mostly used for making more comfortable and zero-emission transportation and bring the accidents of cars to zero
Smart environment	This dimension attempts to make everything digital in the city and makes everything move with technology to create a better life.
Smart people	The most important characteristic of smart cities is known as smart people by using their creativity and learning from public life they can make a more comfortable and flexible life
Smart living	People by using new ways in their life will make improvements and better situations for their own
Smart governance	By using mobile networking and e-government they will increase their support for their plans for future and

	better decision making. In this way, they can give better services to people
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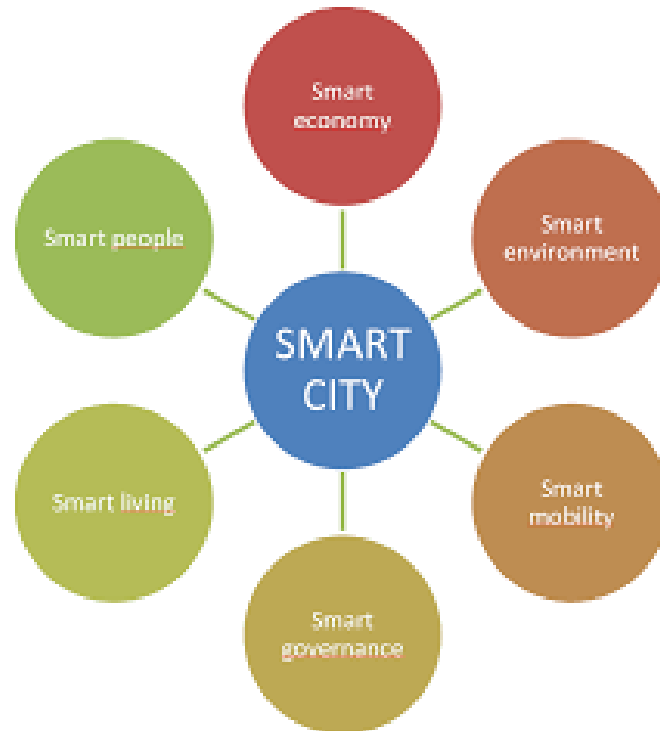


Figure 2.1: Dimensions of Smart City (Smart cities dimension, 2015)

## 2.4 Aims of smart city

- Better and easier life, improving lifestyle and communicate more. In this way by combining technology and people the problems will solve faster and data's will measure more accurate.
- Better use of resources by the public. By using technology and digital mechanism as computers governance can measure the annual use of natural resources for saving them more for future.
- Administration of public and reducing the cost. As an example for public transformation the people will pay less in compare with taxi. And also they can



understand how they have to use public resources to pay less and use more (Zanella, Andrea, 2014).

According to Adam.R (2018):

- Better and more accurate decision making. By using technology and digital improvements people and governance can have decided more accurate and more useful decisions for future.
- The security will increase for communities by using technology as an example we can mention electronic locks for doors instead of normal keys for increasing security.
- Better and more technological transportation for people by using digital improvements to make the transportation more on time and reducing traffics.

Some examples that show how smart city dimensions will work in different situations:

1. The health of structural building: In smart urban territories, governments will use a couple of sensors for changing when the creating shape has an issue. For instance, when the structure has a couple of breaks in the façade it will be advised to fix as fast as time grants.

2. Waste management: it will protect the city from being disorganized and smell horrendous for instance embedding sensors on rubbish holders for when they wound up being full it will alarm and waste cars can come and assemble them.

3. Air pollution: utilizing little debasement sensor, they will quantify the carbon dioxide degree to alert and attempt to oblige the CO2 for having solid ways of life.

4. Noise monitoring: technique for the utilization of this sensor on the lights, it will quantify the complaints around as indicated by the zones for make progressions to shield it from turmoil air corrupting what is more, in the long run, they will utilize it around the produced townhouses to assess the upheavals and gatekeeper the structures by strategies for proper home windows.

5. Smart lighting: it will utilize sensors on the lights for sparing quality as per the sunshine. Right, when night turns out they will routinely begin to work (Zanella, Andrea, 2014).

The speedy town will give each pay and non-advantage associations. Without remuneration benefits, the shrewd city ends up being non-drawing in and close to non-advantage benefits the city and it ends up extremely homogeneous. Modernized urban locales exclusively manage non-open affiliations, which make a bit of leeway (Solitary correspondence, 1998).

The shrewd city will watch an opportunity to everyone who needs to get passage to the Internet. Urban sorting out ends up with inspiration and trust in the astute city (W. J. Mitchell. 1996).

## 2.5 Strategies of smart city

Also, according to Nareej Dassani (2015), there are four main principals for smart cities:

- Obtaining data

The ground level digital devices are liable for gathering information and, tries to find a solution for problems. For example, sensors in the streets are collecting data about traffics or accidents to give it to people and smart mechanism in houses will control the use of electric consumption in houses. Later mechanical headways and the diminishing expense of gadgets have made it possible to introduce a huge number of gadgets in urban areas. These digital structures the essential spine of a digital city.

- Communicate

Information that taken from smart mechanism and framework needs to be imparted among controlling and serving focuses. Wiling urban communities need a correspondence layer that encourages this association and interfaces different gadgets while guaranteeing interoperability, respectability, versatility and security. An incorporated correspondences methodology must include correspondence foundation suppliers, specialist co-ops, IT sellers and city governments.

- Analysis

When information is gathered halfway, the digital city needs to understand it to frame noteworthy bits of knowledge. This "information crunching" normally requires calculations and PCs that are fit for handling information and changing it into insight. For instance, information from traffic sensors could demonstrate blockage in specific regions, and elective courses could be recommended.

- Act

The last advance is to utilize this examination to decide or on the other hand impact conduct. For instance, data of patient that taken from a database of electronic that taken by medical clinics must utilize to create key human services foundation choices dependent on inhabitants' interest for restorative administrations.

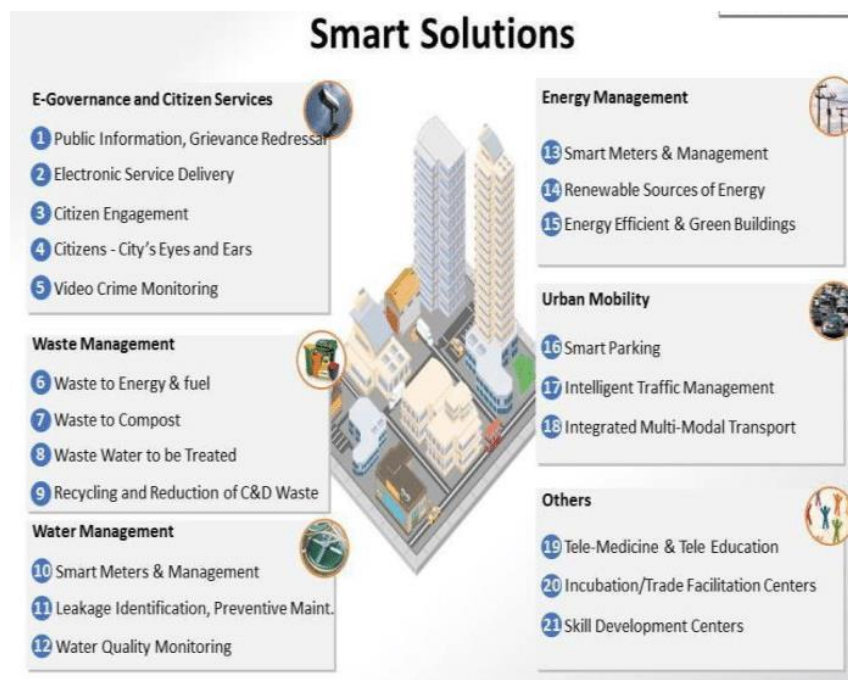


Figure 2.2: Smart Solutions of Smart City (Ahmed, 2019)

## 2.6 Impacts of smart city

In pushing for smarter cities, metropolitan governments can introduce environments that ecosystem innovators - including government, businesses, social entrepreneurs and individuals - can grow. Governments help build platforms, hire a partner ecosystem, retain results-driven partners, leverage new investment, open services to select and control campaigns and crowdfunding. This requires them to assemble an ecosystem of affiliates across the government, establish businesses, start-ups, academia and the nonprofit. Because they unite an ecosystem of numerous

stakeholders, smart cities need a real government. City leaders, regional governments, transportation districts, corporate and nonprofit partners, relying on budget models, monarchies and federal agencies can all contribute to the creation and implementation of a smart metropolitan landscape. Stakeholders need to be able to express their commitments and ensure those glittering statistics flow to the right decision-makers. Creating accountability on the front and creating mechanisms to drive timely choices are also essential. Financing is a major obstacle to many metropolitan smart initiatives. Many progressive projects use the land for lack of funds due to land reclamation. However, cities can counteract this investment through creative processes to fund smart city tasks that are left out of the usual infrastructure financing models. Public-private partnerships (PPPs) play a key role in financing and financing metropolises. However, the success of the model depends on how risk and reward are distributed between public and private entities. Some of the new procedures that are in progress can offer a way forward (Skoworn, 2018).

## **2.7 Summary**

This chapter gives detailed information about both smart cities and creative city. How the creative city becomes important and by which persons developed? Also how this idea raises and become important. Also, the general discussion about smart cities as part of the creative city is discussed. How smart city idea becomes important. What are the strategies etc. this chapter also discussed solutions for problems and how we can apply them? In the next chapter we will look at three successful smart cities and find out the impacts of movements in the cities. Until now there is no exact definition for smart city because each day it's developed.

## 2.8 Successful Smart City Examples in The World

### 2.8.1 Amsterdam, Netherlands



Figure 2.3: Amsterdam, Netherlands

- **Amsterdam smart city**

The Amsterdam Smart Initiative, launched in 2009, currently has more than 170 projects jointly run through neighborhood, government and business. These initiatives can be utilized in wireless interconnected platforms via wireless tools to use the designated authority at the time. The City of Amsterdam (City) can claim to be the target of doing so for mapping, power supply as well as public safety. To enhance its statewide efforts, the city annually satisfies the challenge of the smart city of Amsterdam and wishes for suggestions on accessibility and text pages with Baccobian City. An example of a training program with a MobyPark resident that can be shared with the owners of the hotel parking lot (Jung-Hoon, 2012).

Proposed decisions better than this program can be used by the city to provide the proposed city and make it available to you in different locations. Using smart meters, using smart meters has become possible and you can provide it as your service provider. Other initiatives can be lit. The cooling road (smart lighting) that we can let you light up is a workaround and provides intelligent management that you can do at different times of the day. Through the Supreme Leader, as well as the timing of the Contemporary Tour on specific roads, licensing is permitted so you can control the boundaries of international services using boundaries (Amsterdam smart city, 2015).

- **Planning of smart city of Amsterdam**

Different assignments must be done at some phase of the arranging stage. Most importantly, Amsterdam's savvy city approach is successfully ensured inside the key structure of the city and lined up with its mediation needs, with an unrivaled reference to the propensity to strife nearby climate trade by suitably lessening outflows. Carbon oxide. This system speaks to the aftereffect of the intermingling of a few procedures proposed in the nearby and European positions to address the issues referenced in the underlying catalyst (Annen, 2011).

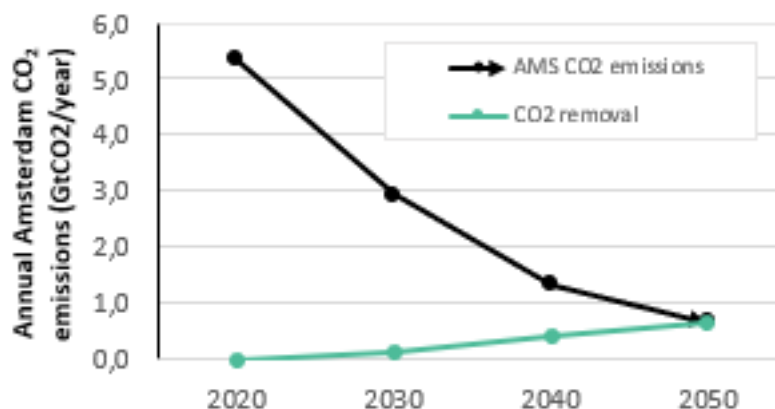


Figure 2.4: Reducing CO2 Prediction, Amsterdam

Another basic entertainment which has been completed over the span of the arranging section is the meaning of another association ready to ensure the ideal usage of undertakings, which is portrayed as an "open stage that joins [public and two privates] parties two and two acts freely " (Annen, 2011).

- **Smart city projects of Amsterdam**

- ❖ Technology and infrastructure
- ❖ Water and waste
- ❖ Mobility
- ❖ Circular city
- ❖ Education and governance
- ❖ Living and citizens

- **Ecosystem solutions of the smart city of Amsterdam**

An open and participatory mindset, coupled with the government's favorable policies, has facilitated an entrepreneurial spirit that has involved many local stakeholders and the backyard of the city. Such extensive partnerships and robust aids to provide the baseline networks to assist progressive ideas and projects, ultimately leading to the formation of the entire smart city solutions ecosystem, making it important for the bee to define the smart city. It is a smart city (B. Gorynski, 2017).



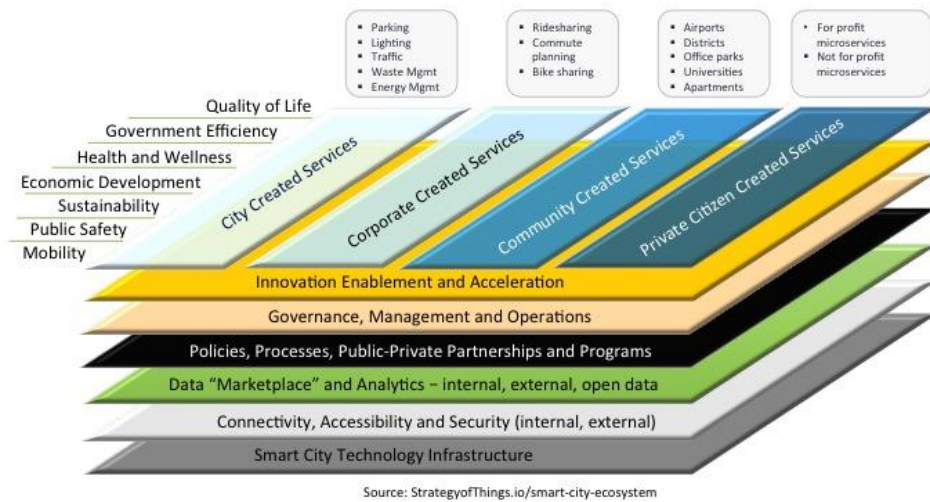


Figure 2.5: Framework of Ecosystem Smart City (smart city ecosystem, 2018)

- **Buur app**

Buur's handheld smart app acts as a lower-level platform for collaboration and encourages a stronger sense of community by connecting with neighbors and creating them to play an energetic role in their neighborhood's security and sustainability. It offers an exchange point where citizens can ask people who live directly around them to do their homework on a daily basis to find out what works best for them.



Figure 2.6: Buur App

- **Initiative mobility**

Thirty percent of metropolitan site visitors - one-third of all city drivers at any given time - are essentially dedicated to searching for a parking lot. Helping people find the need for faster noise reduction, congestion, gas consumption and pollution levels in the city, as well as reducing driver pressures. It can also increase parking revenue while reducing the need for manual parking control costs. With this account, smart visitor management is the goal of Smart Flow, an IoT cloud-based platform that manages video display sensors across Amsterdam and can record traffic flows and parking facilities. The experimental assignment of this smart parking platform resulted in a reduction in the average time required to discover a 43% parking lot. In addition, it focuses on parking costs and helps drivers make smarter choices by revealing the cheapest settings in a particular area (smith, 2017).



Figure 2.7: Smart Mobility (Iamsterdam, 2017)

- **Circular city initiatives**

A circular financial system tries to avoid anything. Resources are reused over and over, and instead of being replaced, they are restored and rebuilt by converting them to new products. This concept derives the most cost-effective cost from all sources and results in large discounts at both ends of the normal economic cycle, i.e. lowering the rate of supply of materials and output waste. Besides, it is also possible to become a circular financial system for large-scale job creation. However, to achieve this kind of economy, it is necessary to redesign products and services. So the first step to becoming an economic system is to explore opportunities and influence. The Circle City of City of Amsterdam scanner did the same thing: it showed most areas in every respect, showing significant progress towards a remote system. This work explored efficient drivers for this transition as well as the results of substantial improvements in city structure and processes. This study identified, in one of the largest ways in the world, more than one waste stream that exists to replace distant models. Also, it proposes well-developed strategies for achieving this goal along with a practical roadmap for their implementation and identifies potential obstacles to success (Jung-Hoon, 2012).

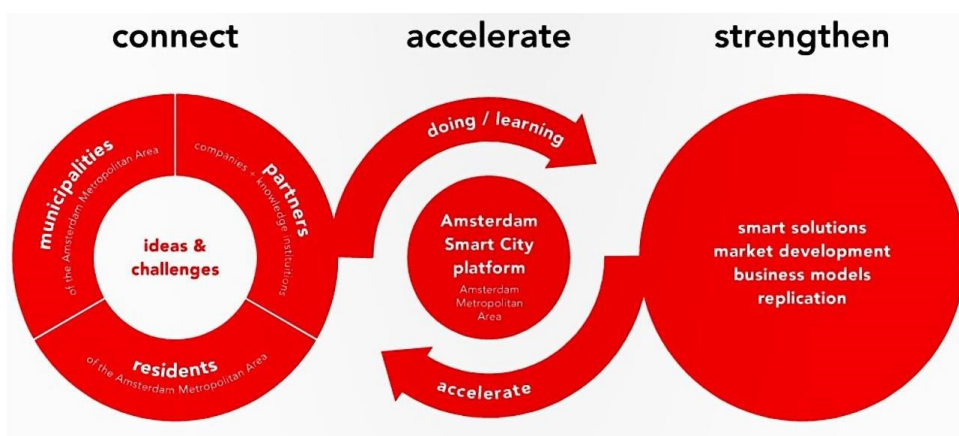


Figure 2.8: Smart City Strategy in Amsterdam(URENIO,2014)

## 2.8.2 New York, USA



Figure 2.9: New York, USA

NOTI are putting forth steady attempts to change New York into a brilliant city. These measures plan to spare assets, for example, vitality and water while diminishing natural effect on NYC and can best serve its populace. Urban savvy structures are tending to issues, for example, road lighting productivity, water exemption and insurance, squander the board and air quality (Tobias, 2008).

- **Smart lighting**

Lighting enhancements show a critical probability of New York City structures. Fluorescent lights and radiant lights are normal, and the lights are difficult to control - most lighting structures in enormous structures are physically controlled. The NYC government knows about the potential for vitality preservation by refreshing lighting installations, and in 2013 they executed the Accelerated Protection and Efficiency Program (ACE). Up until this point, the product has raised more than \$ 350 million in subsidizing, in excess of 650 structures possessed by 16 metropolitan

organizations. Huge numbers of these undertakings are retrofitting LED lights and sparing more than \$ 800,000 at regular intervals while halting in excess of 900 tons of ozone depleting substance discharges (Tobias, 2008).



Figure 2.10: Smart City Lighting in NYC, 2008

It is a significant word that controls refresh and their related controls may likewise be qualified for a money discount from the Con Edison Incentive Program. Land owners can connect with a lighting apparatus manual for ensure their overhauls utilize qualified lights and lights (Tobias, 2008).

- **Smart water metering**

New York City, have populace around 8.5 million, utilizes 1 billion gallons of water day by day. The NYC Department of Environmental Protection is utilizing a huge scale programmed meter (AMR) to get a depiction of water utilization, while giving clients a valuable apparatus to take a gander at consistently they pour water. AMRs have been tuned to in excess of 800,000 properties, furnished with low-power radio gadgets that talk through rooftop mounted beneficiaries. With this framework, DEP

can charge its clients all the more precisely - 17% of bills because of limits of past measurements with assessed charging insights decreased to under 3%. The savvy metering framework likewise stops the advantages of clients: little clients are educated about water utilization 4 days every day, while enormous clients can remain on hourly information. AMR devices are additionally synchronized with cell phone programming that cautions the client to perceivable breaks when recognizing irregular water utilization spots. The Leak Notification programming has effectively spared over \$ 73 million (Tobias, 2008).



Figure 2.11: Smart Water Metering Mechanism

- **Smart waste management**

The NYC Health Branch is the biggest on the planet gathering in excess of 10,000 squanders a day. Gathering junk from a great many refuse receptacles and reusing canisters can be a strategic issue: Waste holders flood whenever left unattended, however, squander expulsion is a normal misuse of gas and work (Tobias, 2008).

Large Belly is a savvy refuse container situated all through NYC and offers noteworthy advantages contrasted with standard garbage:

- Built with a Wi-Fi sensor, it screens waste levels, taking into consideration increasingly effective pickup trips.
- It incorporates a waste blower that works with photovoltaic power and permits the trashcan to store five extra waste examples than the customary one.

These shrewd waste administration frameworks diminish squander assortment recurrence as well as enable them to design all the more effectively. Enormous Belly improves squander assortment productivity by half to 80% and furthermore diminishes contamination by decreasing the measure of time spent out and about (Tobias, 2008).



Figure 2.12: Big Belly Trashcans

- **Quality of air monitoring**

The New York health department has been leading outstanding climate checking since 2008. Checking is finished with 75 impermanent observing stations set up for about fourteen days and eight perpetual air screens setting the realities inside 15 minutes. Because this program, it was discovered that minimal effort warming oil, which is utilized in just 1 percent of NYC structures, has caused the most air contamination in the entirety of the city's vehicles. Checking is a continuous delegate

between keen metropolitan frameworks, and this is because just a single dynamic machine can be seen shrewdly - fixing issues sooner than expected for the most part brings about lower costs than fixing the results. Checking impacts can likewise be imparted to vitality and water shoppers with the goal that they can deal with their day by day utilization, as an option in contrast to getting month to month charges as it were. Despite designing, urban communities can't just preserve vitality, yet they additionally increment air and water agreeableness while limiting water utilization (Tobias, 2008).

### 2.8.3 Barcelona, Spain



Figure 2.13: Barcelona, Spain

Also, Barcelona like many other cities in the world tries to be a smart city and make life easier for people and reduce pollution and emissions. The successful projects that makes Barcelona a smart city is:



- **Space for parking**

Barcelona has implemented a sensor system for drivers that alert them when parking space becomes available. Sensors mounted beneath the asphalt can detect accessible parking areas and alert drivers. The program reduces emissions and congestion by directing drivers to parking spaces. Within a year of its implementation, 4,000 approvals were issued per day for parking. Besides, there is a charge for paying parking rates online and make reservation for them (S. Ravindra, 2018).

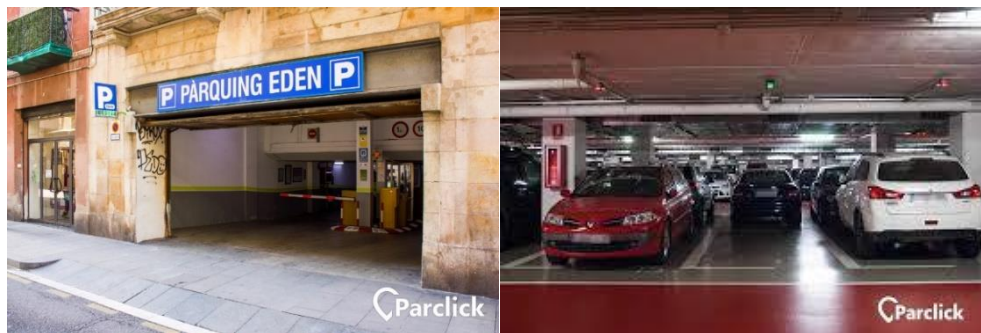


Figure 2.14: Online Park Reservation

- **Street lights and electronic car charge station**

The LED-based lighting system, along with a sensor community, has changed streetlights throughout Barcelona. These lighting fixtures are more efficient and reduce the heat generated by historic lamps and thus primarily to save the city's financial savings. This solution has correctly addressed the problem of using street lighting in a completely unsafe way for the environment. The device uses sensors to receive ambient data (pollution, humidity, temperature, people's presence, and noise) with the help of sensors (S. Ravindra, 2018).

A central unit on the road allows for speeches on the lights, and it also manages numerous home supplies such as electric car charging stations, Wi-Fi and fiber optic

cabling. Sensors can change lights depending on the presence of people and the delay time. Enabling management at the lighting stage provides you with a surprising advantage that can drive people to precise locations in the city (S. Ravindra, 2018)



Figure 2.15: Electronic Car Charging System



Figure 2.16: LED Lights That Decreases the Cost by 1/3 (M. Chino, 2010)

- **Bike System in city**

Barcelona's metropolitan bike system says as a cyclist in view. However, this is only for Barcelona hours. The bicycle is the most important part of Barcelona's public transport system. Cycling is a design and you can set it up, a bike that you can remember from the metropolis of Barcelona. This is a public transport service

intended for bicycle travel that you can buy time. More than 120,000 subscribers in this bike-sharing program sign up for a comment. This initiative will help the use of travel engines in the city. Cycling is close to car parking, parking and subway stations (S. Ravindra, 2018).



Figure 2.17: Bike Station, Barcelona

- **Bus system for transportation**

The Barcelona Metropolitan Transportation (TMB), a Barcelona transport vehicle, has built a new orthodontic bus community of oblique, vertical and horizontal lanes and makes its other features less frequent, more complex and faster to use. to be used. The transit car intends on 95 percent of its trips that the tourist must make one of two switches in the city. The bus transit system also has sustainable mobility in the city and reduces greenhouse gas emissions with the help of hybrid buses. In addition, the shelter has smart buses that use photo voltage panels and wait time displays (Ravindra, 2018).



Figure 2.18: Hybrid Bus Transportation, Barcelona

- **Waste Disposal**

Citizens of Barcelona are saving their smart garbage in smart funds with the help of the smart waste disposal system. These smart buckets use the vacuum and suck waste in underground storage. This reduces the smell of prepared waste and the noise pollution caused by secret vehicles. It also allows the city to better understand the amount of waste from specific locations and optimize the waste stream, which reduces both the resources and time required for the service. Waste incineration is later used to generate power for heating systems (Ravindra, 2018).



Figure 2.19: Smart Trash Bins.

## **2.9 Summary**

All the movements in this cities shows that dimensions of smart city in this cities are successful. After analyzing impacts of movements in these cities, now we will start to analyses the Dubai smart city as case study of this thesis. This chapter shows different usage of uses for smart city. It shows how cities by using technology can improve their cities according to their needs.

## Chapter 3

### THE CASE OF SMART DUBAI

#### 3.1 A Historical Overview of Dubai

- **Culture**

According to Kaur.M (2016) culture in Dubai comes from Islamic traditions. Dubai is one of the tourist cities in UAE. During a year too many tourists will visit Dubai and the people must be respectful to their culture because the minority group of Emirates is so protective of their culture.

Dubai is known as the city of attraction in the Middle East which makes many peoples comes and visit this city from all around the world.



Figure 3.1: The Culture in Dubai (Dubai city guide)

Also, in general, the clothing in the country is affected by the Islamic codes. Many men in Dubai and Arabic countries like to wear their traditional dress which is a long dress with the color of white as the name of Dishdusha with a white hat with a black ribbon. In Dubai ladies also wear a black veil most of the time that closes all over the face except eyes. This wearing is to protect their hijab from people in open spaces.



Figure 3.2: Khandura that Arab People's Wears (Travel Media, 2013)

- **Religion**

The most important night in Dubai backs to the month of Ramadan that continues for a month. During this month people will wake up morning before sunshine to eat and after Azan, they will stop eating or drinking until sunrise. People must know that they cannot drink, eat or smoke in open areas or streets during the daytime if the people and tourists want to eat or drink or smoke that should do it in their homes and in privacy not in public. For examples bar and clubs are not open before 7 pm and they will not serve any drink until that time. This rule is also forced by foreign people and tourists. For example, it does not matter if they are Muslim or Christian, if you are in UAE during Ramadan you should follow the rules in the country otherwise there are religious penalties that you will pay.

According to Dubai city guide in Dubai, we must many mosques because of religion that sounds every moment during a day. Mosques are places for pry and praise.



Figure 3.3: Explaining Amazing to Foreign People (viator)

Dubai is a liberal place in the Middle East and except Judaism other religions are allowed and visitors and tourists must respect to the laws and religion there.

Islam is the official religion of the U.A.E. also, is necessary to the nearby culture. The Arabic word "Islam" signifies "accommodation to God," and the center of the confidence is the conviction that there is just a single God (Allah) who ought to be adored. What's more, in a line of prophets who included Adam, Abraham, Noah, Moses, John the Baptist, David, and Jesus, Mohammed was the last and generally authoritative. Muslims accept that Christianity, Judaism, and Islam are all basically the equivalent, however, that the messages from the previous prophets have been contorted and that Mohammed was picked by God to resuscitate, refine, and sanitize His message (Frammers, 2008).



- **Dubai attractions**
  - **Borj Khalifa**



Figure 3.4: Borj Khalifa (getyourguide)

Development of the Burj Khalifa started in 2004, with the outside finished five years after the fact in 2009. The essential structure is fortified cement. The structure was opened in 2010 as a component of another advancement called Downtown Dubai. It is intended to be the focal point of huge scale, blended use advancement. The choice to develop the structure depends on the administration's choice to differentiate from an oil-based economy, and for Dubai to increase worldwide acknowledgment. The structure was initially named Burj Dubai however was renamed to pay tribute to the leader of Abu Dhabi and leader of the United Arab Emirates, Khalifa container Zayed Al Nahyan Abu Dhabi and the UAE government loaned Dubai cash to pay its obligations. The structure broke various tallness records, remembering its assignment as the tallest structure for the world (Wikipedia,2006).

- **Dubai fountains**



Figure 3.5: Dubai Fountains (getyourguide)

According to Acuto.M (2016), the Dubai Fountain was formally opened in May 2009. Sufficiently bright by 6,600 amazing lights, the Dubai Fountain can shoot water up to 500 feet, which is as high as a 50-story building. It can shower 22,000 gallons of water noticeable all-around at any minute. It can make various examples and mixes noticeably all around, which is exceptionally valued by the onlookers.

The high-pressure water shooters introduced inside the wellspring make the water move. The super shooters can shoot under progressively tension up to 240 ft. noticeable all around, and extraordinary shooters can shoot compelled to 500 ft. noticeable all around. The outrageous shooters are not utilized frequently during appears, as it sets aside a great deal of effort to develop enough strain to shoot water at that tallness noticeable all around.

- **Borj Al Arab**



Figure 3.6: Borj Al arab (getyourguide)

The Burj al Arab (interpretation: Arabian Tower), is a lavish lodging that stands on a counterfeit island about 300 m from the Jumeirah Beach in Dubai, UAE. Remaining at 320 m, it is the third tallest inn on the planet and one of the costliest, costing an expected 7.9bn dollars.

Dubai had delighted in financial success during the 1990s because of oil incomes, however, authorities chose declining stores would require a move in the economy thus they moved into extravagance the travel industry and land advancement. In 1994, the Sheik leader of Dubai dispatched the British consultancy Atkins to plan a structure that would get synonymous with Dubai and the United Arab Emirates.

Despite its stature, 38% is comprised of non-occupy table space, and the structure has confronted analysis in view of its gaudy degrees of plushness and a favoring of style overcapacity. Despite this in any case, since authoritatively opening in

December 1999, the Burj al Arab has prevailed in its point of turning into a notable image of Dubai (Smith, 2019).

- **Palm Islands**



Figure 3.7: Palm Islands (getyourguide)

According to Steiner.C (2010) there are three islands that makeup Palm Islands Dubai including Palm Jumeirah, Palm Deira Ali and Palm Jebel, anyway the main island open to guests is the Palm Jumeirah. Home to the mainstream vacation destination and popular lavish inn Burj Al Arab, Palm Jumeirah additionally includes private property, some of which are home to any semblance of VIPs including David Beckham, just as business attractions, for example, Crescent, The Trunk and 16 Fronds.

All up, Dubai's Palm Islands are home to 5,000 waterfront apartments, 4,000 residential villas, 1,000 water homes, and 60 luxury hotels as well as many marinas, health spas, shopping malls, restaurants, cinemas, sports facilities and dive sites.

However, despite their name and shape, there are no actual palm trees insight on the islands although, as the world's largest manmade archipelago, they are visible from space (Robert, 2004).

- **Dubai museum**



Figure 3.8: Dubai Museum (getyourguide)

Dubai Museum is set inside the Al Fahidi Fort which was home to an amazing ruler up until 1896. It was a spot utilized for protection as well as filled in as a jail, battalion and weapons warehouse. The Fort was a fortification of the government that controlled these terrains in those days. The late Sheik Rashid receptacle Saeed Al Maktoum revamped the Al Fahidi Fort during his reign in 1971 to fill in as a notable gallery always saving the antiquated Arab history (Steiner.C 2010).

A visit to the museum reveals different phases of life in Dubai, before and after the oil boom. The exhibits in the Dubai Museum elaborate on how the city progressed over the years based on a deeply rooted civilization. The museum houses original antiques such as pottery, weapons and tombs. You also get to explore different wings

reflecting the atmosphere of the markets and traditional homes from the past (Yuliana, 2019).

▪ **Dubai mall**

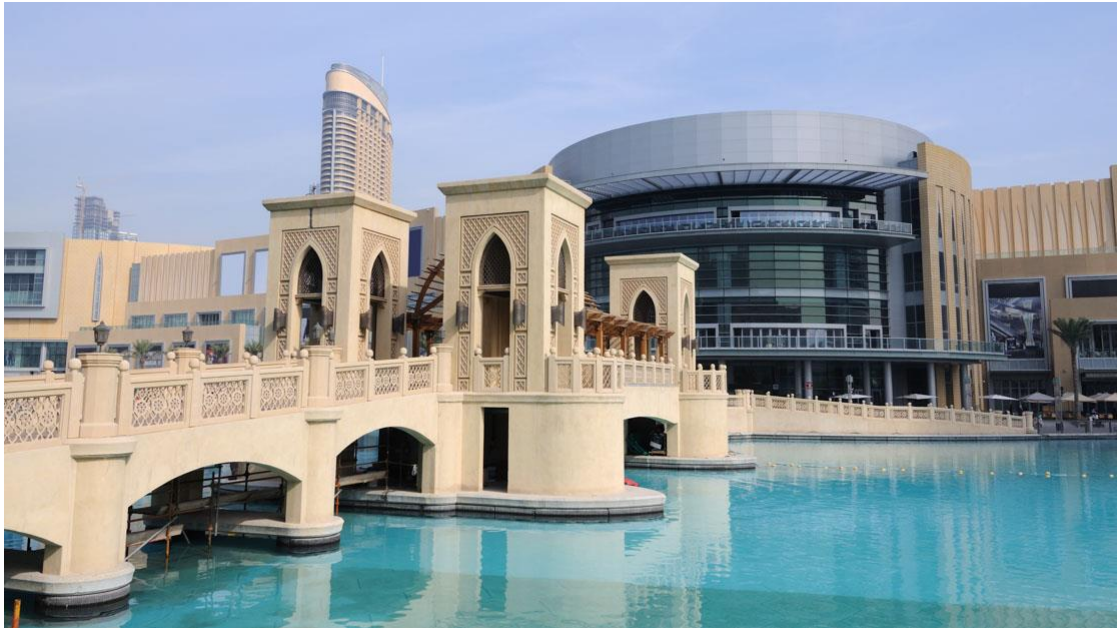


Figure 3.9: Dubai Mall

- ✓ According to Saxena (2011) The biggest mall in the world. It is almost equal to 50 football pitch.
- ✓ Its include 1200 stores without pop-ups.
- ✓ Inside the shopping center, its ground level is home to the Dubai Aquarium, which houses the world's biggest acrylic board. The board is 108 feet wide, 27 feet high and 29.5 inches thick and weighs 541,486 pounds. The acrylic board made it to the Guinness Book of World Records. The aquarium is additionally the world's biggest indoor aquarium.
- ✓ There are many water fountains. water jets are nearly to 500 feet.

- ✓ It has a small park inside the mall that you can experiences all Sega games in one house.
- ✓ Also, it has an ice skating rink in the second floor in Dubai mail.



Figure 3.10: Ice Skating Dubai Mall (trip advisor)

▪ **Dubai marina**



Figure 3.11: Dubai Marina

The Dubai Marina is really an artificial idea at the Jebel Ali end of Dubai on the Arabian Gulf, at any rate, 20 kilometers from the Dubai Mall region. Aside from the shops and shopping centers in the Marina zone, the closest significant shopping

centers would be Ibn Battuta one way and Mall of the Emirates in the other. In any case, individuals who decide to live in the Dubai Marina don't settle on the decision based on its proximity to shopping centers. It is all for the most part the water and water see (Walsh, 2019).

Dubai Marina is not a long way from Palm Jumeirah and like the Palm, required cautious designing to guarantee the water streamed and remained new. The plan was the idea of a Canadian organization for Emaar Properties. Immense earthworks delved profound channels into the sand to bring the ocean water inland, along the coast for separation of around seven kilometers and pull out to the ocean once more. For quite a while, the creation of these channels was the key element of the building site. At that point, practically medium-term, the manner in which a great deal of things occurs in Dubai, there were transcending structures covering the shimmering blue water. In spite of the fact that there are many finished towers and different structures in the Dubai Marina, there are still a lot of chances to purchase existing lofts and new ones too (Walsh, 2019).

### **3.2 Smart city movement in Dubai**

The smart city movement of Dubai officially starts in 2014. Verifiably, the city had executed other significant tasks legitimately or in a roundabout way identified with the "keen" idea before the dispatch of Smart Dubai. In 1999, the ICT Strategy of Dubai was started, quickly following which the e-government motivation was propelled in 2000. Table 1 shows the significant achievements of Dubai Smart City (Dubai statistics center,2014).



Table 3.1: Events of smart Dubai (Dubai statistics center,2014)

Year	Event
1999	The strategy of ICT happens
2000	The initiative of Dubai e-government announced
2009	Department of e-government opened
2013	Formation of the smart city- higher committee of smart Dubai formed
2014	Committee of open data was founded
2015	Data law and office of smart Dubai opened

While Dubai started to increase universal acknowledgment as one of the significant urban communities of the MENA locale, significant framework that incorporates vacation spots and offices, for example, Burj Khalifa and the Dubai Metro, were effectively propelled, which thus altogether upgraded Dubai's profile as a shrewd city and a brilliant the travel industry goal. Simultaneously, by uprightness of UAE's relentless interest in IT framework, out of an all-out populace of 9.58 million out of 2015, 8.81 million became dynamic Internet clients (91.8%), the second most noteworthy proportion after Canada (93%). Among these Internet clients, 7.27 million are versatile Internet clients (75.9%). Prominently, 5.4 million dynamic social records exist, out of which 4.6 million (85.2%) are portable records. As indicated by the World Economic Forum report, UAE positioned first in the territory of "Significance of ICT to Government Vision" and the second in "Government Success in ICT Promotion". Every one of these realities, incorporating the achievements distinguished in Table 1, mirror that Dubai has started and effectively actualized savvy extends in the course of recent years. That being stated, it is

fundamental to dig into a portion of the basic components, which are itemized in the accompanying subsections (Dubai Statistics Center, 2014).

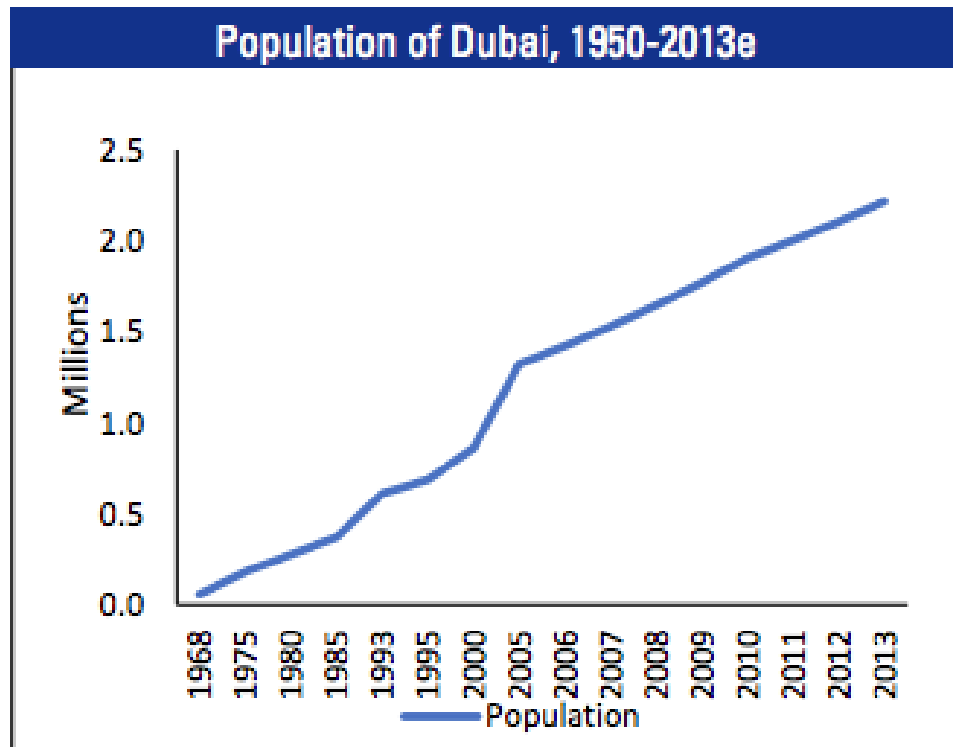


Figure 3.12: Population of Dubai (Dubai statistics center, 2013)

### 3.3 Dimensions of Smart Dubai

There are many bases for smart Dubai now this part has some information about this basis.



Figure 3.13: Key Bases of the Smart City. (KPMG analysis – 2015)

- **Telecom**

- **Wi-Fi access and broadband:**

As Neeraj Dassani (2015) said, Digital urban communities require omnipresent broadband availability through a rapid fiber optic spine and high data transmission Wi-Fi systems. These systems encourage purchaser web use, just as one machine to another machine and one machine to human interchanges (too all in all known as the “web of things”) that shrewd urban communities rely upon. As per Cisco, and evaluated 50 billion gadgets will be associated with the web all-inclusive by 2020, requiring a quick and dependable organize foundation.

### ▪ Smart Telecom in Dubai

According to Akamai's situation of the report given by the web, the speed of the web in Dubai is 4.3 Mbps and ranked as 48<sup>th</sup> in the world. Approximately 3.1% of Dubai's web associations speed record is more than 4 megabits in each second and nearly 0.7% of it is more than 15 Mbps. The telecom supplier in UAE that known as DU in 2014, reported that, a major aspect in Dubai's shrewd city activities, that makes nearly 5,000 hotspots that makes free WIFI internet in 100 areas in Dubai and Abu Dhabi. Du vowed to free offer, boundless, quick access to applications of government; low-transmission capacity free internet; paid premium, the transmission of high capacity of Wi-Fi (Neeraj.D,2015).



Figure 3.14: DU Dubai Main Telecom Supplier (2018)

- **Transportation**

- **Smart Transportation in Dubai**

As indicated by (RTA), the quantity of Dubai vehicles almost multiplied from 740,000 at the end of 2006 and 1.4 million at the end of 2014. The 8.2% increase is one of the most elevated on the planet. RTA needs to concentrate on shrewd transportation answers for manage the expanded interest on transportation of Dubai framework. The RTA is one of the precursors in adding to the Dubai shrewd city procedure. It has taken various activities to create smart transportation frameworks and shrewd government portable applications planned for improving the vehicle organize and benefits and conveying a really coordinated experiences of transportation for its clients. RTA perceived that incorporating Dubai's different vehicle modes is basic in giving a consistent experience of transportation to the clients (Denyanesh, 2015).

According to Sherry Zameer (2018), Transportation, in its different structures, has the most critical effect on our everyday lives, influencing each division from coordination to nature. In Dubai, the Roads and Transport Authority (RTA) has just taken a shot at a multitude of activities that will change the eventual fate of transport. Today, the emirate has propelled transportation, with the driverless Dubai Metro, computerized Salik tolls and taxicabs with Wi-Fi. Driverless vehicle specifically is set to be basic in Dubai by 2020, and can open new open doors for the RTA, including traffic the board and customized administrations like shrewd leaving and electric vehicle charging stations.



Figure 3.15: Automated Transport Buses in Dubai (2018)

#### ▪ Smart parking in Dubai

Sensors of remote are applied in parking spaces and identify whether parking spots are involved. this information is extending to a focal framework the one that can send to phones of clients scanning for spaces of parking (Denyanesh, 2015).



Figure 3.16: Smart Parking in Dubai (2018)

- **Healthcare**

- **Healthcare in Dubai**

A developing populace and an interest for cutting edge social insurance offices will push Dubai to manufacture extra medicinal services framework and embrace keen human services activities. In 2013, Dubai propelled a keen social insurance venture with three primary activities - brilliant applications, shrewd tasks, and savvy emergency clinics. Dubai is additionally intending to execute Electronic Records and info of the hospital System by 2015. These will empower simple electronic access to records of patient, which involve every one of the subtleties important to know the wellbeing status of the patient and the consequences of any tests, X-beams and records of specialists' visits (Gopalakrishnan, 2015).

The framework additionally empowers specialists to send guidelines and restorative supplies to different areas of the emergency clinic, for example, research facilities and drug stores as the framework interconnect all medical clinic divisions and segments. This ought to dispense with paperwork, decrease tolerant holding up time and give an archive of exact patient information while cutting the time required for methodology considerably (Gopalakrishnan, 2015).

Open emergency clinics and centers give free or ease restorative administrations to UAE inhabitants. Expats needing to utilize open emergency clinics need to apply for a wellbeing card from the Department of Health and Medical Services. Current private emergency clinics and a tremendous medicinal focus the size of a little city, fittingly named Dubai Healthcare City, administration ex-pats and Emiratis the same. Dubai Healthcare City is an enormous complex of restorative structures and organizations and incorporates emergency clinics, centers, instructing and investigate

offices, drug stores and associations with global foundations, including Boston University and Harvard Medical School (Gopalakrishnan, 2015).



Figure 3.17: Dubai Healthcare System Authority



Figure 3.18: Mohammad Bin Rashid Academic Medical



### **3.3.4 Buildings**

- **Dubai's smart buildings**

Dubai's developed business and stock retail developed at 5.8% of CAGR and 2.8% of CAGR by territory in 2010.

Also, 2014, Private stock developed at 4.8% of CAGR somewhere in the range of 2010 and 2014. GBC positioned the UAE ninth all around as far as total rough square meters of room affirmed to LEED gauges, which guarantee structures dependent on cost productivity and vitality investment funds. In Dubai, a structure's vitality utilization is a critical network issue. Dubai in 2010, presented a lot of codes that advance the utilization of vitality sparing frameworks, regular lighting frameworks and green structure materials. Dubai's Integrated strategy of energy has an aspiring focus of decreasing vitality and water request by 30% by 2030. Lessening cooling prerequisites inside structures is a key center territory for the DEWA and Dubai Municipality. Dubai, with its quick growing property portfolio, should concentrate on savvy structures as a key switch in turning into a genuinely maintainable shrewd city (Gopalakrishnan, 2015).

For example, the honor winning 92-story private pinnacle, The Burj Mohammed bin Rashid, is 382 m high and is the tallest structure in Abu Dhabi. It offers 474 lofts and penthouses, with the absolute best ocean and city sees crosswise over Abu Dhabi. It was named "sixth Best new high rise in 2014" by Emporia and was the 2015 champ of the "Best Tall Building in the Middle East and Africa" by the Council on Tall Buildings and Urban Habitat. The workplace tower arrives at 59 stories with 72,000 m<sup>2</sup> of prime office space. One of a kind sky workplaces offer unmatched all-encompassing perspectives on the city. These are furnished with an inventive

ventilated exterior, particularly covered to reflect infrared-sun oriented radiation the littlest pinnacle, at 16 stories, houses the 4\* Courtyard by Marriott inn with 195 rooms.

The shopping center has 160 outlets spread more than 60,000 m<sup>2</sup> and is home to a choice of universal design brands, easygoing eating outlets, an 8-screen film and more than 5000 m<sup>2</sup> of patios and housetop gardens.

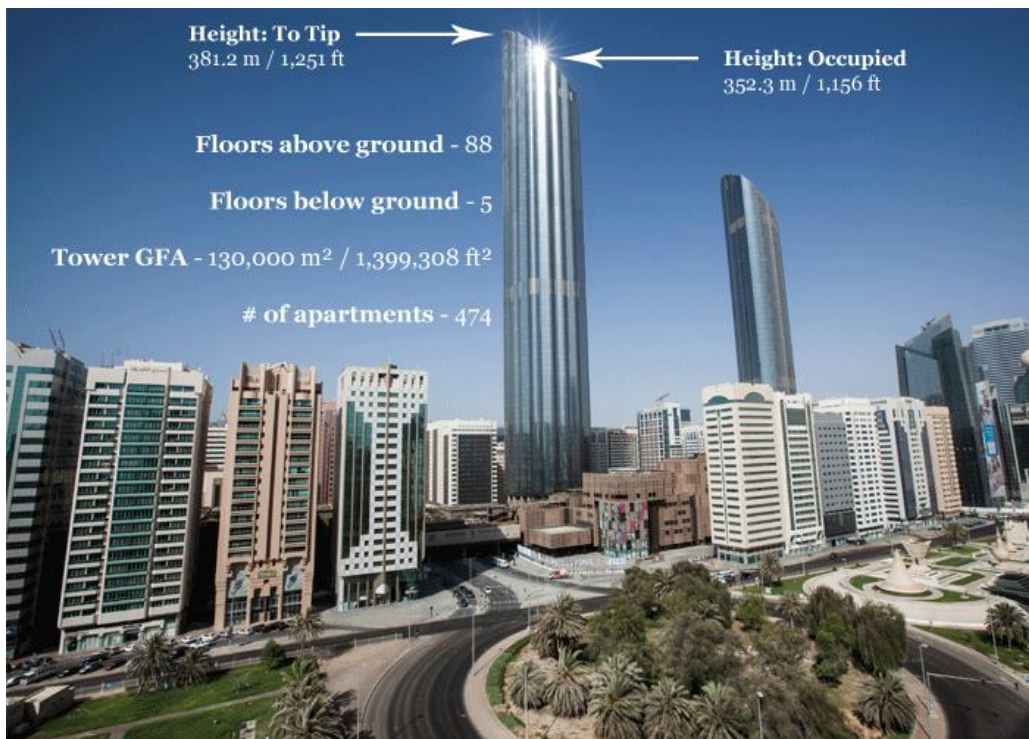


Figure 3.19: Burj Mohammed Bin Rashid



Figure 3.20: Burj Mohammed Bin Rashid

- **Utilities**

- **Smart Utilities in Dubai**

Dubai's pinnacle power utilization developed to 6,850 MW somewhere in the range of 2008 & 2013, speaking to 5.3% of CAGR. Pinnacle water utilization developed 296 million of gallons between 2009 & 2013, speaking to a 2.3% of CAGR. Dubai's developing populace will request more water and power in the approach Expo 2020. Plans of DEWA is to introduce 250,000 shrewd meters in all private, modern and business 2018 property as a component of Dubai's keen city activity. DEWA will send keen lattice to computerize matrix control choices and to convey new administrations to buyers, enabling them to mechanize and control their capacity utilization. DEWA plans to actualize answers for sun powered force in houses. It is additionally creating brilliant applications, building foundation and Stations of charge for electric vehicles. In October of 2014, it marked a IBM with MOU to work together on savvy framework advances, advancement focuses and innovative work projects and offer industry information and driving practices. DEWA could play a functioning and 'keen job' in vitality and water preservation and add to building up a practical city by advising individuals about their everyday vitality and water use utilizing portable applications, and prize shoppers who add to saving vitality and water (Neeraj.D,2015).

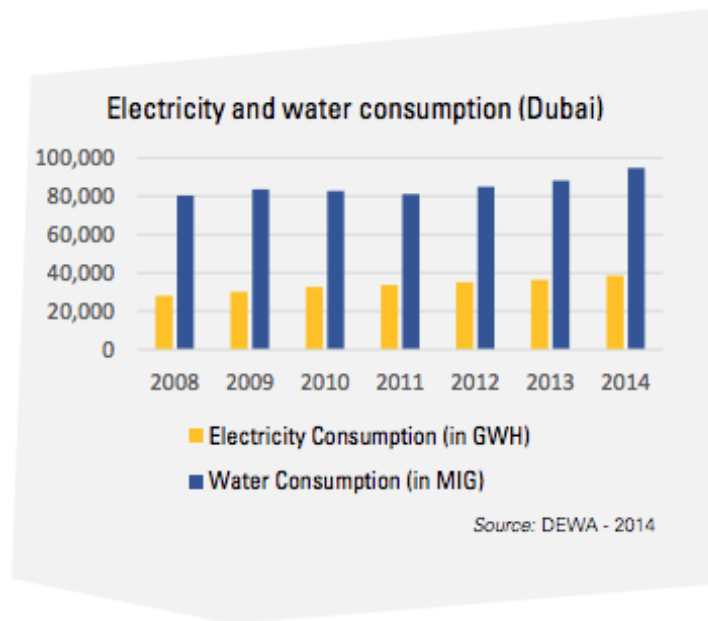


Figure 3.21: Electricity and Water Consumption (DEWA,2014)

- **Tourism**

- **Smart tourism**

According to Buhalis, (2014) Shrewd the travel industry and its rise are legitimately identified with the savvy city idea. Sustainability is at the core of the development of keen the travel industry and more goals are currently organizing it as a strategic objective in the travel industry arranging process. A more noteworthy accentuation is put on arranging and implementation of reasonable measures through keen arrangements including different substances including government, instructive organizations and other such partners that incorporate private-and public-division establishments. Such activities have affected framework improvement both from broader (across different parts) and smaller points of view, the last being specifically identified with the travel industry. This may be found on account of specific formative ventures enveloping shrewd air terminals, brilliant hotels and savvy transportation, which incorporates aviation routes, conduits and surface

transportation systems. Despite that, the development of keen urban communities universally has had an influence on the travel industry sector. A key fixing that makes goals savvy is the utilization of innovation. ICT has had any kind of effect in this respect which gives clients consistent arrangements and coordinated access with an attention on improving tourist encounters; expanding efficiency; improving procedure mechanization all of which are integral to manageable the travel industry goals.

- **Smart tourism in Dubai**

Smart tourism L.L.C is the company with comprehensive management to introduce many tours and travels related to UAE. This company will help to the families and persons who want to have a trip in UAE in cities like Dubai providing information about hotels that people want to stay on according to their budget and give info about car renting.



Figure 3.22: L.L.C in Dubai

- **Public Safety**

- **Smart public safety in Dubai**

Wrongdoing rates in the UAE have consistently been generally low, particularly when contrasting with worldwide midpoints. The UAE is known to be the most secure nation in the Middle East. One of the numerous activities propelled in Dubai incorporate the Dubai Police application. This application has been exceptionally effective and is one of the most mainstream government applications crosswise over Dubai. The application incorporates a bunch of basic Dubai Police online administrations which can be downloaded to a cell phone. These administrations incorporate clients getting to and paying their fines; applying for a decent direct testament; revealing criminal traffic offenses or wrongdoings to the police; giving a rundown of drug stores which are open; and traffic administrations (Neeraj Dassani,2015).

Dubai Police intends to dispatch its first smart robot official - Robocop - inside two years. The humanoid official will give all Dubai Police administrations the general population in six dialects, much like a human police officer. The robot will move around in open zones, for example, shopping centers, and will speak with, and give data to, people in general without human obstruction. It will likewise be connected to a non-crisis call focus (Neeraj Dassani,2015).

Dubai could execute a typical, brought together, associated interchanges stage that empowers different wellbeing and crisis administrations to share data and facilitate and work together on open security issues (Neeraj Dassani, 2015).



Figure 3.23: Robocop for Safety in Dubai (2017)



Figure 3.24: Robocop For Safety in Dubai (2017)

### **3.4 Assessment of Smart Dubai According to Developed Dimensions**

As mentioned in Chapter 2, there are six major dimensions that should be taken into account in the evaluation of smart cities based on the literature review.

- **Smart city dimensions for Dubai**

- **Smart economy in Dubai**

Development of economy in Dubai, on its part, has built up a technique to outfit the continuous advanced change in Dubai and further lift monetary development, profitability and worldwide intensity. Our journey for a brilliant Dubai economy implies utilizing advancements in data and correspondence advances so as to make an all-around focused economy and carefully change key monetary areas and pioneer new guidelines of financial improvement and commitment. It likewise implies handling activities to advance energetic business enterprise and development biological system and one that is powered by profitable R&D speculations, rising advances, open and shared information, and improving joint efforts to support licenses allowed in the emirate. At long last, such a change will make the empowering condition where propelled, the talented, creative and exceptionally beneficial workforce can flourish and fortify Dubai's situation as the most intelligent city of things to come. Improving related guidelines, giving effective open administrations and supporting them through hatcheries and quickening agents will reinforce Dubai's situation as an advancement center point. Dubai has accomplished uncommon financial development rates as a territorial center point. It has solid financial segments and is all-inclusive well-incorporated as an exchange, the travel industry and money focus (Sam al qamzi, 2018)



### ▪ **Smart people in Dubai**

Any smart city depends on three basic layers (establishments) whereupon its entire façade should be raised. The principal layer is innovation. There should be sufficient clients of cell phones to empower a fast association of sensors through which information can stream. In the wake of getting this crude, unstructured information, there ought to be a second layer of the correct kind of utilizations to make an interpretation of it into significant and implementable bits of knowledge and cautions. The third and last layer depends on the use of innovation by the organizations and general society. The achievement of any application relies upon a minimum amount of clients embracing it and therefore, changing their conduct. For instance, they ought to urge individuals to change from private to open vehicles, to lessen water and vitality use (Al marashi, 2019).

Government in Dubai from the primary school tries to show to the children how they can use technology and computer to improve their knowledge for creativity in future. In this way for further years they are more ready and satisfy to improve the quality in city.

### ▪ **Smart mobility**

#### ✓ **BRT (Bus Rapid Transit)**

A BRT bus mostly uses electricity to move so they have almost zero emissions. This special buses uses individual ways to move around the city for public transportation. They are much more accurate than other transportation systems to deliver people to the places that they want. They don't have any traffic in their ways. In this ways this type of public transportation improves the mobility in city (Singh, 2015).

✓ **Flying taxi**

Streets and Transport Authority (RTA) of Dubai is wanting to present Autonomous Air Taxi (AAT) or self-flying taxi before the finish of 2017. In September 2017, a two-seater AAT experienced an effective lady idea flight. Throughout the following five years, RTA will work together with General Civil Aviation Authority and Dubai Civil Aviation Authority to set up the operational necessities for actualizing the AAT administrations. Prerequisites incorporate creating laws and approach administering the confirmation of the airship and the AAT tasks, characterizing airborne courses and hallways, structuring and finding take-off and landing focuses, setting principles for authentic administrators of the AAT administrations, distinguishing the jobs and duties of partners and determining the security and wellbeing guidelines for the AAT (Singh,2015).

✓ **Seniar**

Seniar is the primary navigation system over the UAE. Occupants and voyagers can look through goals and different attractions by Makani number, Omani number, postal code or the name of the goal. The application furnishes drivers with simple to-follow, exact headings to their goals, chopping down movement time and separation. You can download the application from iTunes and Google Play. By this application you can find the wanted place more accurate and easier in Dubai (Singh,2015).

▪ **Smart Environment**

Diminishes contamination to guarantee reasonable improvement. Instances of natural measures incorporate a system of air quality checking stations, an arrangement of

duties to control water and force utilization, and progress to low-outflows vehicles (Singh, 2015).

- **Smart government**

While the United Arab Emirates has received an advancement vision dependent on a free-advertise economy and the advancement of the private division, it additionally perceives the Government's principal job in guaranteeing the prosperity, bliss and personal development of residents. The way that the nation grasps a free-advertise economy doesn't imply that the Government ought to swear off its obligation of giving fundamental administrations, for example, medicinal services, training and lodging.

To guarantee that these administrations are conveyed, the Government needs to change the manner in which it capacities. Else, it can't proficiently and successfully rival the private area. The Smart Government activity was propelled in 2013, by Sheik Mohammed container Rashid, Vice President and Ruler of Dubai. The essential point of this activity is to guarantee the satisfaction of all UAE residents. Sheik Mohammed depicts Smart Government as one that never rests (working 24 hours, 365 days per year), is as inviting as an inn, gives quick conveyance and solid methodology, is imaginative and versatile, serves the residents whenever and wherever inside and outside the nation, improves lives and reacts to desires (jamal al suwaidi,2017).

### 3.5 Evaluation of smart Dubai

Table 3.2: Assessments of dimensions in Dubai

Dimension	Assessment	Is it a successful movement?
Economy	Dubai by using talented people in business form all around the world will improve the economy. The economy in Dubai each day improves more to make Dubai the smartest in the world.	✓
Government	Government by putting more budget to making improvements in city tires to make the city smarter and by use people to work more and never rest like 7/24	✓
Environment	Make the people use cars that have fewer emissions like electronic cars to make the city weather clean and without	✓

	emissions and reducing pollutions from factories by using technologies	
Mobility	By using technologies reducing time for transportation or finding addresses by special apps especially for Dubai	✓
People	society and public uses the most modern technologies to solve their problems and reaching their aim faster	✓
Living	With all other dimensions when they become as successful, automatically the living for the public in Dubai become as smart	✓

Table 3.3: Strategies of the smart city in Dubai

<b>Strategy</b>	<b>Aim</b>
City of flexibility and livable city	<ul style="list-style-type: none"> <li>• performance of ICT enablement of foundation and assets to support proficiency, accessibility, and flexibility.</li> <li>• Upgrade the Emirate's strength through communitarian, associated arranging, mindfulness building, and limit advancement, encouraging status in individual, network, emirate level, and society.</li> </ul>
A comprehensively focused economy fueled by troublesome advancements	<ul style="list-style-type: none"> <li>• All-inclusive focused economy, utilizing ICT advancements as intends to carefully change key monetary areas and pioneer new standards of financial improvement and commitment.</li> <li>• Lively enterprise and advancement biological system filled by gainful R&amp;D speculations, rising advances, open and shared information, and improving joint efforts, expecting to support licenses conceded in the Emirate.</li> </ul>
Society of interconnected with accessible easy services of social	<ul style="list-style-type: none"> <li>• Reaching the lives of individuals in the Emirate—occupant or visitor, through digitizing and revamping access to and usage of organizations in the step by step living; making life more straightforward.</li> <li>• Encouraging comprehensive and viable</li> </ul>

	<p>support of city partners to connect with them in structuring city encounters.</p>
<p>The smooth vehicle driven via independent and shared arrangements of portability</p>	<ul style="list-style-type: none"> <li>• Lift the usage of open and shared transportation means to decrease time spent driving, helping tenants and visitors land at their objectives progressively secure, speedier, and increasingly happy.</li> <li>• Improve city versatility by bridling self-sufficient transportation advancements for expanded profitability, productivity and decreased traffic clog.</li> </ul>
<p>Clean condition empowered by the forefront of advancements of ICT</p>	<ul style="list-style-type: none"> <li>• Cautiously change utilities, gathering, transportation, and waste treatment divisions to reduce the Emirate's Carbon impression for a cleaner, progressively advantageous condition.</li> <li>• Impact ICT to ensure supportability and nature of the Emirate's benefits (water, air, imperativeness, and land) for occupants and visitors.</li> </ul>
<p>Computerized lean associated government</p>	<ul style="list-style-type: none"> <li>• Zero visits of government—gets rid of the need to head to and physically interface with the Government by giving 100% of qualified open organizations through cutting edge channels and concentrating on full electronic gathering.</li> <li>• Conveying improved encounters through interfacing open administrations that focus on occupants' and guests' basic needs and significant life occasions... sparing time and streamlining life.</li> </ul>

### **3.6 Summary**

This part of the thesis reviewed about the history of Dubai and their culture and religion and attractions of Dubai, after that we had some information about the bases of the smart city. After that, a table has been formed to summarize the existing literature based on the main concern of authors regarding smart city dimensions. Also, the assessments of these dimensions show whether these dimensions are successful in Dubai or not and the chapter concludes with the smart city objectives and strategies in Dubai. There is many benefits of smart city in Dubai that we mentioned before as using of special windows can arrange the temperature in houses. Medical system that have all the information of people for emergency etc. all this benefits are connected to technology. Without technology its not possible to do any of this. By the technology people can improve their knowledge to make better and smarter city for their people.



## Chapter 4

### CONCLUSION

The smart city is one of the key movements to makes cities more reliable and more flexible. This movement is used to collect the data electronically and process them for a better future. Digital innovations can give answers to urban communities by helping them save money and enhance the economy, lessen carbon dioxide emissions and create sustainable communities. A smart city can be a tool to help communities develop and apply strategies that fit their own vision of a smart city. A large portion of the discussion gets impeded on attempting to comprehend what 'savvy' signifies as opposed to concentrating on how it can assist urban areas with meeting their objectives. In addition, since the market for technological innovations are generating new ideas and implication areas, it needs new plans of action and methods for working which are yet to be created and actualized. Smart urban communities are as of now seen as key to accomplishing maintainable urban advancement objectives. Specifically, decreasing asset utilization, reusing assets, and recycling waste-all with the help of innovation are guaranteed to improve the satisfaction of citizens as well as governments.

In the case of Dubai, the government tries to improve the city in the direction of a smart city by applying smart assets. As we finalize evaluating the dimensions of a smart city that is applied in Dubai, we can see that Dubai is putting an effort to employ all of the dimensions of a smart city in specific smart people, living

environment, mobility, governance and economy. Regarding smart people, perhaps more bottom-up strategies are required to help create a more participative community in the decision making process. Creativity in learning and education may help to create a more participative society in the long term.

Each of this characteristic analyzed according to the situation of Dubai and with this successful factors in the city we can say that Dubai is one of the smartest cities in the world.

Of course there is too much problems and barriers for transforming normal city to smart city. We can mention the most important ones as budget and people because this transformation needs huge amount of money for using best modern technologies to improve the city. Also many people but mostly old people cannot update their selves with technology to use them. Therefore, these two factors can create a problem for governance regarding transformation.

Other types of problem like environment, political issues, religion etc. can affect this transformation. Some of these problems can be solved easily but some of them not.

In order to benefit people more, government must change teaching system by integrating technology into the education system in early years.

As we finalize we can understand that for making smart cities first the government must have enough budget and second update the people from when they are child to learn and creativity. Otherwise this concept will give a negative results and will be failed.

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