Shenzhen:

Livability in Three Aspects

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Abstract

Shenzhen, known as China's booming silicon valley, used to be a small fish town 40 years ago. Today, it ranks one of the top mega-cities in China and a leading example of urbanization in developing countries. Shenzhen has achieved a lot of economical success. Its Gross Domestic Product (GDP) has exceeded its developed neighbor Hongkong since 2018. Shenzhen also has the highest GDP per capita in mainland China, with over 20 million temporary and permanent population. However, it is still facing livability challenges. Environment Air Quality, Green Spaces, Accessibility of Health Care, and District's Public Safety are still insufficient. By looking at Shenzhen, we could learn about the challenges that come with rapid growth and learn to build our city better. By analyzing the data released by the Shenzhen's government such as the *Shenzhen Statistical Yearbook 2019,* this is a project aimed to raise people's attention to improving the livability of the city, instead of solely focusing on pursuing economic growth. Shenzhen's growth is undeniable. But under the beautiful skyscrapers and city lights, it's people who live in it. We shall not overlook the importance of livability, but prioritize it in a city's sustainable development.

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Introduction

Urbanization is one of the most significant trends of the past and present century, providing the framework and energy for global change (López Moreno, 2017). Today more than 55% of the world population lives in cities-70% of the world population will reside in cities by 2050 (United Nation DESA, 2018).

However, fast-growing cities also lead to different issues. "Cities' formal organization, infrastructural patterns, density, intensities of program, distributions, and scale" (Bullivant, 2012) are crucial factors that play out in cities' growth. With the widening gap between rich and poor, cities' problems are changing. But the government and policymakers are falling behind on the race (Bullivant, 2012).

Shenzhen, after four decades of dramatic urbanization, was developed from a fish town to a modern mega-city. Benefit from the Chinese 'Reform and Opening-up' policy, Shenzhen started with 310 thousand residents in 1979 and in the same year it became the first special economic zone in China. Today, Shenzhen, with the name of China's Silicon Valley (CNN, 2018), has more than 20 million population (OECD, 2015), 13 million year-end permanent population, and 27,000 USD GDP per capita in 2018 (Statistics Bureau of Shenzhen, 2019). Shenzhen serves as one of the best examples of the 21st-century urbanization in developing countries. However, What will be the challenges that come with the fast urban development and rapid growth of the economy? What are some experiences that other cities could take away from Shenzhen's urbanization movement?

By studying and visualizing the data from Shenzhen Official Statistical Yearbooks and Shenzhen's district's government statistics books, this thesis will conduct an evaluation of Shenzhen's livability challenges in three different aspects, including Environment Air Quality, Green Spaces, Accessibility of Health Care,and District's Public Safety, which function as part of OECD's criterion of measuring people's well-being of life.

The thesis will begin with an overview of Shenzhen's background information. We will first walk through its achievement and challenges in the environment, and discuss the health accessibility in Shenzhen and the Public Safety Study of Shenzhen. At last, we will introduce the design and data used in the interactive storytelling and visualization application associated with this thesis, which can engage more audience to learn and explore Shenzhen's growth and livability challenges it is still facing.

Shenzhen's Growth and Development

Shenzhen, a coastal city, established in the southern Guangdong province of China in 1979, which covers 1997.3 square kilometers of land and more than 310 rivers. It is located on the east edge of the Zhujiang River (Pearl River) estuary. It is neighboring Dongguan City on the north, and Hongkong on the South. It is located at a strategic location. Today People in Shenzhen can commute to Guangzhou, which is the capital of Guangdong within 30 minutes by high-speed trains or 2 hours by car. The traveling time to Hongkong is about 15 minutes by high-speed trains or 30 minutes by subway, and approximately an hour's ferry ride to Macau.

In the past decades, numerous special economic zones and free trade zones helped the tremendous growth in the third world (Higgs, 2014). In 1980, three years after the Cultural Revolution, Shenzhen was promoted by Deng Xiaoping, and its partial districts became the first experimental Special Economic Zone (SEZ) in China to practice the capitalist market economy under the communist government (Holmes, 2017). A large number of domestic migrants from all the places of China have been moving to Shenzhen since then. In 2010, the Shenzhen SEZ expanded from its four of nine districts, which is around 396 km^2, to the whole city (Xinhua, 2010).

So far, Shenzhen is the only city in China which reaches a 100% urbanization rate. In 2019, the city managed more than 20 million population with an average age of 33 (Shenzhen Government). It has become the most densely populated urban region in China and 5th in the world (USA today), which has 6484 population per km^2 and it was 157 population per km^2 when it was just established in 1979.

The Gross Domestic Product (GDP) of Shenzhen in 2018 is 12,000 times larger than the GDP in 1979, which raised from 200 million CNY in 1979 to 2.4 trillion CNY in 2018 (340 billion USD with 1 USD to 7.1 CNY exchange rate 03/2020). It was also the first time Shenzhen's GDP has exceeded its neighbour Hongkong. At the same time, the GDP per capita rose from 625.2 CNY in 1979, which is about 1.7 CNY per day, to 189,568 CNY in 2018, 526 CNY per day.

Based on the three-sector model in economics, the composition of Shenzhen's GDP 2018 is 0.1% of Primary Industry, 41.1% in Secondary Industry, and 58.8% of Tertiary Industry. China's economic success in past decades is based on resource-intensive manufacturing, exports, and low-paid workers (The World Bank). Shenzhen is the epitome and the frontline of China's growth miracle. Factories like Foxconn

manufactured products like iPhone, TV, and other products for the world. Due to the constantly increasing land price, many manufacturing factories are moving to cheaper areas like Dongguan, other places in inner China, or even different countries in recent years (Zou, 2014). There are still 3.7 million registered manufacturing employees in Shenzhen in 2018. Besides the hardware manufacturing industry, Shenzhen is also one of the technology and innovation centers in China. It is the birthplace and headquarters for some of China's top technology companies like Tencent, Huawei, and DJI. There are more than a half million people working in the information transmission, software, and information technology industry in Shenzhen.

After four decades of development, Shenzhen has become a significant mega-city in China and to the world. Shenzhen, sitting in the heart of Pearl River Delta, has one of the main ports in mainland China for export and import trade, ranking the 3rd busiest container port in the world. (World Shipping Council). Shenzhen also has one of two stock exchange markets in Mainland China. There are a lot more that can be mentioned about the rapid growth of the economy and development of a city, but we can't forget that a city is also a place where most people live or are going to live. For an individual, the liveability of a site is always concerned.

Liveability in a Megacity

Liveability is a subjective concept which tries to define a place's positive or negative impact on individuals. It is usually associated with terms like well-being and Quality of Life. There are uncountable variables that could influence the status of a person, which makes these abstract concepts very difficult to define or measure. The World Health Organization defines Quality of Life as

> "An individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. It is a broad-ranging concept affected in a complex way by the person's physical health, psychological state, personal beliefs, social relationships, and their relationship to salient features of their environment."

Different indexes or measurements have been used to define the relationship between human beings and where they live. The Gross Domestic Product (GDP) index mentioned in the last section, shows Shenzhen has become a market with outstanding value. Does it mean Shenzhen has a high Quality of life? GDP is a measure of wealth, and it is frequently used as a proxy for well-being in mainstream economics, but many

critics argue the GDP is limited. It just represents the cash flow and nothing more. (Higgs, 2014)

Human Development Index (HDI) is used by the United Nations Development Programme (UNDP) to normalize and measure the mean of a healthy life, being educated, and a standard wealth of living. Shenzhen's HDI reached 0.845 and ranked 3rd in China after Beijing and Shanghai in 2016, which is about 0.1 points above China's national average HDI (China HDI 0.749 in 2016). Shenzhen's HDI is the highest among 330 prefecture-level cities in China, and it is considered a high human development region. The HDI value displays fundamental aspects of development outcomes. (UNDP) However, even though UNDP introduced an Inequality-adjusted Human Development Index (IHDI), which adds inequality as a new dimension into counting the human development level, it is still deficient. Elements like environment, gender, sustainability, and many other objective and subjective dimensions, which are essential to development and well-being, are vacant.

The OECD has designed a framework, which tries to measure the Better Life Index or the well-being of different countries by using data from 11 factors. The choosing of the 11 dimensions is based on "theory, practice, and consultation on the issue of how to best measure well-being from a comparative perspective", according to the OECD. However, the OECD Better Life Index is only available for 35 countries. The measure cannot provide the details on a smaller scale, like cities and regions.

This thesis will not demonstrate all the factors and to debate which one is the most relevant to a city's liveability. It may change by time, by culture, scenario, and other matters. This thesis will not try to measure the liveability or quality of life in Shenzhen. Instead, it will take a close look at three critical aspects associated with the citizens' Quality of Life in a new mega-city and assess the city's livability within these parameters.

Environmental Aspects of Livability

> "Sustainability is a new idea to many people, and many find it hard to understand. But all over the world there are people who have entered into the exercise of imagining and bringing into being a sustainable world. They see it as a world to move toward not reluctantly, but joyfully, not with a sense of sacrifice, but a sense of adventure. A sustainable world could be very much better than the one we live in today."
> **— Donella H. Meadows Jorgen Randers Dennis Meadows, The Limits to Growth: The 30-Year Update**

Environment-related issues have become a more and more critical factor globally, considering development level, well-being, and liveability. It is a major dimension when the United Nations plans its Sustainable Development Goals for 2030. The late 1960s and 1970s was the start of environmental regulation. Due to the perfection in pollution regulation, safety laws, and wage equality in industrialized countries, many mass-production industries moved to the developing region (Chp 9, Higgs, 2014). The myth of economic growth with the damaging of living environment is repeatedly happening since the Industrial Revolution.

There are many successful examples of economic growth over the past forty years in the developing world. Unsurprisingly many of them also achieved a pollution miracle. In the 2000s, China faced severe environmental problems. There were 16 out of the 20 world's most polluted cities in China (Sanders, 2007). Years later, the crown of pollution was taken. 22 out of the 30 most polluted cities in the world are from India in 2018. More than 90% of the world population is impacted by polluted air. 63% of cities in the world exceed the WHO PM2.5 guideline, which fails in providing clean air to its citizens (Griffiths, 2019).

Air Quality’s Impact on the Quality of Life

China has put a lot of effort into improving its air quality since it has been known for polluted cities and as the world’s factory. China released the National Action Plan in 2013. Study has shown the country has made significant improvements. The residents are expected to live 2.3 years longer in 2017 compared to 2013, even though the average Air Quality Index (AQI) is still above China’s National standard and far beyond WHO guidelines (Greenstone, 2018).

Shenzhen's air quality has some improvements since 2013. According to the *Shenzhen Statistical Yearbook 2019, the data range from 2001 to 2018,* the days of Haze reached its peak around 187 days a year in 2004 and is reduced to 20 days in 2018. “Shenzhen's PM2.5 average concentration has been the lowest in 15 years! And, the AQI has reached the national 'good' or 'excellent' category for 94.5% of the days in 2018” according to the Shenzhen News report in 2019. The city official government website also promotes Shenzhen as a city with top air quality ("Shenzhen Review" sz.gov.cn). Nevertheless, these optimistic arguments are controversial.

The China official Technical Regulation on Ambient Air Quality Index (2012) is using a less strict AQI threshold, which is based on WHO air quality guidelines' Interim Target-1, as its standard for excellent air quality. The Interim Target-1 is the first of the three-step goals that WHO proposed to help the highly polluted region. For instance, if the average year PM2.5 concentration is 60μg/m^3, it means "Good" ("良") in China's standards. But it would be categorized as "Unhealthy" under the US EPA Air Quality System, which is a system much closer to the WHO guideline.

According to the WHO, PM2.5 under 10 μg/m^3 annual mean, under 25 μg/m^3 24 hours mean, and PM10 under 20 μg/m^3 annual mean 50 μg/m^3 24 hours mean will be considered as good air and no significant public health impact. PM2.5, as an essential air index, is missing in Shenzhen Statistical Yearbook, and the PM10 annual mean is about 10 μg/m^3 less compared to the index in the 2000s. In recent years, the annual mean was going up and down from 42 μg/m^3 in 2016 to 45μg/m^3 in 2017 and got slightly better in 2018 to 44 μg/m^3. It is twice as much as the WHO guideline.

Based on the data from The World Air Quality Project, using US EPA Air Quality System measurement, the Shenzhen 2014-2019 PM2.5 AQI index annual mean is 123 in 2014, that is around 44.4 μg/m^3. It leads to "Unhealthy for Sensitive Groups." The annual mean finally got to 97 in 2019; for the first time, the annual air quality achieved "Moderate" level, since 2014. At the same time, the number of days above AQI 150 ("Unhealthy") declined from 104 to 21 days a year.

Green Spaces and their Co-benefits for Livability

Shenzhen is a coastal city with a long hot summer. Bearing the subtropical monsoon climate.The annual average temperature in Shenzhen is 23 degrees celsius. The record shows that extreme maximum temperature could go up to 38.7 °C (Meteorological Bureau of Shenzhen Municipality).
With an average of 1,935.8 millimeters a year, Shenzhen has abundant rainfall. The average yearly sunshine is 1837.6 hours.

In terms of trees and meadows, the green coverage rate in the city developed areas has maintained to be 45%, and the forest coverage rate is around 40% in the past decade. As a new city benefiting from the top-down urban designs in the 1980s and 1990s, a network consisting of more than 900 city parks is produced. The urban green space development in Shenzhen is foresight (Zacharias and Tang, 2010). The index like

green coverage rate has become one of its advantages when comparing Shenzhen with other cities (World Cities Culture Forum). But, it is still not good enough.

In the matter of Per individual Public Green Areas rate, the number from Shenzhen was going down from 2015's 16.9m^2 to 15.4m^2 in 2018. 9m^2 per capita is the bottom line for public green spaces, and 50m^2 is ideal according to some earlier studies (Russo and Cirella, 2018). On the other side, the average heat caused by the Heat Island Effect between June to August is waving around 1.30°C, and the annual average temperature was 0.99°C in 2018 (Shenzhen Urban Heat Island Monitoring Bulletin, 2011-2018). There is a lack of investigations on the heat-related health issues in China. Every year more than 600 people in the US are dead because of extreme heat (CDC). Heat Island is a phenomenon that the city environment is much warmer than its nearby rural regions, and it could cause a series of problems including energy consumption, heat-related health issues, air pollutants, etc (US EPA).

The green infrastructure plays a vital role in cities' livability and sustainability. Many studies have shown the urban green space is correlated to the residents' well-being, happiness level, sociality satisfaction level (Jee, Han, and Kim, 2019). Moreover, it is an important infrastructure that helps cities reduce heat, filter air pollution, reduce carbon emission, and increase safe routes and places for transport, interaction, and physical activities.

Health Accessibility as Criteria of Liveability

> “Hence Capital is reckless of the health or length of life of the labourer, unless under compulsion from society. ”
> ***-Karl Marx, Capital, Volume I, Chapter 10***

> "The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition."
> ***-WHO, 25 Questions and Answers on Human Rights***

The accessibility to health infrastructure and service is a significant aspect of a city's livability. It is crucial that everyone, especially those people who are vulnerable, older, younger, or marginalized, has reasonable access to health services when they need it. Also, it is vital that the health facilities in the city have the strength and capacity to respond to emergency health crises like an epidemic outbreak.

Patients in China are trusting and prefer going to a public hospital, compared to private ones. Due to the health resources shortage and the recent public health crises, including the notorious Putian private hospital network scandals, faulty vaccine incidents, and the COVID-19 outbreak, people are criticizing the health system a lot in China (Wee, 2018, and Buckley, 2020). In 2018, there are 2.59 licensed doctors and 6.03 hospital beds per 1,000 people in China. The utilization rates of hospital beds were 91.1% in public hospitals and 63.2% in private hospitals (NHC, 2019).

In 2018, with over 99 million patients visiting health services in Shenzhen, there were 3,806 health care institutions, and 67.6% of them were private clinics. There were 139 hospitals, and 78 of them are general hospitals. Average of 33 hospitals were built per decade in the last thirty years.

In 2018, there were 34,747 licensed doctors in the city—2.8 doctors per 1,000 people. Moreover, there were 43,569 hospital beds in total, which is 3.3 hospital beds per 1000 people. These people rates were the number of doctors and beds divided by the 13 million permanent year-end population reported by the Statistics Bureau of Shenzhen in 2018. Yet, if we use 21 million as the population, which is the average monthly residents' statistics report by China Mobile in 2017, the rate of doctors and beds per 1,000 people will drop to 1.6 doctors and 2.1 beds.

The average utilization rates of beds were 84% in Shenzhen in 2018, which means there is an average of 6,971 empty hospital beds in the city. The condition also varies from the locations and facilities. Luohu, which is one of the sub-regions in Shenzhen, holds 20% of the hospitals in Shenzhen. The average utilization rates of beds in the public hospital are all above 90% in the past decade. It was overloaded in 2010 to 105% and 2012 to 101%. On the other hand, in the Nanshan district, the utilization rates of hospital beds were 84.5% in 2017 and fell to 78% in 2018. Regardless of the regional differences, Shenzhen's empty beds will be filled up shortly, hypothetically, if Shenzhen get a similar COVID-19 outbreak circumstance like New York City in March 2020: the confirmed cases went from 154 cases on March 13 to 9,045, on March 22, in ten days (NYC Department of Health).

Evaluating Quality of Life by Crime and Safety

> “The moral conscience of society would be found in its entirety in every individual, endowed with sufficient force to prevent the commission of any act offending against it, whether purely conventional failings or crimes. But such universal and absolute uniformity is utterly impossible, for the immediate physical environment in which each one of us is placed, our hereditary antecedents, the social influences upon which we depend, vary from one individual to another and consequently cause a diversity of consciences.”
> **-Émile Durkheim, The Rules of Sociological Method**

Everyone has the universal right to live safely and away from harm. It is a basic factor when considering well-being (OECD). Safety could mean various things, in this section it mostly covers the study of judicial and police-related public safety open data released by Shenzhen local government. However, the lack of transparency and corruption issues have reduced the credibility of the Chinese justice system and its crime statistics. The legal system in China is considered flawed based on different reports and studies (Huang, 2016; Liang, He, and Lu 2014).

Once again, the crime and safety statistics are not included in the most recent bilingual Shenzhen Statistical Yearbook 2019. According to the Shenzhen People's Procuratorate's report in 2018, which is a brief release, there were 18,965 criminal cases conducted, 23,579 people arrested, and 29,434 people prosecuted in Shenzhen 2017 (people.cn). But how many cases were reported to the police and how many open cases remains in Shenzhen every year are unknown to the public.

Furthermore according to Law of the People's Republic of China on Penalties for Administration of Public Security, if the violence or crime behavior is not dangerous enough for criminal punishment, the public security organ, normally is the police department, will impose on him/her penalties including warnings, detention of 1- 15 days and fine. The violations will be recorded as a public security case (治安案件), but not a criminal case (刑事案件). Minor offenses, such as setting fireworks, displaying disgracing, stealing slogans, and more severe violence violations like damaging others properties, gang-fighting, illegally restricting other's freedom, beating up others, forcing laboring, begging, and robbery, could all fit in the penalties law. The local police department is responsible for determining whether it is a criminal case or not.

Fortunately, official crime statistics are public and accessible in the Luohu district Statistical Yearbook 2018 and Nanshan District Statistical Yearbook 2019. Luohu and Nanshan are two of the nine sub-regions in Shenzhen, and they are also among the four oldest SEZs. There is more than 1 million year-end permanent population living in Luohu, which covers 78 km^2. Nanshan is about 187 km^2 with a 1.5 million year-end population. Besides, it is noteworthy that people who live in other sub-regions in Shenzhen could access both regions easily either by private or public transportation.

3 homicide cases were on file in Luohu in 2017, and the homicide rate per 100,000 people was 0.29. Homicides are serious crimes which "creates a violent environment that has a negative impact on society, the economy and government institutions."(UNODC) Regarding homicides statistics, China has a decent record. In 2017, the homicides per 100,000 people were 0.6; as a developing country with an immense population, this number is exceptional even when compared to countries in the developed world (The World Bank). Luohu's homicide rate is lower than the national average.

How about crime in an overall situation? As reported by the Luohu public security organ, the criminal cases on file each year were going up and down from 12,188 cases in 2008, to 7,926 cases in 2017, and the public security cases dropped from 92,120 to 9,505 cases (Luohu Bureau of Statistics, 2018). The overall crime rate ((Criminal Cases + Public Security Cases) ÷ Permanent Population in that year) per 100,000 residents dropped from 11,590 in 2008 to 1,743 in 2017. As a reference comparison, with 2 million populations in Queens, New York, the crime rate is 1559 per 100,000 residents in 2018, which is considered safer than 40% of cities in the USA (Location Inc, 2018). Hong Kong, the more developed city, compared to Shenzhen, had the overall crime rate of 758 in 2017 and 787 in 2019 (Hong Kong Police Force, 2020). Due to the difference in the laws and crime definition in different political regions, measuring from different areas may not reflect the accurate crime situation. Back to Luohu, 70.4% of the criminal cases in 2017 are either fraud or theft-related, and 2.36% are homicide, violent crime, rape, or robbery. However, 74.9% of the public security cases were categorized as "Acts Infringing upon Rights of the Person and of Property'' in the 2018 Luohu annual statistic report, which includes various violent crimes.

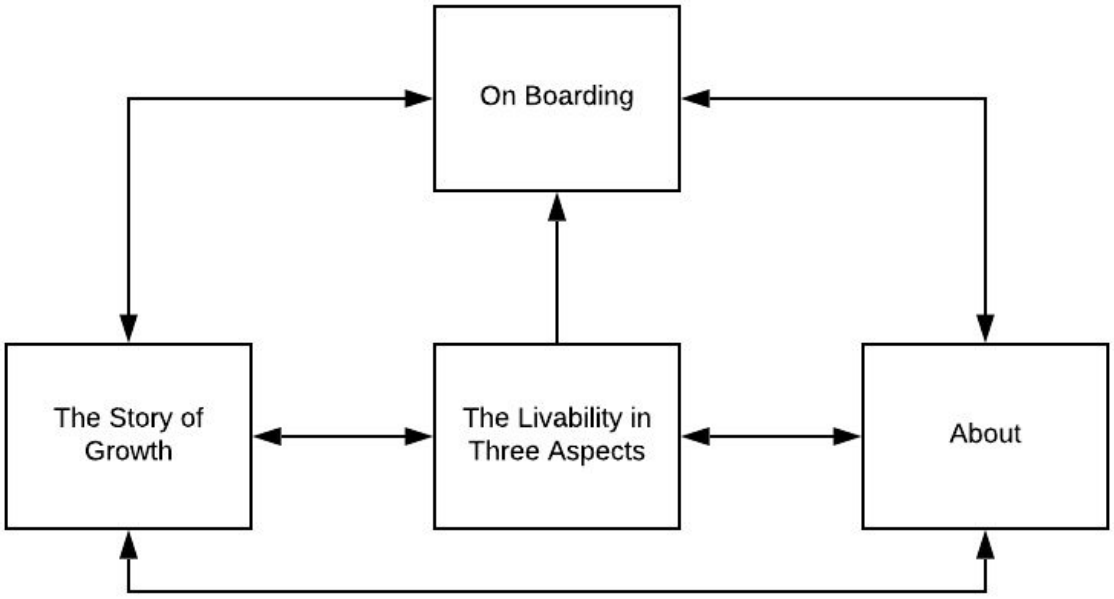
There were 6818 criminal cases on file in the Nanshan area in 2018, and less than half of them were solved, that is, 3070 cases, and 2988 people were arrested based on the Nanshan annual statistical report 2019. 91.5% of the suspects were non-Shenzhen

registered residents. On the other side, 8355 public security cases were conducted. Plus the criminal cases, the overall crime rate is 1016 per 100,000 people in 2018.

Storytelling and Visualization Project

Web Application Design & Information

In order to engage more audience, the web application *Shenzhen: The Growth and Livability of a Mega-city* is built to be associated with this thesis. The tools used to build this web experience include Nuxt.js, Mapbox GL JS & Studio, D3.js, vue-scrollama, and Baidu Map API.



The Web Application Flowchart

The application consists of two major parts. The first part is the background information and the history of Shenzhen starting as a small fish town and later becoming a mega-city. By simply scrolling the website, the audience will read and watch the story of Shenzhen unfold with intriguing animation and multi-layer information including text description, photos, satellite images, maps, and statistical data.

The second section is a visualization tool, which allows users to explore Shenzhen's livability in three aspects. The menu on the right bottom is used to switch between different topics. A information panel on the left shows the study and visualization of statistics related to the current topics. Behind the information panel, an interactive map of Shenzhen demonstrates the

geographical-livability-related data of Shenzhen. By clicking the control button on the right edge of the user interface, the audience will be able to take full control of the map. The audience could highlight or hide different layers on the map, and even add more interesting data points on the map. With the help of the interactive map, the audience could find out which regions in Shenzhen needed more attention and improvement regarding the green coverage, hospital accessibility, and police station accessibility. For more information and the user interface design of the project, please check out the appendix section.

Data & Methodology

The data for the web application is mostly provided and collected from Shenzhen Government Open Data Platform API and Mapbox Data. Many datasets provided by The Shenzhen government's Open Data Platform are unorganized and faulty, including repeated columns and rows, missing values, and missing units. A lot of effort was put into cleaning and managing the dataset by using The application Numbers, and Python's Numpy and Pandas libraries. The old satellite images are collected from USGS's Landsatlook. The data of 15-minute-driving reachable regions of major hospitals and 5-minute-driving reachable regions of all police stations are generated by using Mapbox's Isochrone API.

Conclusion

The three major livability factors: environment, health accessibility, and crime in the rapid-growing city Shenzhen are deficient. Many improvements need to be made.

The open datasets from the Shenzhen government are imperfect. Due to the limitation and inaccuracy of datasets, some of the conclusions may not reflect the real situations. The different major statistics and indexes like PM2.5, ICU beds, crime, and public safety are missing in the datasets. More accurate, transparent, and detailed data is needed.

The air quality has improved in the past decade, but Shenzhen citizens are still exposed to unhealthy air. The air quality standard in China may demand an update since the old standard is misleading, and many Chinese cities already have a high HDI and average GDP per capita, which is close to some developed countries. More green public space needs to be built in order to reduce problems like heat island effects and carbon emissions.

Concerning medical accessibility, Shenzhen's hospital beds per 1000 people rate are way below the average rate in China. Moreover, there is a shortage of doctors. There is an uneven distribution of patients between the public and private health facilities in Shenzhen, causing an overload in public hospitals. It is a waste of private hospitals' medical resources.

Regarding the crime and safety aspects, the data is not transparent on the city scale. For these sub-regions of Shenzhen, where the public safety data is available to some degree, there is an improvement in its public safety statistics. However, these regions are still under a critical condition due to a large number of the migrants. There are a large number of crime and public safety cases, even though the homicide rate is low.

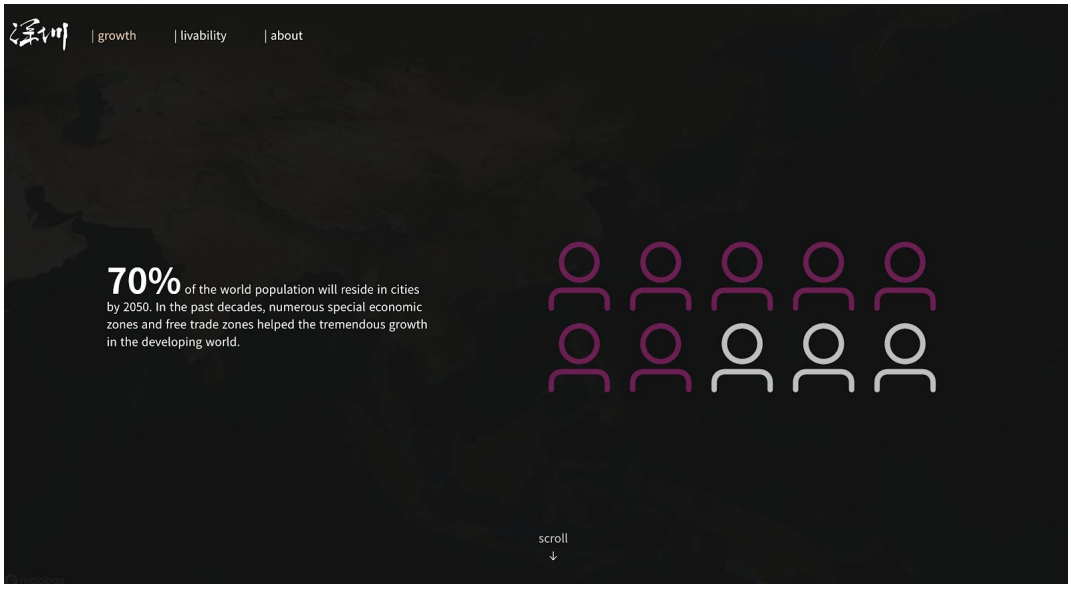
It is noteworthy that there are still other factors relevant to livability that this thesis didn’t cover. Shenzhen’s development towards a modern mega-city with high livability still has a long way to go. This thesis hopes to raise more attention to these critical areas that are affecting people's everyday life, and invite more discussion about how to build our cities to be more livable for people.

Appendix

The Storytelling and Visualization Web Application Link:
https://shuvitran.github.io/szapp/

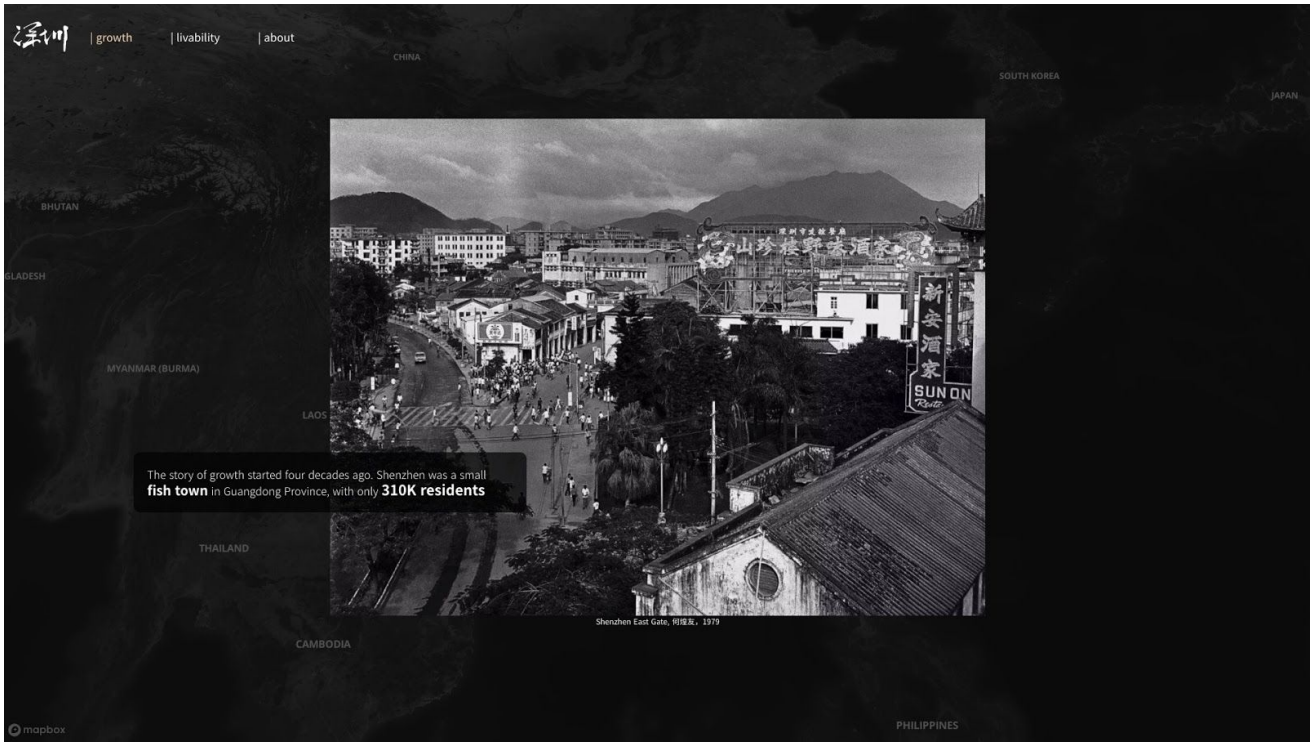
Storytelling and Visualization Web Application UI:

Onboarding Page



Story of Growth-1

Story of Growth-2



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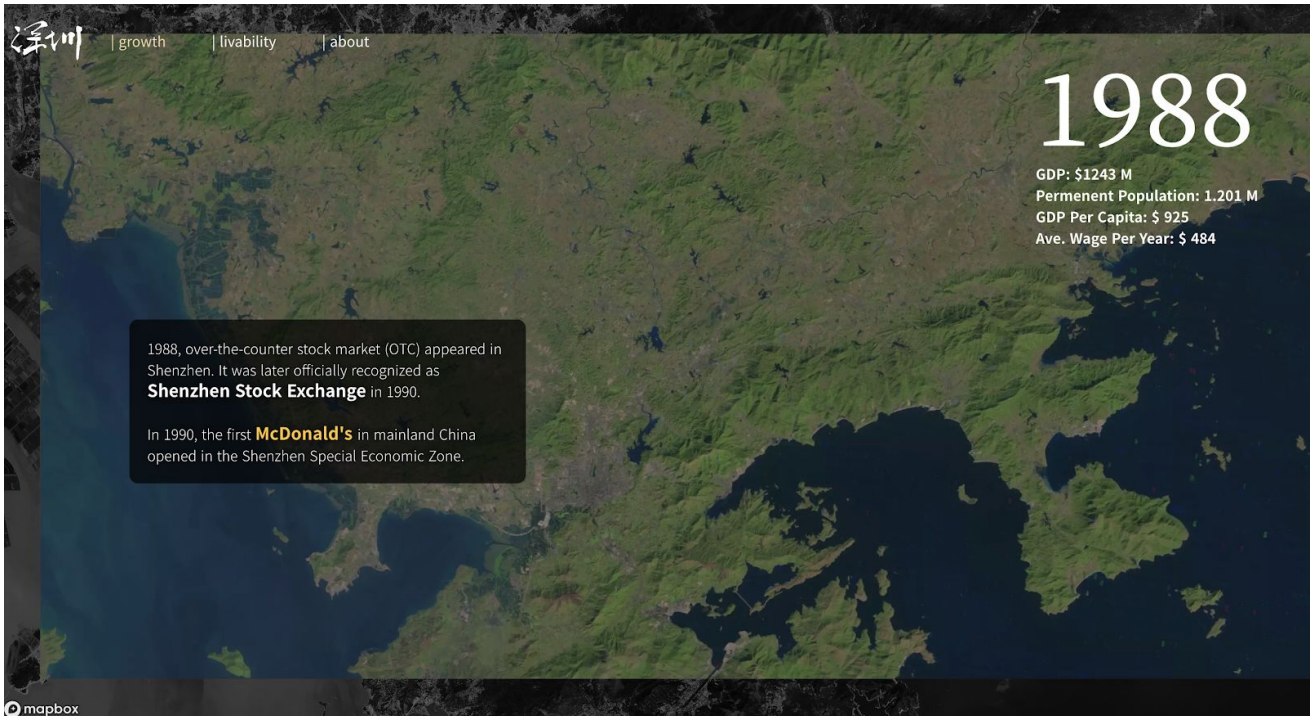

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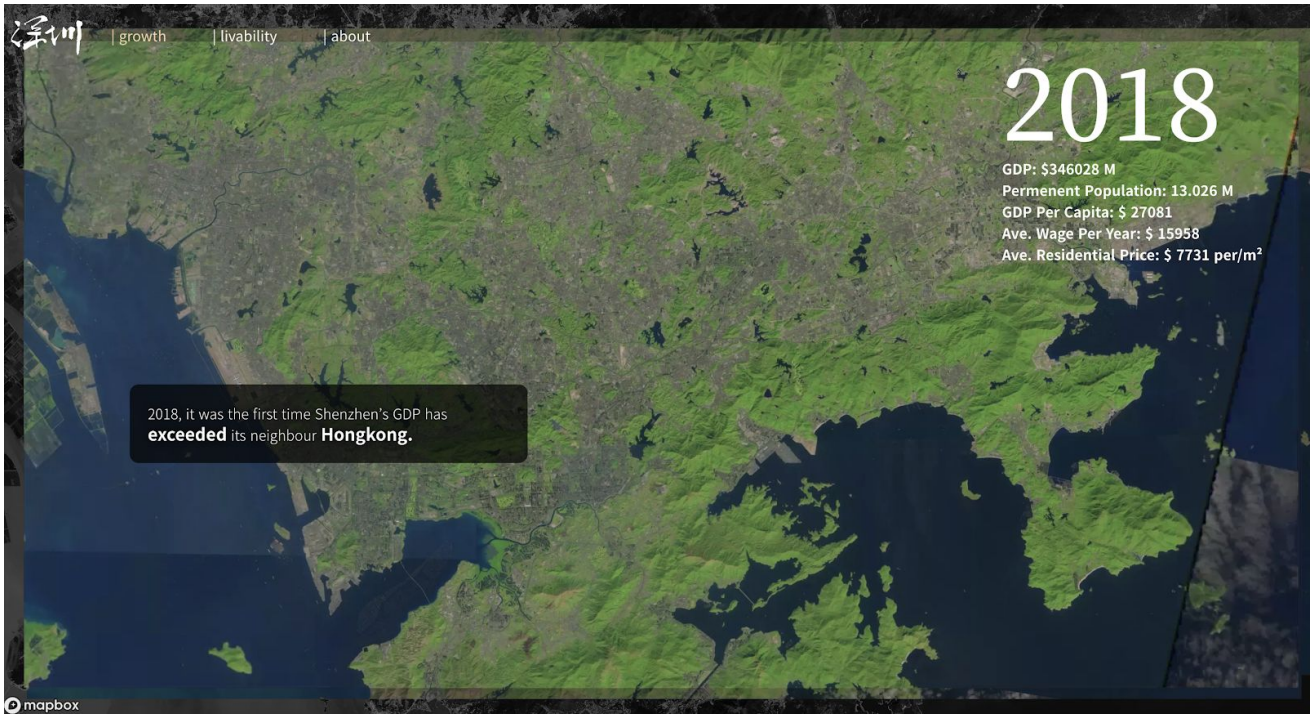

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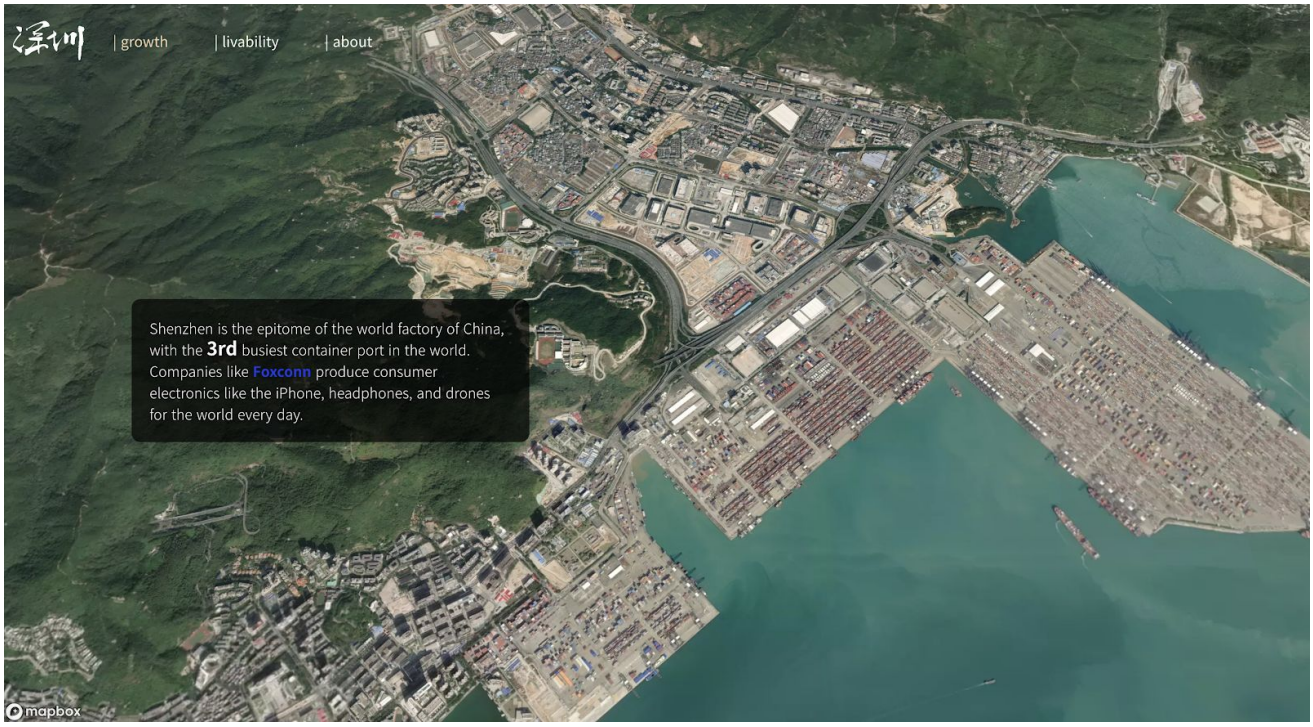
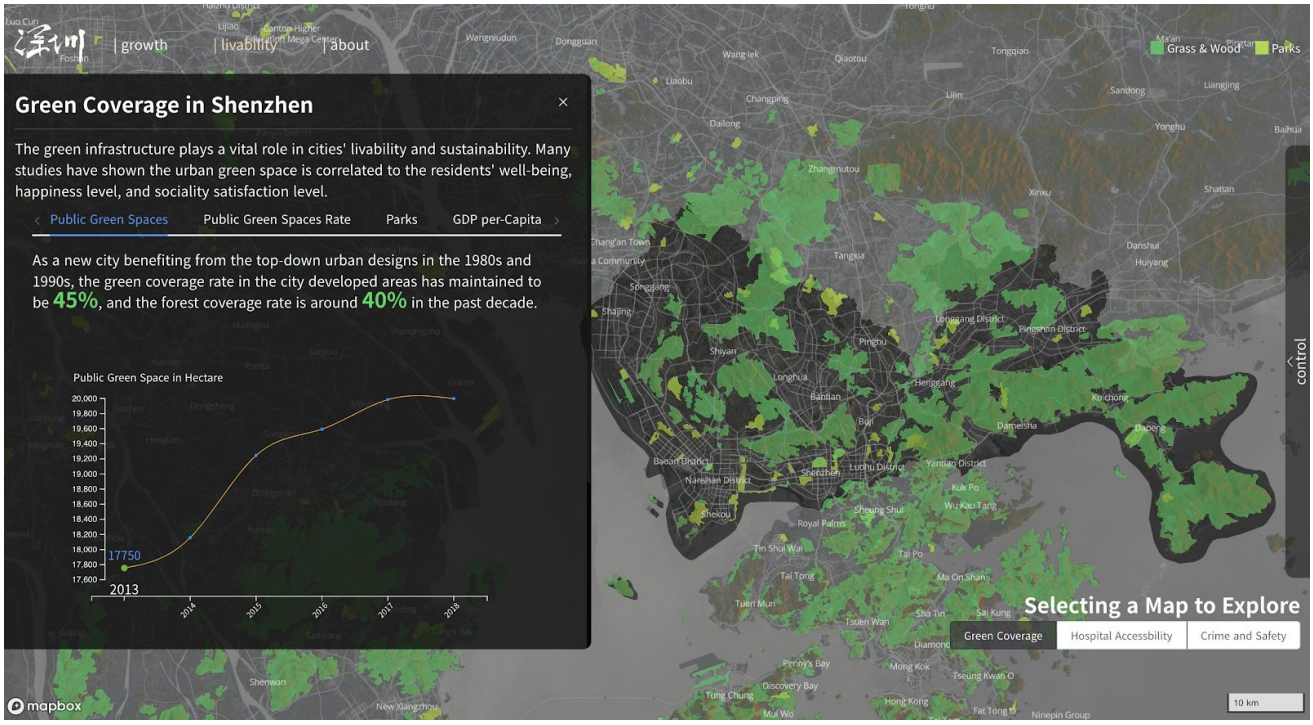
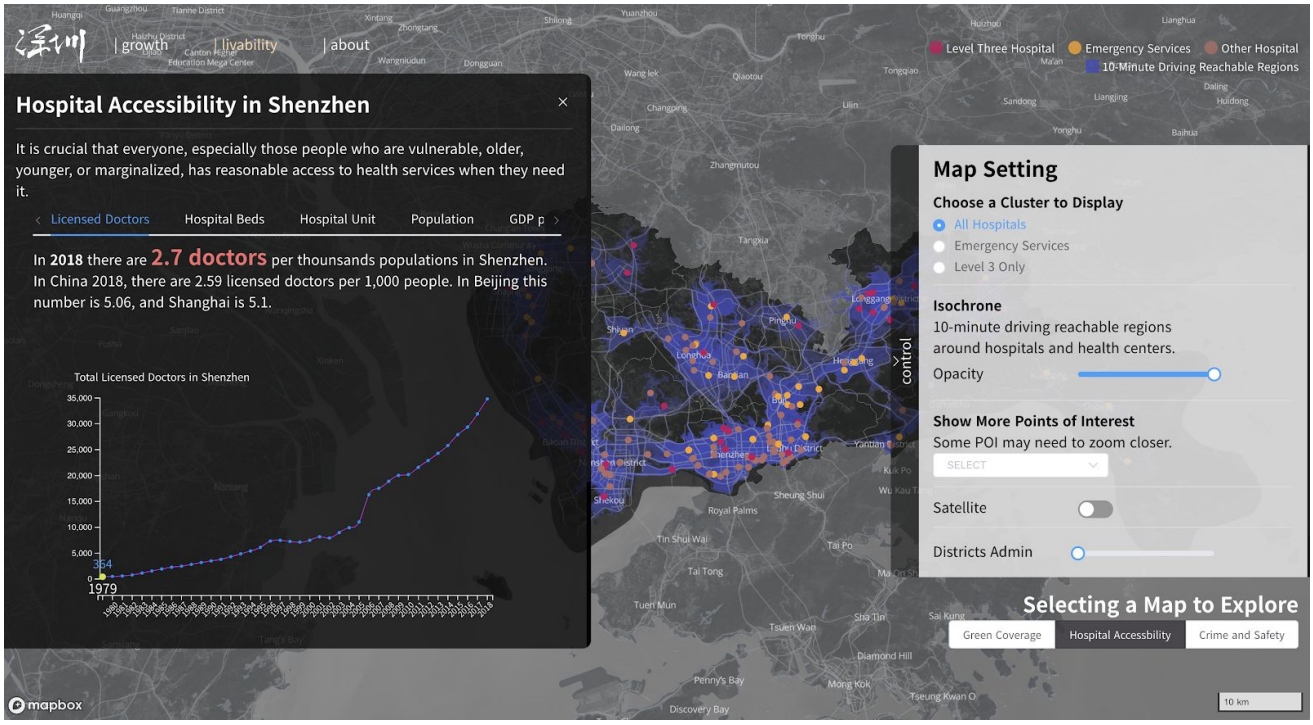


The Story of Growth-6



The Livability in Three Aspects: Green Coverage



The Livability in Three Aspects: Hospital Accessibility

The Livability in Three Aspects: Crime and Safety

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