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Ky indicators of smart cities : a model study from china(shenzhen city)

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Abstract ;

This study aims to identify smart city indicators, and learn how big data, cloud computing, Internet of Things, and artificial intelligence, which are four variables that have caused major changes in the operational mechanisms of the entire city. This study examines the case of the most important smart city in China, Shenzhen,. The study found that the integration of the four variables represents the main pillars for the success of smart cities.

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1. *Introduction*

Urbanization, development of cities, Overpopulation, the development of economic growth, and the emergence of a series of technological developments. As a result, several problems and challenges local and global, particularly related to global warming, save resources, pollution, and crowding. Thy are one of the greatest that human beings have to solve in the 21st century is, on the other hand , With the progress of human society during the current century, innovation and development of networking, digitization, intelligence, information and automation have promoted the emergence of smart cities, wich reliable in the face of problems that hinder urban development. So, in order to solve the troubles of urban development and realize the sustainable development of cities, the construction of smart cities has become an irreversible trend in the development of cities in the world. Where, smart city touted an effective solution to make cities healthier, greener, safer and better places to live and work.

China is one of the countries that currently focus on smart cities, as it started with some pilot cities, just like other leading countries such as Germany, Britain, Denmark and others.The levels of progress and smart of the city differ from country to country and from state to state in same country sometimes.

The trend to build smart cities is a modern trend, and there is no unified and specific global agreement on defining smart cities, so there are numerous cities claiming to build smart cities and/or adopting some forms of smart city strategies and initiatives.

What are the characteristics that are unique to the criteria for smart cities ? And what are the indicators of the growth of smart cities?

2. LITERATURE REVIEW

- Study for Wenxuan Yu, and Chengwei Xu(2018).Titled developing smart cities in china: an empirical analysis. The study found that environmental pollution like air pollution in particular was a key driver for the development of the smart city, where, the relationship between smart city development and pollution, had a curvilinear relationship (bell-shaped), besides, smart cities initiatives in China were driven not only by technical rationalities but also by political rationalities.

- Study for Xiangyuan Xiong(2018). The principle goal of Smart Cities is to improve the management in cities and transform the urban area. In order to increase the quality of life. This study aimed to analyse the cost benefit oftren portation projects in smart cities.The study concludes that the smart transportation is not cost- efficient in Newark, and the net present

value is 65.5 and the benefit-cost ratio is 0.35 (it means the project costs outweigh the benefits in 30 years).

- study of Zurinah, T. Jalaluddin, A,M(2016).Titled : Main Criteria In The Development Of Smart Cities Determined Using Analytical Method. The stydy aimed to examine the requisites of a smart city, and to use the Analytic Hierarchy Process (AHP) methodology in assigning weightage to each element that is considered essential to its development. The study found that there are six complementary criteria (smart environment, smart mobility, smart living, smart people, smart economy and smart governance) that are the basis for smart city development, also, it found that the success of a smart city is the result of careful strategic planning in all important aspects of these criteria.

- Study for Richard Hu (2019). Titled The State of Smart Cities in China : The Case of Shenzhen. This study has tried to address the question of to what extent the smart cities in China conform to or differ from their international counterparts. This study has included an overview of the Chinese smart cities and a case study of Shenzhen a leader in the Chinese smart city. The analyse have revealed general accordance between the Chinese smart cities and analytical framework; they have also identified several explicit characteristics that mark the Chinese smart cities, and differentiate them from international smart cities. The use of smart technology in Shenzhen has seen tangible results of improvement in areas of public security, telemedicine and transport.

- Study of Guijun, L.Yongsheng, W. Jie, L. and Yulong, L (2018). Which dealt with the topic of Evaluation on Construction Level of Smart City: An Empirical Study from Twenty Chinese Cities. Based on the bibliometrics and Chinese experience with smart city construction, this study firstly suggested dividing the smart city system into four subsystems, that is, smart infrastructure, smart economy, smart governance and smart participation and to establish their corresponding indicator systems, after giving a weight to each indicator to assess the level of intelligence of the city.The study found that there are different levels of intelligence for 20 major cities in China.

- Dong, L . Ye, T . Vincent Y, L. and Yi Zhang (2015).Titled The Performance of the Smart Cities in China: A Comparative Study using or through Self-Organizing Maps and Social Networks Analysis. The study found that there is an improvement in the levels smart of the ten smart cities selected in China, compared to previous studies.

more smart cities in China have become similar to Beijing or Shanghai during 2005–2010. The reason behind this result can be attributed to Urban development policy is oriented from

top to down driven in China: once a pilot city is selected, other cities are supposed to follow the development pattern of the experimental cities.

2.1Concept of Smart City

The concept of smart cities initially is referred to initiatives that digital and ICT-based innovation to improve the efficiency of urban services and generate new economic opportunities in cities (OECD, 2020) .

Later, the concept became an overarching concept, and dependent more on intelligent methodology and proper implementation of solutions than on technology as an enabler .

Smart city, digital city, Intelligent City, city brain brain(an artificial intelligence system that uses big data and big computing power to improve and fix traffic problems), Ubiquitous City, Sustainable City, wireless city, Ecocites, Virtual Community and future city, the most largely terms that are used to refer to smart cities. while the most common term is “Smart city”.

lot of definitions of SC exist, but no one has been recognized universally yet.

Here are some common definitions:

- A city connecting the physical infrastructure, the IT infrastructure, the social infrastructure and the business infrastructure to leverage the collective intelligence of the city (Evandro G, 2020).

- Giffinger and his colleagues provided one of the most widely cited definition of smart city, which included six essential components : smart economy, smart people, smart governance, smart mobility (connection),smart living and smart environment (Wenxuan Yu, 2018) .

- Singh defined in 2014: eight key aspects that could define a Smart City: smart governance, smart energy, smart building, smart mobility, smart infrastructure, smart technology, smart healthcare, smart education and smart citizens (Xiong, 2018). These different keys are what make the cities smart, the nformation and communication technology are insufficient factors to shift from traditional cities to inteligent.

- Chinese government, has been defined a smart city as a new concept and model which utilizes the next generation of information technology, such as the Internet of Things, cloud computing, big data, to promote smart urban planning, construction, management and services for cities” (James Kin-Sing Chan, 2015).

The concept of smart city According to the British government, is not static: there is no absolute definition of a smart city, no end-point, but rather a process, or series of steps, by which cities become more “live able” and resilient and, hence, able to respond quickly to new challenges (Evandro G, 2020).

There is no specific definition of what constitutes a « smart city » among practitioners and academia. But the definitions often have in common that a smart city is It is a city driven by using technological intelligence and the Internet of things, and pushes the quality of resource management and service. Smart city projects are part of a general concept city modernisation. The smart city can be summarised as high quality of life by application of new generation of ICT technology.

In summary, a smart city can be compared to an ecosystem, where the smart infrastructure is interconnected with citizens, resources, companies and government together to form the core of modern society.

2.2. Indicators of the Smart City :

First, There is a basic condition that must be available to talk about smart cities, which is facilitation of smart collaboration and innovation between government, private sector businesses, academia and civil society. Often referred to as "quadruple helix".Then we talk about the standards set for smart cities.

Many organisations have created their own catalogs of criteria to define whether a city is Smart or not. Hence, for the city or community to be truly smart, they need to advance in all or some of the key strategic action fields inferred from the above definitions. It listed below :

- **smart transportation system:** It is also known by several terms such as Smart mobility or e-Traffic, it intended turn current systems into smart transportation networks in order to increasing the efficiency and service quality of urban transportation must be to enhance the use and adoption of new mobility solutions(autonomous vehicles) as well as to increase people’s mobility through efficient mobility management and infrastructure investments, traffic management improvements, human-machine interactive systems, vehicle safety, and security advancements. Using artificial intelligence, can mitigate heavy traffic by electronically monitoring and diverting traffic, while reducing emissions and energy consumption through the remote control of stop lights and other energy-guzzling devices.

- **smart economic development:** signifies that the city can thrive with continuous jobs and economic growth. a city's attractiveness for start-ups, investors, businesses, and new talent, growing the economy in an innovative and sustainable way. In order to promote the development of smart economy, great efforts should be made to develop smart industry, improve innovation ability and promote Internet application (Guijun, 2018).

It is important that smart cities manage the environment and natural resources carefully, because growth brings capital, visitors, and talent, thus increasing demand for resources, resulting in serious consequences for future development.

- **Smart living (e-Home):** the use of electronic services, connectivity, and social platforms, to provide citizens with access to: e-Health(high-quality medical care) and e-Education(education at home or by experts from remote locations), safety, housing conditions, and smart buildings to help improve household convenience and safety, through integrated and remote monitoring and appliance management(smart washing machines, smart refrigerators, smart air conditioners, smart TVs and other home appliances to be controlled remotely using a smart phone or a networked device).

- **Smart environment :** The reduction of waste production, Control of pollution, emission reduction, water management, achieving energy efficiency, and accelerating the local energy transition are some important goals of "smart environment" initiatives.

- **Smart governance :** is about strengthening the connections and interactions between the government and all stakeholders. this model can help to increase efficiency and effectiveness as well as transparency and trust.

- Smart governance is about the future of public services(digitalization of public services should be one of the key priorities), greater efficiency, community leadership, mobile working and continuous improvement through innovation.

- **Smart society :** signifies that the city is for its inhabitants. transforming the way citizens interact, smart education.

All indicators are based on an important indicator, which is the smart infrastructure indicator, and other indicators are integrated, for example the smart energy indicator(city produce more energy than it uses) is integrated with the smart transportation indicator and smart living indicators.

The smart economy and smart governance can be regarded as the Target Layer, because both of them are the goals of smart city construction and their improvement will contribute to the

construction of smart infrastructure and smart participation. This is consistent with the findings of Guijun, L's study.

In all these factors, information and communication technologies plays a vital role. This technology is being generated by giants companies such as IBM, Huawei, Cisco, wich they are investing millions of dollars in incubating technologies that support smart city initiatives.

3. METHODOLOGY

This research was based on a review of the literature on the topic of smart cities, depending on the approach descriptive wich has been relied upon to present the theoretical approach about smart cities, and the analytical approach has been relied upon to clarify the basic indicators of smart cities.

In order to obtain secondary data, specialized internet sites were searched, where theinformations, statistics, and literature on the subject was examined, then the general trend of smart cities in general, and the case study of Shenzhen in particular, were addressed.

Accordingly, the analysis was based on two parts of the literature: an overview of smart cities and the extent to which this view matches the pioneering urban experience of the city of Shenzhen based on four pillars: money, administration, technology, resources and citizens.

4. RESULTS

4.1. Overviews and global trends in smart city development in china:

The number of smart cities in the world is unknown exactly due to Different definitions and criteria used to label a smart city. Generally, Europe, North America, Japan and South Korea, china, singapore have been leading regions in smart city development.

The market for smart cities is an upward market that holds many opportunities for developing the economy and the city, in Norway, the « Innovation Norway" has identified smart cities as one of six areas of opportunity for sustainable economic growth in Norway. Europe had the largest smart cities market share in 2019, Germany and Spain are the key markets for smart cities in Europe.

China has seen rapid urbanization with a compound annual growth rate of over 1% in the past decade. Due to urbanization, Asia faces a gap in infrastructure investment amounting over 2 $ trillion per year (Deloitte, 2020) .

Currently, china has about 800 smart city pilot programmesunder way (Songwanich, 2020).

The development of smart cities is driven by goverment investment, and partnership with private tech companies.

In 2013, the Ministry of Housing in China published a pilot smart city list, which includes 37 cities, one year later, 100 more areas were selected for the list (Dong ,2015). Currently, china has about 800 smart city pilot programmesunder way (Songwanich, 2020). The market size of smart city rose from 6.2 billion yuan in 2015, to31.8 billion in 2020 and to 37.9 billion yuan in 2021.

Table 1.market size of smart cities in china (billion yuan)

years	2021	2020	2019	2018	2017	2016	2015
values	37.9	31.8	26.4	21.84	17.88	11.44	6.2

Source: Statista Research Department (2020), Market size of intelligent city informationization of government in China 2015-2018

The global smart cities market size is expected to register a grow from 410.8 billion $in 2020 to 820.7 billion $ by 2025 at a compound annual growth rate of 14.8% (markets and markets, 2020) and itis expected to reach 463.9 billion by 2027, at a compound annual growth rate of 24.7 for period 2020-2027 (research, 2020).

The city brine system, is a system that uses big data and computing power to monitor, improve and fix traffic problems in Hangzhou, it has successfully helped reduce traffic congestion by 15% (Songwanich, 2020).

In November 2012, the Ministry of Housing and Urban-Rural Development released A Notice on Conducting National Pilot Smart Cities. This notice attached a set of pilot indicators for smart cities, comprising four major dimensions support system and infrastructure, smart construction and liability, smart management and services, and smart industry and economy.

To apply for becoming ‘national pilot smart cities’, local cities should have in place an economic and social development plan incorporating the smart city, a completed smart city development outline, secured funding source (e.g., government budget), and leadership arrangement.

More than 500 smart cities are being builtacross China, equipped with sensors and cameras (Chandran, 2020).

Smart cities in China are classified into three groups: first rank includes 13 cities, second rank includes 6 cities, and third rank includes 6 cities (Deloitte, Super Smart City, 2020).

It is estimated that the market value for building the Chinese smart cities increased from 740 billion by 2014 to 10,500 billion by 2019, and is forecast to reach 25,000 by 2022. This booming market has attracted the established global firms such as IBM Corporation and Cisco Systems (are investing significantly in Research and Development activities to introduce new technologies for connected infrastructure in cities), and those locally-grown firms that have rapidly developed to achieve global competitiveness and reputation (Hu, 2019).

4.2. Shenzhen Smart City

Shenzhen grew from a fishing and rural village into international metropolis by 40 years, and has won by 2010 a nickname of 'China's Silicon Valley' or 'China's smartest city'.

The city of Shenzhen,is the first Special Economic Zone in China to allow foreign investments.

with a population of 12 million Now. Already more than 58% of the population are urban dwellers, compared to just 18% by 1980.Shenzhen's major sources of GHG emissions are the manufacturing, building and the transportation sector**.**

Its aims to become a "socialist model city". He Lifeng, the minister in charge of China's National Development and Reform Commission, published an article in People's Daily, in which he said"Shenzhen is an international and innovative city. The problems encountered in the modernisation of country are likely to appear in Shenzhen first" (Zheng, 2019). The governance models that have proven successful in Shenzhen will be replicated in other Chinese cities. It is one of 27 megacities worldwide(10 million or more) (CHEN, 2019) .

Longgang is one of the most well-known smart districts in Shenzhen and in China, as every year large numbers of city representatives from China and around the world visit to better apply Longgang's experience to their own Smart City deployments (Xiang, Longgang, Shenzhen: Giving Birth to a Smart City, s.d.).

The progress made in the city was measured through several indicators like add value of new industies, international trade value of hi-tech industies, patents certified, Rand D Expenditure.

Table 2. Indicators of the knowledge economy in shenzhen2010-2017

Years	Add value of new industy(RMBmillion)	International trade value of hi tech industies (10.000 $)	Patents certified	RD expenditure (10.000RMD)	R D personnel(persons)
2010	282.051	19.770.075	34.951	3.333.102	177.756
2017	918.719	22.775.570	94.250	9.769.377	281.369
Change (2010-2017)	226%	15%	170%	193%	58%

Source: Richard, H (2019).The State of Smart Cities in China: The Case of Shenzhen. Energies 2019, 12(22), 4375; p9.

The most preferred sectors to be smarted for intelligent cities are: water supply, uninterrupted energy supply, solid waste management, storm water management, public sevices, public transportation, public safety, health, education, employment, police.economy, building, housing.

5.DISCUSSION

The development of smart cities is primarily from top to down and predominantly driven by partnership between government investment and private tech companies. China's smart cities are strongly driven politically, as they are clearly mentioned in national plans:

various plans have been released to support on smart transport in China. These include (Perez-Cerezo, 2018):

- The Implementation Plan to Promote Smart Transportation in 2016 by the Ministry of Transportation and the National Development and Reform Commission ;

- The 13th Five-Year Plan for Modern Comprehensive Transportation System in 2017 ;

- The Medium- Long-term Development Plan for the Automobile Industry(connected vehicles) in 2017 ;

- In August 2017, the Ministry of Transportation announced a new intelligent road demonstration applications. Their development involved by the most important leading companies in China.

Traffic congestion costs China's economy nearly 2% of GDP, an estimate result found that the country needs more than 50 million new parking spots.

The public-private partnership has been a strong driver behind the success of Shenzhen, where, A large number of world-class high-tech enterprises have been founded in Shenzhen , including DJI, Huawei, China telecom and Tencent.

Shenzhen has reached cooperation with these high-tech companies in several sectors, including education, health, housing, social security, and transportation by adopting artificial intelligence and big data technologies and internet of things and cloud computing.

Huawei worked with Shenzhen Traffic Police to build a brand new ICT platform and smart transportation solution with intelligent algorithms, big data analytics, and other innovative technologies.the broad deployment of Huawei's NB-IOT intelligent parking system has solved the problem of finding a parking space and ended fiddly payments by connecting every parking spot in the city to a single system (Huawei, 2020). Huawei and China Telecom has planned to convert Shenzhen into a gigabit city, providing connections of 1,000 megabytes per second(Full coverage), and this is the cradle of the smart city (Juan, 2016).

All buses and taxis in Shenzhen are already electrified, It is currently working on switching from electric cars to automated cars, connected or smart cars.

The city has achieved many gains as a result of adopting a smart city, the most important of these gains are as follows:

- Shenzhen ranked the fifth place in the urban cities with congestion reduction, which was also the relatively lowest city in the megacity level congestion list (Zhang, 2018).
- roads are equipped with Huawei-supplied smart street lamps each featuring a sunlight-based illumination controller, which reduces energy consumption by 80 percent (Kang Xiang, s.d.).
- Since the implementation of smart policing, the total number of criminal incidents in Longgang has decreased 29 percent. This is the largest such decrease in the history of the city, and serious crimes have been drastically curtailed (Xiang, s.d.).

Based on the literary studies conducted on the topic, a set of benefits that result from chenzhen adopting smart cities have been concluded, We summarize it as follows:

- solution to the problem of global warming;enable citizens to report problems in real-time ;
- lower healthcare costs;

- solve the urban population growth, traffic congestion, and security;
- Accesss to cleaner air and water ;
- Reduced wastage of resources and pollution ;
- businesses are attracted by cities who act on innovation (attract the best minds);
- Growing economy.

The core of a smart city lies in facilitating the lives of citizens on the one hand and making the city a destination for entrepreneurship, competitiveness and reputation on the other hand.

On the other hand, the smart cities face several challenges, like the cost which is considered the most important factor (design cost, operation cost), data privacy, and public safety.

6.CONCLUSIONS

Smart cities face problems and challenges related to traffic, crime, energy efficiency, and improved public services.

The smart city market will develop continuously as the result of many smart solutions:

- According to the UNPF, by 2030the total population is expected to live in urban, roughly 67 %;

- huge investments by public and private players;

- expansion of various automation product portfolios by manufacturers;

- advancement in automation technology and adoption of Big Data, Cloud Computing, Internet of Things technologies, and Artificial Intelligence.

The goal of smart cities is achieved by adoption of smart indicators, such as smart economy, smart building, smart transportation, smart living, smart governance, smart education, and involvement of smart citizens.

Success in achieving smart cities is linked to strategic government planning for both smart infrastructure, innovation and sustainability.

high-tech enterprises, capital companies, and architecture firms are leading the way Smart cities China, which defines its future directions, and that the net cities and the platform cities

are one of the smart cities that these companies lead. They share the most recent concepts of building digital cities**.**

The achievements of the development of cities, both horizontally and vertically, can be considered as the creative destruction of urban technology, thanks to four Techniques technologies: artificial intelligence, the cloud of computing, the Internet of things, and big data.

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