How has New York City developed as a smart city?

Evaluating smart city contributors in New York City

A Thesis Presented to the Faculty of Architecture and Planning

COLUMBIA UNIVERSITY

In Partial Fulfillment of the Requirements for the Degree

Master of Science in Urban Planning

by

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May 2019

Contents

Acknowledgements

I would first like to thank my thesis advisor, Prof. Douglas Woodward, who has helped me with my thesis throughout the year in many ways. He has always been willing to help me and encouraged me to accomplish my thesis. Since English is not my first language, I had several issues, but he has patiently helped me in improving my thesis.

I would also like to thank my reader, Prof. Anthony Vanky, who has valuable knowledge in the field that I have been interested in. His plethora of knowledge has helped with me to narrow down my topic and develop conclusions.

I would also like to thank to an officer from the Mayor's Office of the Chief Technology Officer and Daniel E. Alam, an Economic Development and Technology Policy Analyst at the Office of Manhattan Borough President, who gave me valuable insights about smart city in New York. Their opinion helped me in grasping a comprehensive understanding of these complex issues in New York City.

Lastly, but not the least, I would like to thank all my friends in the Urban Planning program. They have been my inspirations and motivations, which have helped me to continue working on my thesis.

Chapter 1. Introduction

Abstract

Recently, the rapid growth in technologies has changed our lives dramatically. Thus, utilizing technologies and data is becoming more and more necessary in various fields, including urban planning. The purpose of this study is to develop a matrix to measure the level of smart city in New York City and evaluate all projects, incentives, guidelines or pilot projects contributing to making New York City a smart city based on the matrix developed. This evaluation will be mainly qualitative, followed by interviews with experts in the field to get their insights toward smart city concepts in New York City. Ultimately, this study will identify best practices based on evaluation and deficiencies, as well as next steps that New York City should take to be an even smarter city and redefine smart city concept in New York City based on the findings. I believe that this series of study on smart city concept in New York City will help to understand characteristics in New York City regarding smart city concept, which could be helpful for the city to improve or other cities to refer. In addition, I believe that understanding the dynamics around technologies and the use of data and evaluating them as a whole from planners' perspective, not project by project, will significantly improve the quality of the city in a comprehensive way.

Introduction

We are now living in the middle of the emerging era of the Internet of Things (IoT) and big data, and we have become accustomed to the convenience brought by them in our daily lives. One of the greatest benefits in the planning field is that “the big data allows us to do

sophisticated data analytics for understanding, monitoring, regulating and planning the city." (Rob Kitchen 2013)[1] Also, data analytics can help us realize a more inclusive planning participation process. Thus, I believe we have no choice but to utilize technologies and data to make our lives more convenient, equitable and sustainable. In order to make the best use of current technologies and abundant data available, we, as planners, have to grasp the big picture of what is going on and try to incorporate technologies and data as tools, not as solutions. "Smart city" is one of the concepts that utilizes technologies and big data into the urban planning field and has been discussed in many cities around the world. Across the globe, smart city technology spending is anticipated to hit $80 billion this year, and grow to $135 billion by 2021, according to a report from the International Data Corporation (IDC).[2] The success of the smart city concept depends on various considerations, but largely depends on government initiatives and active innovation. In this sense, I believe New York City has already established a good environment to be a smart city and in fact was once awarded the title as "The Most Smart City" in 2016, at the Smart City Expo World Congress.[3] But how has New York City developed as a smart city? What policies or incentives have combined to contribute to making New York City smart? Currently, there are no comprehensive series of studies or analyses on Smart City projects in New York.

[1] R. Kitchin, "The Real-Time City? Big Data and Smart Urbanism," GeoJournal 79:1 (2013) 1-14.
[2] IDC "Worldwide Semiannual Smart Cities Spending Guide"
https://www.idc.com/tracker/showproductinfo.jsp?prod_id=1843
[3] Smart City Expo World Congress http://media.firabcn.es/content/S078016/SCEWC_Report2016.pdf

The main purpose of this paper is to understand smart city contributors in New York City, such as policies, projects, organizations and institutions, and to critically evaluate them in order to make the most use of them in the urban planning field. This study will use mainly qualitative analysis to understand the current situation and potential for the future in a comprehensive way. First, this paper will develop a matrix to measure the level of smart city in New York City. The matrix will be created by considering both New York City's comprehensive plan and other existing studies on smart city measurements. Since situations and contexts differ greatly city by city, there will be no universal way to measure "smart city." Specifically, there is still no matrix or standard to measure different projects or policies on the smart city strategy in New York City, although the City currently puts a very high value on the development of smart city technologies. Thus, defining a matrix to measure the smart city concept in New York City is also one of the primary goals of this study. This study will also evaluate Smart City contributors, including the policies, projects and organizations, based on the matrix which has been developed prior to the analysis. Interviews with some of the experts in the field will follow to get their insights on smart city policies and projects. Ultimately, this research will identify successful initiatives, policies and projects and also deficiencies and recommendations which New York City should take to be an even smarter city. Finally, this study will redefine the concept of "Smart City" in New York City based on the evaluation.

Value to Planners

The rapid growth in technologies has changed our lives dramatically yet confusingly. It is hard to stay current with all the fast-growing technologies for planners and policymakers, but

there is a critical need to be able to utilize them effectively. New York is ever-growing and has established a solid data environment and is open to introducing cutting edge technologies. Thus, New York City has a great potential to be a smart city by utilizing technologies and data in appropriate ways. I believe that this series of study on smart city concept in New York City will help to understand characteristics in New York City regarding smart city concept, which could be helpful for the city to improve or other cities to refer. In addition, I believe understanding the dynamics around technologies and the use of data from the planner's perspective will be of significant help to improve the quality of New York City.

Background

As the population in urban areas grows and the number of connected devices increases, many cities have realized the need for utilizing technologies and data in order to improve the quality of their cities. There are many cities that have been making efforts to utilize technologies and data in urban planning, such as Singapore and Toronto. Of course, New York City is not an exception. Singapore is well known for its progress in utilization of technologies and data in the urban planning field, which has been encouraged by the Singapore Smart Nation Initiatives.[4] Among many projects, what is unique is that Singapore has established the urban real-time data platform, "LIVE Singapore!"[5], facilitating the collection, combination, and distribution of multiple data streams from urban networks with the help of the Massachusetts

[4] Singapore Smart Nation Initiatives Website https://www.smartnation.sg/
[5] LIVE Singapore Website http://senseable.mit.edu/livesingapore/

Institute of Technology (MIT) Senseable City Lab.[6] This user-friendly platform allows citizens to access a wide range of useful real-time data and has become an effective tool to involve them in the decision-making process.[7] Toronto is also well known for its pioneering smart city development by Sidewalk Labs[8] on Toronto's east waterfront with a vision to be a new type of place that combines the best in urban design with the latest in digital technology to address some of the biggest challenges facing cities, including energy use, housing affordability, and transportation. However, currently, Sidewalk Labs is facing a difficult situation due to a tense relationship with the citizens since no one at Sidewalk Labs, nor in the local government, has given a direct answer to questions about how their data will be used yet. In New York City, starting from sensors to measure air quality, sound and heat to Wi-fi Kiosks and the first quantified community in Hudson Yards, there are wide ranges of technologies. The data security of those varying technologies may be of concern.

Mayor Bill de Blasio and the City Administration have been working to make New York City the world's leading city for tech development. Much of this wide-ranging tech focus was promoted when Mayor de Blasio appointed the city's first Chief Technology Officer (CTO), Minerva Tantoco, in 2014. She helped the administration build an incredible team, new programs and a new strategy for partnering with the tech sector. In 2016, Mayor de Blasio appointed Miguel A. Gamino Jr. as the CTO and asked him to work with all City agencies to

[6] Dietmar Offenhuber, Carlo Ratti (2014) "Decoding the City Urbanism in the Age of Big Data" https://www.academia.edu/9468998/Decoding_the_City_Urbanism_in_the_Age_of_Big_Data
[7] Kristian Kloeckl , Oliver Senn & Carlo Ratti (2012). "Enabling the Real-Time City: LIVE Singapore!" https://www.tandfonline.com/doi/pdf/10.1080/10630732.2012.698068?needAccess=true
[8] Sidewalk Lab Website https://www.sidewalklabs.com/

develop a Smart City and "Internet of Things" strategy that ensures coordination, collaboration and innovation across the City. Additionally, New York City has established a robust open data environment when Local Law 11 of 2012, known as "Open Data Law," was signed by Mayor Bloomberg on March 7, 2012. In accordance with this law, New York City Department of Information Technology & Telecommunications (DoITT) works with the Mayor's Office of Data Analytics to add and make data from agencies across the City available on the NYC Open Data Portal. This rich open data environment has ensured the accountability and accessibility of the New York City government, and also helped to make various innovations possible.

As we can see, how each of these cities has tackled utilizing technologies and data and their focuses or concerns differ greatly city by city. Thus, it's hard to measure its success, outcomes or impacts by universal ways and is also challenging to define what a "smart city" is, which is supposed to utilize technologies and data, by considering complex issues in each city.

Chapter 2. Literature Review

Definition of "Smart City"

There is a plethora of pieces of literature and studies on "Smart Cities," but what exactly is "Smart," especially in the urban planning field? I believe the definitions differ depending on cities and their goals. "Smart" itself by definition from New Oxford American Dictionary means "Having or showing a quick-witted intelligence." Considering the dictionary definition, we can assume that "Smart City" is a city which has "a quick-witted intelligence" achieved by different kinds of technologies. In addition to some of the studies on defining "Smart City", this chapter

will also look at definitions from different perspectives; from academia, people in the tech field, companies to organizations, cities and countries.

There are several studies looking at various definitions of a smart city. The International Telecommunication Union (ITU) Focus Group on Smart Sustainable Cities analyzed over 100 definitions related to smart cities, and the following definition was the outcome of their analysis: "A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects."[9] Anthopoulos (2017) also examines various definitions and defines smart city as "the utilization of ICT and innovation by cities (new, existing or districts), as a means to be sustainable in economic, social and environmental terms and to address several challenges dealing with six dimensions: people, economy, governance, mobility, environment and living".[10] Hollands (2008) defines smart city more comprehensively and mentions that "smart city involves quite a diverse range of things, such as information technology, business innovation, governance, communities and sustainability and improve economic and political efficiency and enable social, cultural and urban development."[11] These definitions above mostly define smart city as a city that utilizes ICTs as tools to improve the quality of cities.

[9] ITU-T Focus Group on Smart Sustainable Cities (2014) "Smart sustainable cities: An analysis of definitions" https://www.itu.int/en/ITU-T/focusgroups/ssc/Documents/Approved_Deliverables/TR-Definitions.docx
[10] Anthopoulos, Leonidas G. (2017) Understanding Smart Cities: A Tool for Smart Government or an Industrial Trick? https://www.researchgate.net/publication/316188926_Understanding_Smart_Cities_-_A_tool_for_Smart_Government_or_an_Industrial_Trick_httpslinkspringercombook1010072F978-3-319-57015-0
[11] Robert G. Hollads (2008) "Will the real smart city stand up?"

Experts from technological fields focus more on technical aspects of "Smart City.' Victoria Sazonchik (2018), a business development manager at the Altabel Group, first broadly defines "smart city" as a city that "employs digital technology to improve municipal management, governance, or long-range design and planning and introduces five technologies powering Smart Cities: Smart energy, Smart mobility, Smart infrastructure, Smart public service and Smart care."[12] Teena Maddox (2016) from TechRepublic has a similar definition. She defines smart city as a city that "utilizes IoT sensors, actuators and technology to connect components across the city, and it impacts every layer of a city, from underneath the streets, to the air that citizens are breathing. Data from all segments is analyzed, and patterns are derived from the collected data." [13] She also mentions six key technologies that makes a smart city work: 1) smart energy, 2) smart transportation, 3) smart data, 4) smart mobility, 5) smart IoT devices. Sidewalk Labs, which was founded in 2015 as a subsidiary of Alphabet to develop technology for alleviating urban problems, has a unique definition. According to Elizabeth Woyke (2018), Sidewalk Labs thinks of smart cities as "being rather like smartphones and sees itself as a platform provider responsible for offering basic tools and plans to let third parties access the data and technologies, just as developers can use Google's and Apple's software tools to craft apps."[14] This definition by Sidewalk Labs is unique and matches with what New York City has been doing since New York City has the robust open data platform which offers

[12] Victoria Sazonchik (2018). "From Smart Technologies To Smart Cities" https://www.smartresilient.com/smart-technologies-smart-cities

[13]Teena Maddox (2016). "Smart Cities: 6 Essential Technologies." TechRepublic. Accessed October 30, 2018. https://www.techrepublic.com/article/smart-cities-6-essential-technologies/.

[14] Elizabeth Woyke (2018). "A smarter smart city" *MIT Technology Review* https://www.technologyreview.com/s/610249/a-smarter-smart-city/

basic tools and plans to let people access the data and technologies. These definitions by experts from technological fields mention specific areas that technologies can be involved in.

It is also interesting to examine definitions by some of the companies involved in smart city technology. For instance, IBM regards Smarter City as a city that can "transform their traditional approach to information management, adopting a smarter approach that helps provide the quality of services that residents require while optimizing resources".[15] Cisco defines smart city as a city that "uses digital technology to connect, protect, and enhance the lives of citizens. IoT sensors, video cameras, social media, and other inputs act as a nervous system, providing the city operator and citizens with constant feedback so they can make informed decisions."[16] Cisco also mentions that "Smart + Connected Community is Cisco's visionary answer: using intelligent networking capabilities to weave together people, services, community assets, and information into a single pervasive solution."[17] Hitachi defines smart city as "environmentally conscious city that uses information technology to utilize energy and other resources efficiently and satisfy the needs of residents".[18] These definitions focus more on a networked system as a basis for smart cities.

[15] IBM Industry Solutions "IBM Smarter City Solutions" (2011) ftp://ftp.software.ibm.com/la/documents/imc/la/cl/news/events/infrastructuresummit/smarter_city_solutions.pdf
[16] Cisco "What is a Smart City?" https://www.cisco.com/c/en/us/solutions/industries/smart-connected-communities/what-is-a-smart-city.html
[17] Cisco "Smart + Connected Communities" (2010) https://www.cisco.com/c/dam/en_us/solutions/industries/docs/scc/09CS2326_SCC_BrochureForWest_r3_112409.pdf
[18] Yoshihito Yoshikawa, Atsutoshi Sato, Shigeki Hirasawa, Masato Takahashi, Mayuko Yamamoto "Hitachi's Vision of the Smart City" (2012) http://intic.org/wp-content/uploads/2018/03/Hitachis-Vision-Of-A-Smart-City.pdf

As planners, the definition by The American Planning Association (APA) should be also noted. APA recognizes "Smart City" to mean cities that use information and technology to engage citizens, deliver city services, and enhance urban systems, which results in cost efficiencies, resilient infrastructure, and an improved urban experience.[19] This definition is more comprehensive and also considers the planning process.

Moreover, as planners, we have to consider all the issues occurring in cities comprehensively, so it is also helpful to look at smart city concepts set by different countries or cities. Busan Green u-City in South Korea is an early example of a smart city, which uses a "cloud-based infrastructure delivered by Public-Private Partnership to improve the effectiveness of city management, generate new growth opportunities for local businesses and raise the quality of citizen's lives." "Smart London", a smart city initiative in London, is about "how the capital as a whole functions as a result of the interplay between different 'systems', is also where the linkages between these different systems are better understood, where digital technology is used to better integrate these different systems, and London as a whole works more efficiently as a result.."[20] Denver, Colorado, has been working on a smart city project spurred on by the U.S. Department of Transportation's Smart City Challenge, which was launched in 2015 to ask mid-sized cities across America to develop ideas for an integrated, first-of-its-kind smart transportation system that would use data, application, and technology to

[19] "Smart Cities and Sustainability." American Planning Association. Accessed October 29, 2018. https://www.planning.org/ontheradar/smartcities/.

[20] "Smart London Plan" (2013) https://www.london.gov.uk/sites/default/files/smart_london_plan.pdf

help people and goods move more quickly, cheaply, and efficiently. [21] Denver's Smart City Program mission states that "Providing the bridge between the people, services, goods, travel choices, information, and technology, allowing for engagement, accessibility, and adaptability while being flexible enough to continually evolve, learn, and get 'smarter'." with more focus on mobility.[22] It is obvious that their visions and focuses differ greatly city by city. Thus, in order to define smart city for this study, this study refers to the definition of smart city by the New York City government. New York City government defines smart city as "a city where anyone and everyone has open access to facilities[23]" which puts more value on equity. By considering other definitions as well, this study defines "Smart City" as "a city that uses ICTs and other technological means to improve quality of life by providing equal and efficient services in order to achieve City's goals." This study will redefine the definition in conclusion based on the evaluation.

Existing studies on measuring Smart City

There are numerous studies to measure and assess Smart Cities. For example, the Smart Cities Council, a network of leading companies advised by top universities, laboratories and standards bodies which will work globally to make cities more livable, workable and sustainable, published "Smart City Index Master Indicators "[24] which has six dimensions:

[21] U.S Department of Transportation "Smart City Challenge" https://www.transportation.gov/smartcity
[22] U.S. Department of Transportation "Beyond Traffic: Denver The Smart City Challenge" https://www.transportation.gov/sites/dot.gov/files/docs/Denver%20Vision%20Narrative.pdf
[23] NYC gov 2017 "New York Named "2016 Best Smart City," NYC To Host 2017 International Conference On Urban Technology At Brooklyn Navy Yard" https://www1.nyc.gov/office-of-the-mayor/news/909-16/new-york-named-2016-best-smart-city-nyc-host-2017-international-conference-urban
[24] Smart City Council (2014). "Smart City Index Master Indicators Survey" https://smartcitiescouncil.com/resources/smart-city-index-master-indicators-survey

Environment, Mobility, Government, Economy, People and Living. Each dimension is followed by several working areas with detailed indicators. Environment, one of the six dimensions, has three working areas: Smart Buildings, Resources Management and Sustainable Urban Planning. In order to measure the level for Smart Buildings, the indicators suggest calculating the number of LEED or BREAM sustainability certified buildings in the city, the percent of commercial and industrial buildings with smart meters, the percent of commercial buildings with a building automation system and the percent of homes with smart meters. "Smart City Index Master Indicators "heavily rely on quantitative analysis, so if the city has access to these data, the analysis could be very accurate and useful to assess the level of Smart City and understand the progress that cities are making in this area. Deloitte, a major consulting firm, has created the "Deloitte Smart City Framework" and defines three goals - quality of life, economic competitiveness, and sustainability. These goals can provide the foundation for a smart city initiative. Deloitte also defines six urban domains: economy, mobility, security, education, living, and environment, where technologies can bring changes.[25] Price Waterhouse and Coopers (PwC) conducted research on analyzing the readiness of cities to implement new technologies and evaluated current initiatives which are related to adopting the latest innovative solutions. *"The Index of Cities' Readiness*"[26] was measured based on the development level for smart housing and utilities, digitalization of culture and tourism, unmanned transport, digital economy, smart healthcare, open adaptive learning, proactive

[25] William D. Eggers, John Skowron (2018). "Force of changes: Smart cities" https://www2.deloitte.com/insights/us/en/focus/smart-city/overview.html
[26] PwC (2017) "The Future is Coming: Index of Cities' Readiness" https://www.pwc.ru/ru/assets/the-future-is-coming-english.pdf

security, virtual service, virtual city and infrastructure readiness. This indicator covers a variety of areas, but the basis of its detailed calculations is not clear, which makes it hard to utilize their methods. The British Standards Institution (BSI)[27] conducted research on Smart City standards and found that there are Smart City standards at three different levels: technical, process and strategic standards. The technical standards are mostly about 'what' needs to be done in terms of implementation and/or operation to establish infrastructure. Process standards deal more with the 'how' and are related to actions or steps to be taken. Strategic standards explain 'why' and provide guidance for stakeholders in planning and management. In addition, there is an interesting indicator that measures the "Maturity" of a Smart City developed by The Scottish Government, Scottish Cities Alliance and Urban Tide. The Smart Cities Maturity Model measures cities in terms of City Management Status, Smart City Status and Effect on Outcomes and identifies the level of the cities at five levels. This indicator is mainly qualitative with only a few criteria, so cities can easily assess their levels in terms of their maturity as a Smart City.

There are different ways to measure the "smartness" of a particular city, so there is not one single universal standard, especially since each city has different goals, complex challenges and contexts. The study on measuring Smart City Evaluation by the Open University[28] also recognizes the difficulties of measuring the impacts of smart city programs and projects on wider city outcomes. Dylan (2017)[29] also conducted research on definition and application of

[27] British Standards Institution (BSI) "Mapping Smart City Standards" https://www.bsigroup.com/LocalFiles/en-GB/smart-cities/resources/BSI-smart-cities-report-Mapping-Smart-City-Standards-UK-EN.pdf
[28] The Open University (2016). "A Tale of Evaluation and Reporting in UK Smart Cities" http://oro.open.ac.uk/46008/7/__userdata_documents4_ctb44_Desktop_Tales_Smart_Cities_Final_2016.pdf
[29]Dylan (2017). "Unfolding the Smart City Label: Definition and Application of Performance Measurement System for Smart Cities" https://pdfs.semanticscholar.org/0e08/5870dd884114ccbf846e6354fbdeef61a3ed.pdf

performance measurement systems for Smart Cities by analyzing existing literature in the field of performance measurement systems and smart cities and concluded that there is no agreement on how the performance within application domains can be measured. Therefore, this study also acknowledges the difficulty of use standards to measure a Smart City, especially considering complexities in New York City.

Chapter 3: Research Design

First, this study will identify the policies, projects, organizations and institutions contributing to the smart city concept in New York City, which are defined as "Smart City Contributors." Then, this study will examine some of the existing indicators, standards and framework that are used to evaluate a smart city. Using New York City's comprehensive plan, OneNYC, as a comparison, this study will develop its own matrix to measure the smart city concept in New York City. Finally, this study will evaluate Smart City Contributors based on the matrix developed. This evaluation will be conducted on all the contributors as a whole, rather than on a project-by-project basis, which will allow us to understand a holistic view of the smart city concept in New York City. Interviews with experts in the field will follow to get valuable insights toward the Smart City Concept in New York City. This study conducted an interview with an officer from the Mayor's Office of the Chief Technology Officer and an Economic Development and Technology Policy Analyst from the Office of the Manhattan Borough President. Ultimately, this study will identify the level of New York City's Smart City, best practices, deficiencies and also next steps New York City should take to be an even smarter city and redefine smart city concept in New York City based on the evaluation.

Chapter 4: Smart City Contributors in New York City

Smart City Contributors

Our lives in New York City have been supported and improved greatly, thanks to various technologies. In 2016, New York City was awarded as “The Most Smart City” at the Smart City Expo World Congress, so New York City has been recognized as an advanced city in terms of utilization of technologies around the world. The technologies that are used in New York City range from different kinds of sensors to smart furniture. This study examines the projects, incentives, guidelines or pilot projects, which are defined as “Smart City Contributors”, contributing to making New York City as smart city. This study has identified 54 Smart City Contributors in total, including projects that haven’t been implemented yet.

Figure 1 below shows the number of Smart City Contributors between 2003 and 2019. It shows how the number of Smart City Contributors has increased greatly since 2014, when Mayor Bill de Blasio was elected as the 109th Mayor of New York City. It is also surprising to note that there was no major increase in the number of Smart City Contributors between 2002 and 2013, when the former mayor of New York, Michael Bloomberg, was serving. However, he played an important role since he enacted the “Open Data Law”, which has established a foundation for New York to be a smart city.

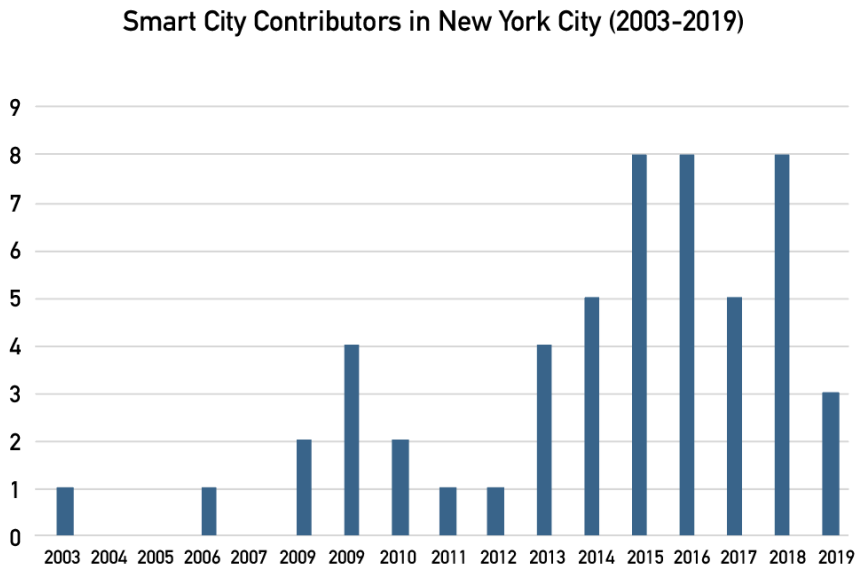


Figure 1. Smart City Contributors in New York City (2003-2019)

This study categorizes these Smart City Contributors based on means that realize these Smart City elements: GPS, Sensor, Internet Access/ Data Infrastructure, Initiatives/ Competition, Website/Application, Urban Innovation Hubs, and Wireless Networked Technology and Guidelines. Figure 2 shows the number of Smart City Contributors in New York City for each of the categories.

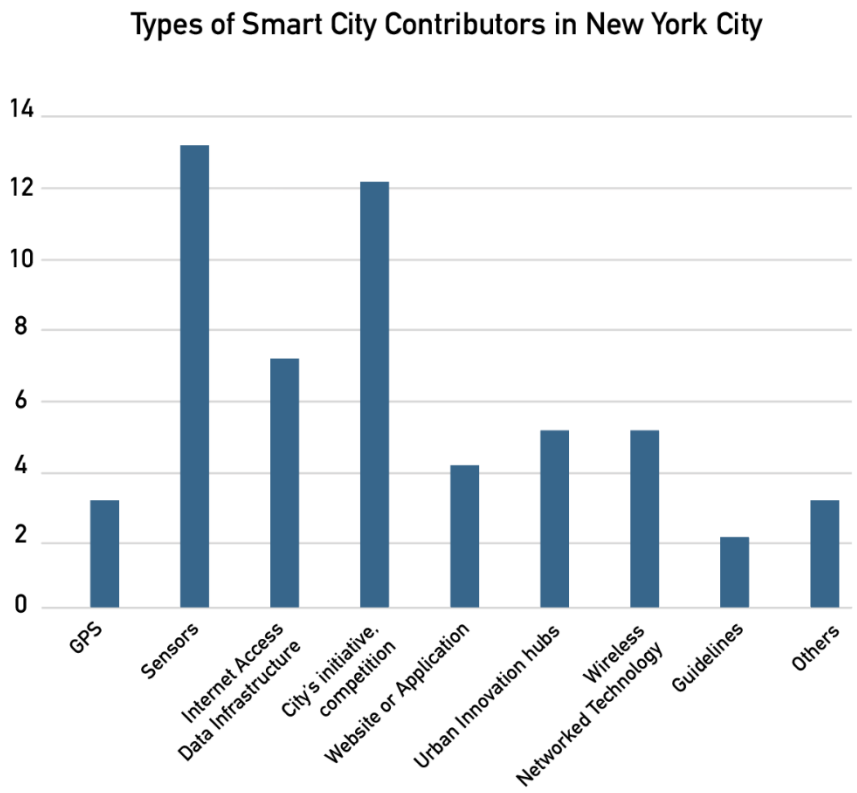


Figure 2. Types of Smart City Contributors in New York City

The most-used technology is sensors, but each of the sensors has a different purpose. The earliest sensors introduced were sensors to monitor air quality installed by the New York City Department of Health and Mental Hygiene in 2008. These sensors have contributed to creating healthy life in New York City, as well as sensors for smart waste management, monitoring water quality, power, noise, heat and hot water in buildings. Midtown in Motion[30] by Department of Transportation was a successful project with implementation of traffic sensors, cameras and EZ – Pass Readers, which gather real time traffic information and has resulted in a decrease of travel time by 10% in the city. Sensors for real time gunshot detection,

[30] New York City DOT (2012) "Press Release" https://www1.nyc.gov/html/dot/html/pr2012/pr12_25.shtml

ShotSpotter, contribute to safety in New York City. One year after a pilot program started in Brooklyn and the Bronx in 2015, the mayor proposed to expand ShotSpotter to all five boroughs with a 3-million-dollar allocation. Thousands of sensors will be implemented in the first quantified community in Hudson Yards, where Sidewalk Labs is located, in the middle of 2020 in order to collect information on pedestrian traffic, air quality, energy production and consumption, and even the health and activity levels of workers and residents. This project will make the most use of technologies and data to understand the city, which will soon reveal the great potential of technologies applied in the urban planning field and great concern at the same time. Although, first phase of Hudson Yards just opened recently, it has already raised privacy concerns. For instance, Vessel, the honey-comb shaped staircase in Hudson Yard, has extreme terms & conditions which claims full rights to any photos taken by visitors in the Vessel's immediate vicinity. They have slightly modified their terms & condition, but visitors would be prone to privacy concerns in the future again when the entire project will be completed in 2020.

Initiatives or competitions for Smart City are also active Smart City Contributors in New York City. These initiatives or challenges allow everyone to participate, thus encouraging equity. The first competition focusing on technical solutions, Call for Innovation[31], started in 2014. A call for Innovations is an open solicitation of ideas and proposals that aims to provide innovative solutions to challenges facing the city and find new ways of improving the lives for all New Yorkers. Collaborating with different city agencies and not-for-profit organizations, a

[31] http://www.nyc.gov/html/cfi/html/index.html

call for innovations looks for technical solutions to solve different issues in New York City, such as technical solutions the New York City Housing Authority (NYCHA) pilot to reduce electrical demand, proposals that actively shape the city's response to driverless cars and so on. New York City acknowledges future growth in technological fields and established the Computer Science for All initiative[32] for every public school student in New York City to learn computer science. Since the New York City Mayor's Office of the Chief Technology Officer established NYCx[33], which is the world's first municipal program to transform urban spaces into hubs for tech collaboration, research, testing and development[34], in 2017, competitions for seeking innovative solutions have been very active. NYCx has launched an open competition program, called Moonshots, to encourage entrepreneurs around the world to partner with the City to propose solutions to real-life problems and deliver groundbreaking business models that transform and improve lives in New York City. NYCx has launched two NYCx Moonshot challenges so far – the Governors Island Connectivity Challenge and the Climate Action Challenge. NYCx also has established the NYCx Co-Labs in Brownsville, Brooklyn, to build a neighborhood-based partnership to co-design stations to a set of challenges and to make neighborhood spaces available for testing new technologies aiming to address the neighborhoods' most pressing needs. Two Co-Lab Challenges have been developed: "Safe and Thriving Night Corridors", seeking for creative solutions to encourage more people to enjoy, navigate, and use Brownsville's public spaces at night and "Zero Waste in Shared Space",

[32] Computer Science for All: Fundamentals for Our Future https://www1.nyc.gov/office-of-the-mayor/education-vision-2015-computer-science.page
[33] New York City Mayor's Office of the Chief Technology Officer website https://tech.cityofnewyork.us/#our-work
[34] The Official Website of the City of New York https://www1.nyc.gov/office-of-the-mayor/news/679-17/de-blasio-administration-brownsville-community-leaders-nycx-co-lab-challenges-in

looking for innovative solutions that increase resident participation in recycling and waste-reduction opportunities while reducing trash and litter in the common areas in public housing. These open competitions and initiatives would work well, especially in New York, thanks to the rich open data environment and numerous tech companies. These competitions and initiatives will keep contributing to improve New York City by offering innovative solutions, while ensuring equity.

Another noted Smart City Contributor is data infrastructure and internet access. New York City has started making efforts for ensuring equal access to the Internet for all, especially for lower income individuals who don't have access to the internet. This project began in 2009 by kicking off "The NYC Connected Communities Initiatives."[35] This initiative aims at making critical enhancements to public computer centers in low-income communities around New York City. Later, Harlem Wi-Fi was introduced in 2013 and Parks Wi-Fi was introduced in 2014. What is more, LinkNYC was introduced in 2014. Currently, there are 1,867 LinkNYC kiosks across the five boroughs that provide free public Wi-Fi, phone calls, device charging and tablets for access to city services, maps and directions and the City plans to expand the number of LinkNYC kiosks. In addition, a new and unique approach, Digital Van, was introduced in 2016 to bring free high-speed internet service into the homes of tens of thousands of low-income New Yorkers. Thus, New York City has made great efforts to offer internet access equally, especially to those who can't afford it by themselves. Moreover, what is remarkable in New York City is its rich open

[35] The Official Website of the City of New York https://www1.nyc.gov/office-of-the-mayor/news/432-09/mayor-bloomberg-connected-city-initiative

data environment. Efforts for establishing an open data environment started when former Mayor Bloomberg signed Local Law 11 of 2012, known as the "Open Data Law"[36]. Later in November 2015, January 2016, and December 2017, Mayor de Blasio approved several amendments to the Open Data Law. According to Daniel E. Alam, an Economic Development and Technology Policy Analyst at Office of the Manhattan Borough President, "the open data environment in New York City is the most robust in cities in North America. What we need to do is to provide people training to utilize them." In addition, this open data environment has revealed what all the city agencies are doing, so it ultimately increases transparency of agencies' roles. Thus, this rich open data environment has provided various advantages for New York City to be smart and equal for all people.

Another notable smart City Contributor is urban innovation hubs. The first urban innovation hubs, the Urban Future Lab, was established in 2014 by the New York City Economic Development Corporation, partnered with New York University's Polytechnic School of Engineering. Later, Urban Tech NYC, URBAN-X, Brownsville Innovation Lab and The Grid were established. These urban innovation hubs provide facilities for entrepreneurs to create innovative solutions for the City. These urban innovation hubs have made the most use of being in New York where a lot of innovation can happen since New York City is an economic center in the United States and has numbers of creative class people.[37] (Florida 2002)

[36] NYC OpenData Website https://opendata.cityofnewyork.us/open-data-law/
[37] Richard L. Florida (2002) "The Rise of the Creative Class"

In order to control the use of technology and ensure equity or privacy, guidelines play an important role. In 2016, "Guidelines for the IoT"[38], a set of comprehensive guidelines for ensuring the responsible and equitable development of smart city technologies, was published by Mayor's Office of the Chief Technology Officer. These guidelines list policies on privacy and transparency, data management, infrastructure, security and operations + sustainability to provide a framework for deploying connected devices and IoT technologies in a coordinated and consistent manner, while ensuring privacy, security and equity at the same time. These guidelines have established robust rules on introducing new technologies in the City and helped agencies as well as citizens since privacy concerns are one of the biggest issues towards introducing technologies.

Actors' Roles

Next, this study will examine Smart City Contributors based on specific actors. Although this study mainly focuses on projects done by City agencies, there are a variety of institutions, including private companies and schools, which work with city agencies. The chart below shows the number of actors based on types.

[38] Guidelines for the Internet of Things website https://iot.cityofnewyork.us/

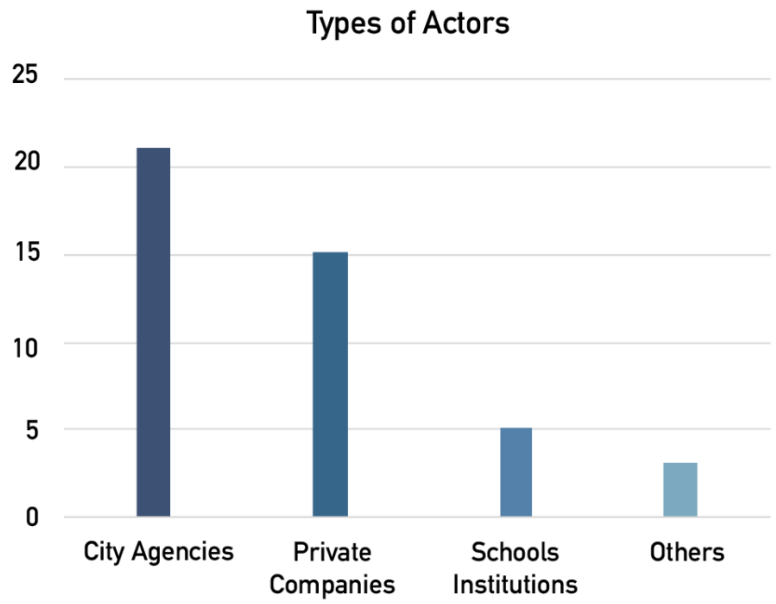
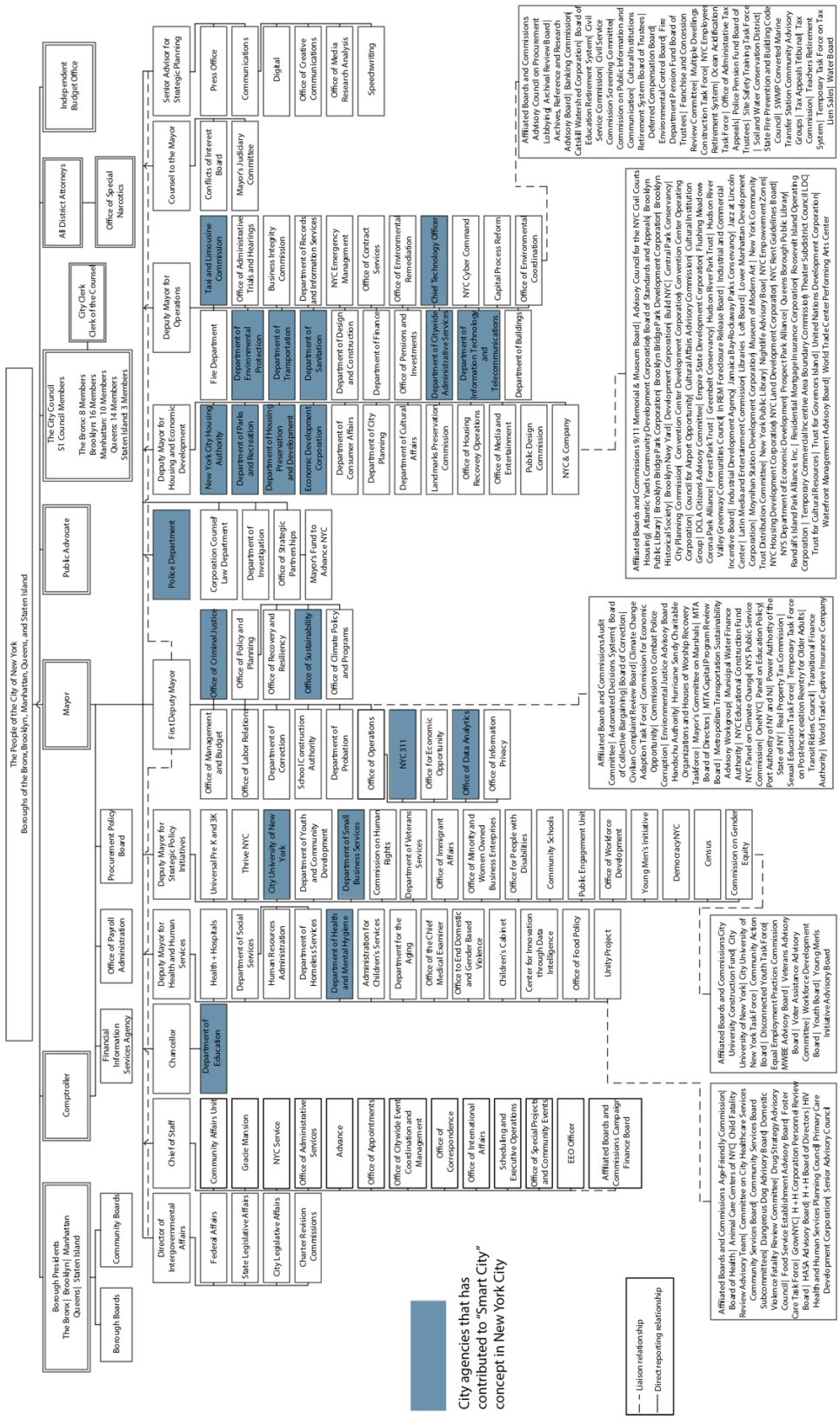


Figure 3. Types of Actors contributing to Smart City in New York (2003-2019)

Figure 4. City agencies diagram (Source: NYC Organizational Chart, https://www1.nyc.gov/office-of-the-mayor/org-chart.page)



City Agencies	Number of Projects
NYC Department of Information Technology & Telecommunication	11
NYC Economic Development Corporation	9
Mayor's Office of Technology and Innovation	6
Mayor's Office of the CTO (NYCx)	6
NYC Department of Sanitation	4
NYC Department of Transportation	3
MTA	3
NYCHA	3
NYCParks	2
Mayor's Office of Data Analytics (MODA)	2
NYC Department of Environmental Protection	2
NYC Department of Small Business Services	1
NYC Department of Citywide Administrative Services	1
NYC 311	1
NYC Taxi and Limmousine Commission	1
NYC Department of Health and Mental Hygine	1
NYPD	1
NYC Criminal Justice	1
NYC Housing Preservation & Development	1
NYC Department of Education	1
NYC Department of Sustainabiligy	1

Table 1. List of public agencies contributing to Smart City in New York

Among the City agencies, the New York City Department of Information Technology & Telecommunication, known as DoITT, has the largest number of projects relating to Smart City in New York. The New York City Economic Development Corporation (EDC), Mayor's Office of Technology and Innovation (MOTI) and Mayor's Office of the Chief Technology Officer follow. It should be noted that the Department of City Planning (DCP) hasn't contributed to any of these projects. However, this study acknowledges that DCP has contributed a lot to establish foundation which has helped other projects, such as Zola and NYC 3D Model. Zola offers a platform which allows easily search complex zoning and land use regulations in New York City

and NYC 3D Model is a publicly available model consisting of every building in New York City present in 2014. These platforms are not really helpful for public people, but helpful for planners and others. DCP is supposed to supervise plans for the city, so collaboration with other city agencies for their projects would help to improve their services and will lead to function a city from a more holistic perspective. Most of the projects have been done a collaboration within city agencies, but some of them have been a cooperation between city agencies, private companies, schools/ institutions etc. The chart below shows how all the 54 projects examined in this study have been realized.

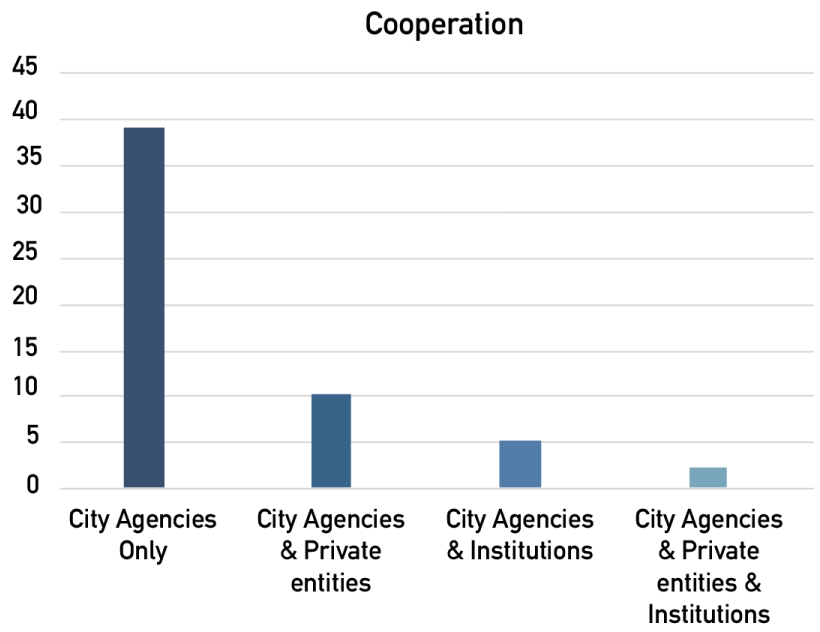


Figure 5. Cooperation among actors for Smart City Contributors

Of course, there are also various projects done by only private companies, which has contributed to making New York City smart, such as Uber, Lyft, and Airbnb. The emergence of these private companies has definitely helped to make our lives more convenient, but also

caused various problems, such as issues with cabs. For example, Uber and Lyft have provided efficient transportation means, but also caused congestion around the City. Airbnb has offered a variety of types of flexible means to stay in the City, but also caused several problems, such as an increase in rent and racial discrimination. In addition, Amazon's plan to build new headquarters in Long Island City was pulled out due to oppositions from local activists. Projects led by mainly private companies miss a holistic view of making a city better, so cooperation with city agencies is advisable. This is true especially in New York City, where the situation is more complex than other cities, so cooperating with just one big company to make a city smarter would not work, unlike in some other cities. However, in order to take advantage of various innovative ideas, the City also has to rely on private companies.

This chapter has examined 54 smart city contributors based on their means of implementation and actors. These projects will be evaluated with the matrix developed in a later chapter.

Chapter 5: Define the matrix

"How to measure Smart City?" is such a big question, although more and more cities have been trying to create a smart city. Similar to the number of different definitions for "Smart City," there are also various ways to measure "Smart City." In order to develop the matrix to measure the Smart City concept in New York City, this study examines several standards, frameworks and matrix to measure smart city. This study will use 18 existing standards,

frameworks or matrices which are often seen in studies on measuring smart city and detail enough to refer to.

Name of Indicator/ research/ frameworks	Developer	Year
Smart City Index Master Indicators	Smart City Council	2014
A smart city model -technical view	British Standards Institution	2015
Smart City Framework	Deloitte	2018
Index of Cities' Readiness	PwC	2017
multi-dimensional smart city model	ISO	2014
Smart City Dimensions	Kamel Jouili & Abdurahman Al Furjani & Isam Shahrour & Kent Washington	2017
Primary Index for urban intelligent development	Hongbo Shi , Sang-Bing Tsai , Xiaowei Lin and Tianyi Zhang	2017
Smart Cities	Juniper Research	2017
Smart City Applications	GSMA Smart Cities	2013
Measuring the success of smart cities	European Smart Cities Initiatives	2017
Smart Cities Community	IEEE	2017
ASEAN Smart Cities Framework	ASEAN Smart Cities Network (ASCN)	2018
Smart applications in eight domains	Mckinsey	2018
European Smart Cities Ranking (ESCR) Model	Vienna University of Technology/ University of Ljubljana/ Delft University of Technology (Giffinger et al. 2007),	2018
CITYkeys indicator framework	CITYkeys	2017
Ericsson: Networked Society City Index	Ericsson Ltd. with Sweco Ltd.	2016
Smart city literature – 6 domains	Dylan van der Hoeven	2017
Building a Smart + Equitable City	Mayor's Office of Technology and Innovation	2015

Table 2. List of indicators, research and frameworks reviewed in this study

Through the research, it has turned out that there are several categories that most of the standards, frameworks or matrices have in common, shown in table 7, although their detailed indicators differ. The seven categories that they have in common are: Environment, Mobility, Economy, Living, Governance, Infrastructure and People. Five focuses mentioned in "Building a Smart + Equitable City" published by Mayor's Office of Technology and Innovation are also fall under seven categories identified here.

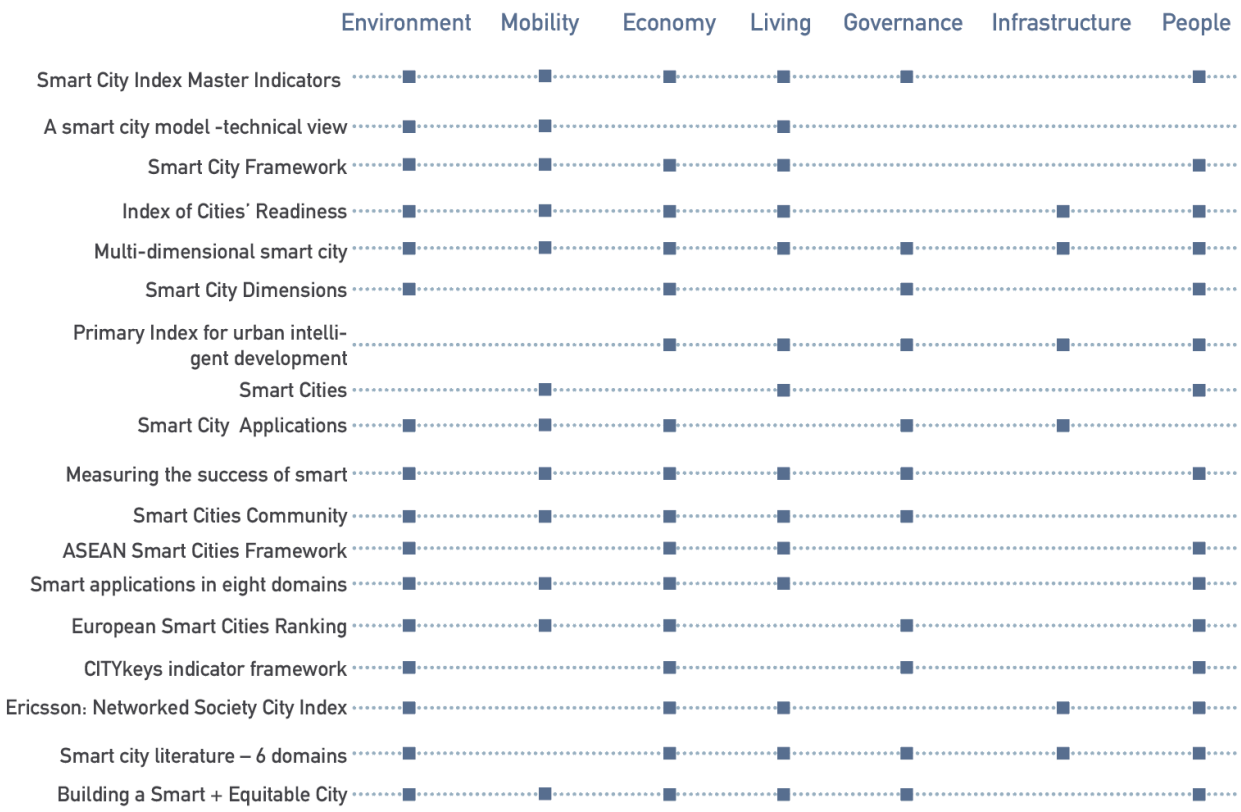


Table 3. Comparison of list of indicator, research and framework with 7 categories

Next, this study will examine New York City's comprehensive plan, OneNYC.[39] It is important to have vertical consistency with the City's comprehensive plan to achieve the City's overall vision, so all the projects in New York City should follow the goals mentioned in OneNYC as well. Thus, considering the City's visions and goals helps to develop a matrix which corresponds with complexities in New York City. OneNYC has four principles: Growth, Equity, Sustainability and Resiliency. Each of the principles has specific goals to achieve. This study will use these visions and goals to make the matrix suitable for New York City. The table below

[39] OneNYC website https://onenyc.cityofnewyork.us/

shows four principles with their goals and how they are correlated with seven focus categories mentioned before.

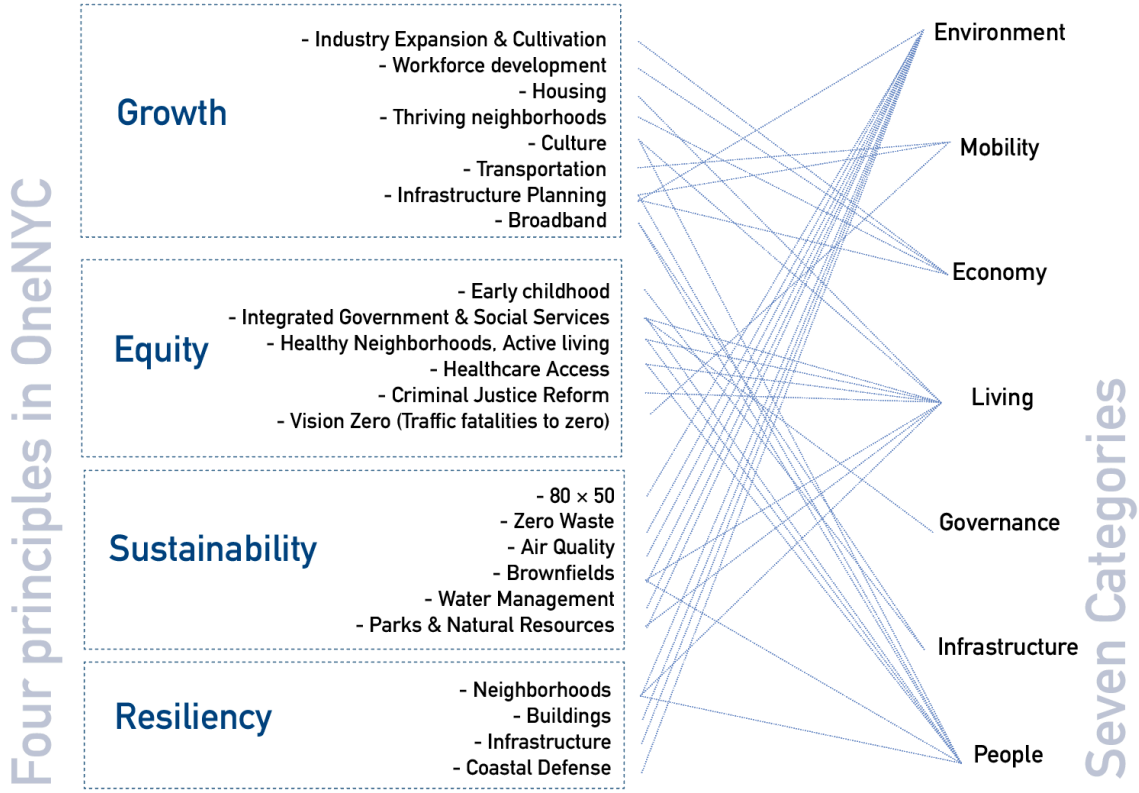


Figure 4. Four principles, their goals and correlation with seven categories

According to table 4, the growth principle covers five of seven Smart City categories: Economy, Living, People, Mobility and Infrastructure, and the equity principle covers four of seven Smart City focuses: People, Governance, Living, People and Mobility. On the other hand, the sustainability principle and resiliency principle are mostly for the environmental category.

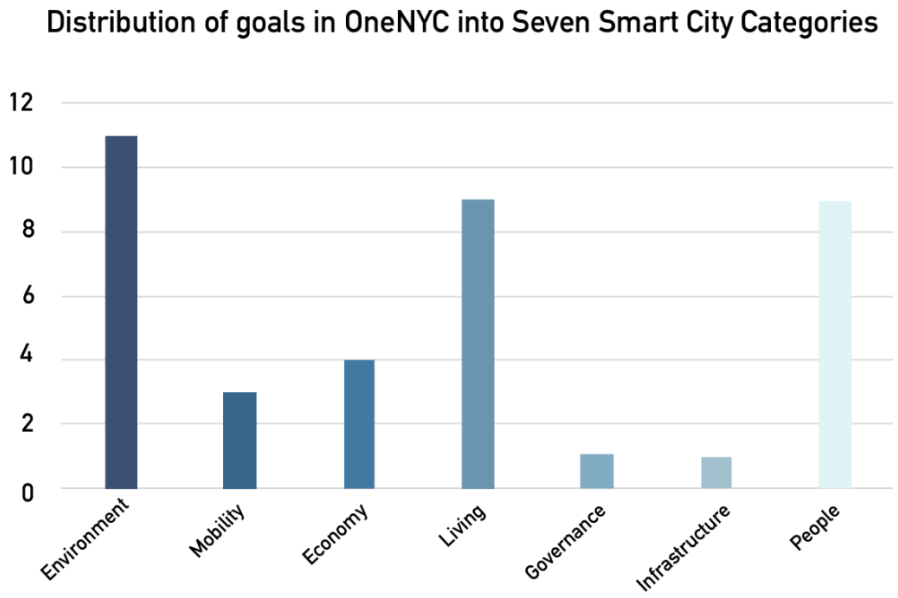


Figure 6. Distribution of goals mentioned in OneNYC into Seven Smart City focuses

According to figure 6, OneNYC also covers the seven Smart City focuses identified before, although their distribution is not even and many of their goals are applied to the environment, living and people. Since the seven focuses are consistent with OneNYC, this study will use these seven Smart City focuses as indicators to evaluate all the Smart City Contributors examined in the previous chapter to assess the level of Smart City in New York City.

Based on Smart City Index Master Indicators[40], which explains detailed working areas for smart city focuses, and OneNYC, this study defines specific areas of implementation for each of seven Smart City categories.

[40] Smart City Council (2014). Smart City Index Master Indicators https://smartcitiescouncil.com/resources/smart-city-index-master-indicators-survey

- Environment: Smart buildings, Resources Management (Energy, Carbon Footprint, Air quality, Waste Generation, Water consumption, Greenhouse gas reduction, water management, parks & natural resources), Sustainable Urban Planning (Climate resilience planning, coastal defense)
- Mobility: Efficient transport, Multi-modal Access, Technology Infrastructure, Vision Zero (Traffic fatalities to zero)
- Economy: Entrepreneurship & Innovation, Productivity, Local and Global Connexon, Industry Expansion & Cultivation
- Living: Culture and Well-being, Safety, Health
- Governance: Online services, Open government, Privacy
- Infrastructure: Internet infrastructure, data infrastructure
- People: Inclusion, Education, Creativity

Chapter 6. Assess smart city contributors

Assessing Smart City contributors with seven focuses

In this chapter, the study will evaluate all the Smart City Contributors and all the actors examined in chapter 4 with the seven Smart City categories with working areas identified in chapter 5, then identify some of the deficiencies and best practices. Table 5 shows how all the 54 Smart City Contributors have contributed to seven Smart City focus categories.

Table 5. Smart City Contributors Evaluation table

Table 5 shows that Smart City Contributors have contributed more on “Living”, ”People” and “Infrastructure”. Many scholars argue that Smart Cites should be people-oriented. Also, an officer from Mayor’s Office of Chief Technology Officer mentioned during his interview that New York City is trying to be smart for people to provide services equally and efficiently. Thus, Smart City Contributors in New York City have done great work in terms of providing people-oriented equal services. Smart City contributors working for “Living” have mostly been dedicated to improving well-being among other working areas. Smart City contributors for “People” have mostly focused on equity since New York City stresses equity. Those working for “Infrastructure” mostly have contributed to internet infrastructure, which is a foundation for many other projects. However, Smart City Contributors in New York City have to do more, especially for “Mobility” and “Governance”. Although the total number of Smart City Contributors for “Governance” is low, New York City has the most robust open data program among cities in the United States. Thus, New York City already has the environment to establish a better open government, so how to utilize policies and recourses already in place is critical. As Daniel E. Alam mentioned in his interview, the City should invest more on open data coordination, as well as training for city employees to maximize the resources the City has. It is also obvious that the City needs to invest more on “Mobility,” as many New Yorkers are frustrated about the transportation system in New York City. Some of Smart City Contributors for “Mobility”, such as “Transit Signal Priority (TSP)”, are not visible, so it is difficult to measure or understand their effects or direct benefits to people. Furthermore, some of the contributors are serving only for a limited number of people. For example, “Drive Smart Initiative” selected only 400 drivers who received the Drive Smart OBD-II device allowing them to access real-time

services to help them save money, save time, and drive more safely. Also, NYC Connected Vehicle Project only involves up to 8,000 cars, taxis, trucks, pick-up trucks and buses. “Midtown in Motion”, a responsive traffic management, only works in limited neighborhood and Citibike is also only beneficial for those who can pay. Thus, these Smart City contributors are still unknown in terms of success. On top of that, none of Smart City Contributors have been dedicated to improving the poor subway system in New York City. “Mobility” is very critical for New Yorkers, so there is still space to improve. Integrating technologies into mobility systems should definitely be considered, in order to establish a sustainable mobility system which can accommodate an increasing population in New York City.

Assessing actors

Table 6 illustrates how actors have contributed to each of seven Smart City focus categories in New York City. It has turned out that many of the actors from city agencies have contributed to the seven categories relatively evenly, while private companies have contributed more to economic and infrastructure, and schools and institutions have contributed more to infrastructure. It is difficult to decide which actors have contributed the most in terms of making New York City smart, but obviously, Mayor's Office of Technology and Innovation (MOTI) and Mayor's Office of the Chief Technology Officer are leading agencies in terms of the numbers of projects. MOTI is the only agency that contributes to all the seven Smart City focuses categories.

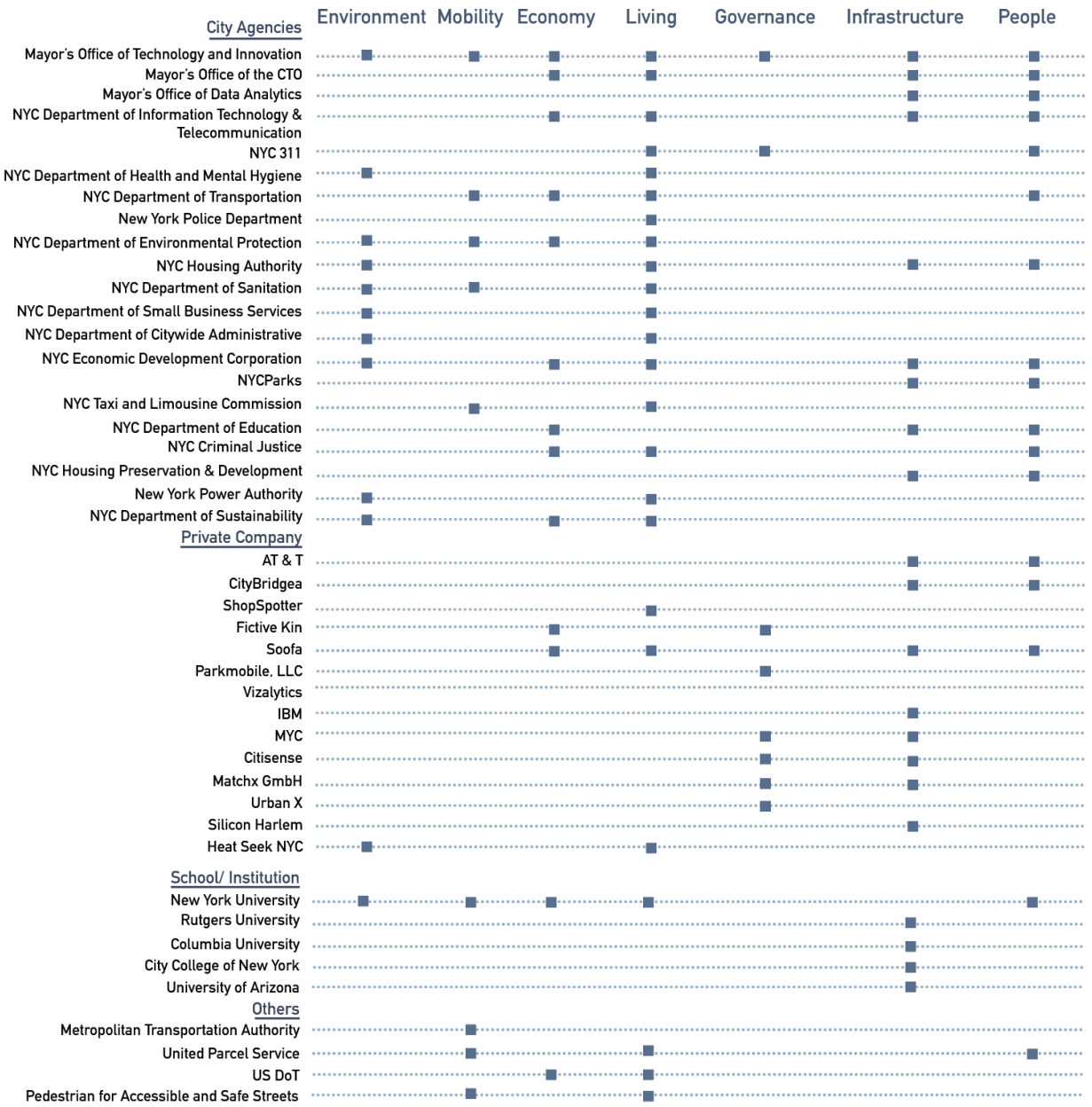


Table 6. Smart City Contributors Actors Evaluation table

Best Practices

Based on the series of evaluation, this study redefines Smart City concept in New York as "a city that utilizes technological means as tools to improve the quality and efficiency of city

services while ensuring equity." According to the evaluation, this study has identified three best practices which fulfill Smart City Concept in New York City: Open Data Law, LinkNYC and NYCx Challenge. All of them are unique to New York City and also ensure equity for people.

As mentioned before, Open Data Law is a critical foundation which makes New York City smart. Since Open Data Law was first enacted in 2012, it was updated in 2015, 2016 and 2017 by Mayor de Blasio, which makes some of the requirements stronger. The Open Data team, which consists of the Mayor's Office of Data Analytics (MODA) and Department of Information Technology and Telecommunications (DoITT), is responsible for carrying out Open Data Law. During the Fiscal Year 2018, 629 new datasets were published and 38 datasets have become automated.[41] Open data environment in New York City has become more and more robust and has established a better environment. Daniel E. Alam from the Manhattan Borough President's Office also answered that New York City has the most robust open data environment. This rich Open data environment allows access to any kinds of datasets in the City by anyone, which ultimately contributes to active civic engagement and innovation.

LinkNYC is also a unique project, which has a huge impact on people, done as a collaboration between city agencies and a private company, CityBridge. There are currently 1,867 LinkNYC kiosks across the five boroughs. Figure 7 shows the distribution of LinkNYC. It is clear that the distribution is more concentrated in Manhattan than in other boroughs. New

[41] NYC OpenData (2018) "NYC Data At Work" https://opendata.cityofnewyork.us/wp-content/uploads/2018/09/2018-NYC-OD4A-report.pdf

York City plans to increase the number of LinkNYC kiosks to 7,500, so they can improve internet access for the people. Moreover, what is unique about this project is how they monetize this project. Since this project is done as a collaboration between city agencies and a private company, it is not funded by taxes. This system is very simple, yet beneficial for both city agencies and the private company, and is easy to apply to other cities. Although, it is not clear how they decide locations for new kiosk, which is likely to be decided based on profitability, or what CityBridge or Sidewalk Lab or Google truly want to get from this project, they have contributed to improving life for people in New York City.

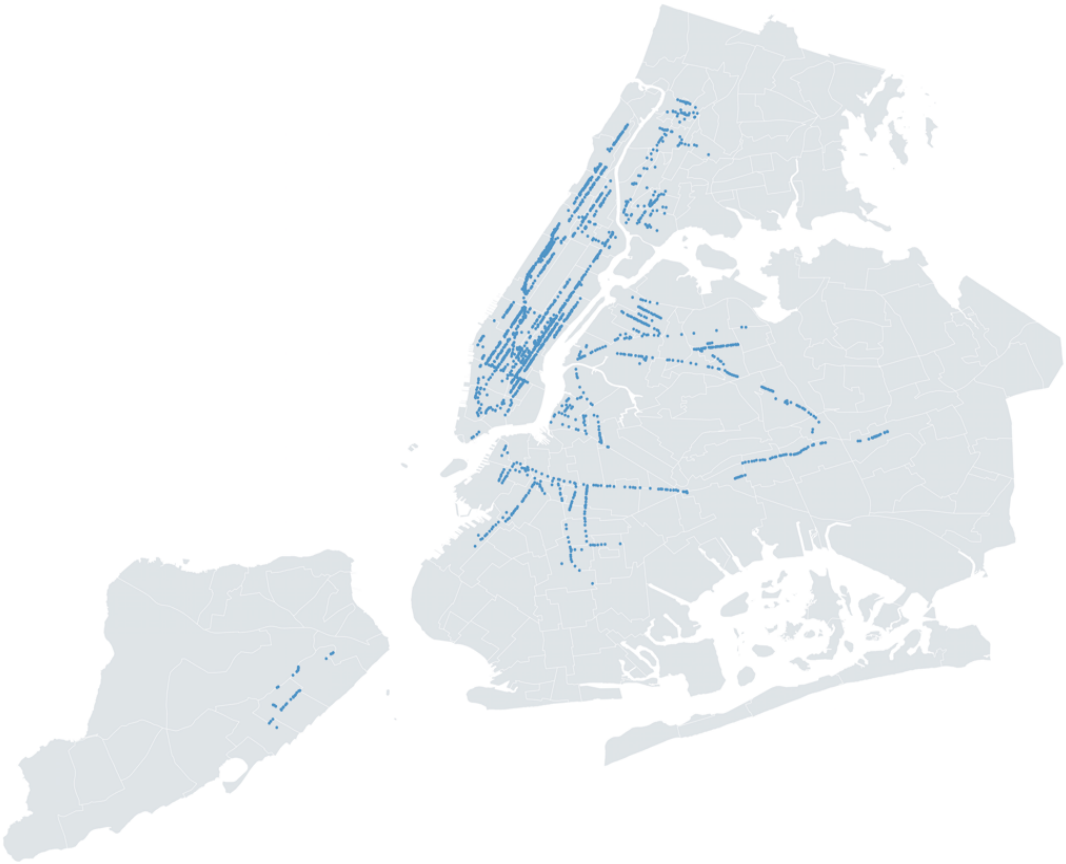


Figure 7. Distribution of LinkNYC

NYCx Challenge is also a unique approach to ask innovative solutions for some of the issues in New York City. NYCx is running two challenges: the Moonshot challenge, which encourage global entrepreneurs to partner with the City to propose solutions to real-life problems and deliver groundbreaking businesses that transform and improve the way we live, and Co-lab challenges, which enable members of NYC communities to voice concerns on the neighborhood level and work with entrepreneurs to surface problems, co-create prototype solutions, and apply, test, and grow emerging technologies. These challenges encourage the engagement of all kinds of people, from local communities to global entrepreneurs. So far, NYCx has launched two NYCx Moonshot challenges: “Governors Island Connectivity Challenge,” which seeks the world’s most inventive thinkers to provide high-speed, low-cost internet connectivity on Governors Island, and “Climate Action Challenge”, which seeks to test breakthrough technologies for charging electric vehicles. These challenges are very unique and helpful for many people, but right now, it is hard to track how they have implemented since there is no official information available online. These challenges which seek solutions to people from all over the world may work in New York City, where there are various companies and many people who pay attention to the City, but they are not necessarily applicable to other cities. In addition, in 2017, NYCx has established NYCx Co-Labs, which is a hub for experimentation and education located in high-need, high opportunity neighborhoods, in 2017. Public programs and workshops take place throughout the year, which encourage New Yorkers of all ages to test and give feedback on technologies aimed at improving quality of life and city services. This project is very neighborhood-oriented and responsible for considering opinions from local people, while regarding this as a pilot to implement on a large scale. The NYCX Co-

Lab also works to connect community members to economic opportunity through training programs. Moreover, NYCx launched two Co-Lab Challenges: “Zero Waste in Shared Space,” which seeks ways to get to zero waste and litter and increase recycling in Brownsville’s public housing, “Safe & Thriving Nighttime Corridors,” which seeks creative technology solutions that encourage more people to enjoy, navigate, and use Brownsville’s public spaces at night. This project is people-centered and contributes a lot to Smart City focuses. Also, this project has an effective way of implementation since this project has started in underserved areas and also been regarded as a pilot project to expand on a bigger scale.

Through assessing each of Smart City Contributors and actors with seven Smart City focus categories, this chapter has identified some of their deficiencies and best practices.

Chapter 7: Summary

Conclusion

As stressed several times, it is difficult to define what a smart city is. This study redefines smart city concept as “a city that utilizes technological means as tools to improve the quality and efficiency of city services while ensuring equity” by reviewing all smart city contributors. In addition, it is also difficult to define a matrix or standard to measure the level of smart city since each city has different goals or issues that they want to achieve. Through examining major standards or matrices and comparing with New York City’s comprehensive plan, OneNYC, this study defines the following Smart City focus categories as a matrix to measure smart city

concepts in New York City. Below are the seven smart city focus categories with specific working areas identified by comparing with OneNYC.

- Environment: Smart buildings, Resources Management (Energy, Carbon Footprint, Air quality, Waste Generation, Water consumption, Greenhouse gas reduction, water management, parks & natural resources), Sustainable Urban Planning (Climate resilience planning, coastal defense)
- Mobility: Efficient transport, Multi-modal Access, Technology Infrastructure, Vision Zero (Traffic fatalities to zero)
- Economy: Entrepreneurship & Innovation, Productivity, Local and Global Connexon, Industry Expansion & Cultivation
- Living: Culture and well-being, Safety, Health
- Governance: Online services, Open government, Privacy
- Infrastructure: Internet infrastructure, data infrastructure
- People: Inclusion, Education, Creativity

Based on the resulting matrix, this study evaluates all the Smart City Contributors and actors, then proceeds to identify best practices and deficiencies. This study has shown that Smart City Contributors in New York City have more contributed to “Living”, “People” and “Infrastructure“ greatly, which are providing people-oriented equal service. While Smart City Contributors have been contributed less to “Mobility” which still has many areas of improvement. Among a few Smart City Contributors for “Mobility”, some of their effects are

not clear, and the rest of them only serve for a limited number of people. What's more, none of the contributors have been dedicated to improving the New York subway system at all. Integrating technologies into the mobility system will help to establish a sustainable mobility system which can accommodate an increasing population in New York City, so New York City is still far from perfect in terms of utilizing technologies and data to improve "Mobility" in general.

In terms of evaluation for actors, results show that many of the actors from city agencies have contributed to seven Smart City focuses evenly, while private companies have contributed more to "Economic" and "Infrastructure", and schools and institutions have contributed more to "Infrastructure". It is difficult to decide which actors have contributed the most in terms of making New York City smart, but obviously, the Mayor's Office of Technology and Innovation and the Mayor's Office of the Chief Technology Officer are leading agencies. Surprisingly, the NYC Department of City Planning has not contributed to any of these projects. Although NYC Department of City Planning (DCP) has been aware of needs for utilizing technologies and data and has launched NYC Planning Labs in 2017, these projects are mainly for supporting internal use, not for the public. While it would be difficult for DCP alone to work on projects relating to smart city, they should collaborate with other city agencies to enhance those projects done by other city agencies, since DCP has a more holistic view for improving the City.

Based on the evaluations and incorporation smart city concept in New York City, which put more value on equity, this study identifies three best practices: Open Data Law, LinkNYC and NYCx challenge. These three projects complement each other and can be a starting point for cities to become a smart city. The Open Data Law has established the most robust open data environment, which is a crucial foundation for New York City to be a smart city. LinkNYC has offered people access to the internet through a smart and practical way which is beneficial to both the City and a private company. NYCx challenge is also a unique, but conscious approach for seeking for technological solutions that can solve complex issues in New York City and testing them in underserved areas, while considering the potential to apply them to a bigger scale. None of the cities has the same problems as New York City, but these three best practices can be a reasonable and effective starting point for other cities.

A series of research and evaluation on Smart City Contributors allows understanding some of the success and deficiencies. In the near future, more and more Smart City Contributors will be implemented, but what New York City has to keep in mind is a Smart City concept in New York City and make sure if they will ensure equity and improve the quality of the quality and efficiency of city services.

Limitation

A major limitation of this study is that all the evaluation was done by qualitative analysis, which can be very subjective. There are several studies that measure the level of a

smart city in quantitative analysis, but their methods are not clear and easy to refer to, especially because New York City has complex issues. Hudson Yards, a first quantified community, just opened on Marth 15th and the 2019 NYC Smart City Program will be implemented by deploying hundreds of Smart Sensors across the business districts in New York City, so more and more data relating to the City will be quantified, which will make it easier to calculate the level of a smart city in New York City in a quantitative way in the future.

Appendix

- Matrix analysis table
- Smart City Contributors Table
- The Number of Projects per agencies
- Smart City Contributors Actors List
- Interview Summary (Official leading a technology program for the City of New York, Daniel E Alam, Economic Development and Technology Policy Analyst at the Office of Manhattan Borough President)

- Matrix analysis table

Title for Indicator, Research, framework	Developer	Environment	Mobility	Economy	Living	Governance	Infrastructure	People	additional
Smart City Index Master Indicators	Smart City Council	o	o	o	o	o	-	o	
A smart city model - technical view	British Standards Institution (BSI)	o Energy, water, waste	o	-	o Health, Safety	-	-	-	Media
Smart City Framework	Deloittee	o	o	o	o Security	-	-	o Education	
Index of Cities' Readiness	PwC	o	o	o	o	-	o	o	
multi-dimensional smart city model	ISO	o	o	o	o	o	o	o	
Smart City Dimensions	Kamel Jouili & Abdurahman Al Furjani & Isam Shahrour & Kent Washington	o	-	o	-	o		o Society	policy, technology
Primary Index for urban intelligent development	Hongbo Shi , Sang-Bing Tsai , Xiaowei Lin and Tianyi Zhang	-	-	o	o	o	o	o	
Smart Cities	Juniper Research	-	o	-	o		-	o	
Smart City Applications	GSMA Smart Cities	o	o	o	-	o	o		

Measuring the success of smart cities	European Smart Cities Initiatives	o	o	o	o Livability	o	-	o Skills	
Smart Cities Community,	IEEE	o	o	o	o	o	-		
ASEAN Smart Cities Framework	ASEAN Smart Cities Network (ASCN)	o	-	o	o	-	-	o	
Smart applications in eight domains	Mckinsey	o Energy, Water, Waste	o	o	o Healthcare, security	-	-	o engagement & Community	
European Smart Cities Ranking (ESCR) Model	Vienna University of Technology/ University of Ljubljana/ Delft University of Technology (Giffinger et al. 2007),	o	o	o	-	o	-	o	
CITYkeys indicator framework	CITYkeys	o	-	o	-	o	-	o	Propagation indicators
Ericsson: Networked Society City (ENSC) Index	Ericsson Ltd. with Sweco Ltd. (2014)	o	-	o	o	-	o	o	
Smart city literature – 6 domains	Dylan van der Hoeven	o		o	o	o	o	o	
Building a Smart + Equitable City	Mayor's Office of Technology and Innovation	o	o	o	o	o		o	

- List of Actors and number of projects

Actor	Number of Projects
City Agency	
NYC Department of Information Technology & Telecommunication (DoITT)	11
NYCEDC	9
Mayor's Office of Technology and Innovation (MOTI)	6
Mayor's Office of the CTO (NYCx)	6
NYC Department of Sanitation	4
NYC Department of Transportation (DoT)	3
MTA	3
NYCHA	3
NYCParks	2
Mayor's Office of Data Analytics (MODA)	2
NYC Department of Environmental Protection	2
NYC Department of Small Business Services	1
NYC Department of Citywide Administrative Services	1
NYC 311	1
NYC Taxi and Limmousine Commission	1
NYC Department of Health and Mental Hygine	1

NYPD	1
NYC Criminal Justice	1
NYC Housing Preservation & Development (HPD)	1
NYC Department of Education	1
NYC Department of Sustainabiligy	1
NYC Department of Sustainabiligy	1
Private Companies	
AT & T	1
CityBridge	1
ShopSpotter	1
Fictive Kin	1
Soofa	1
Parkmobile, LLC	1
Heat Seek NYC	1
IBM	1
MYC	1
Citisense	1
Matchx GmbH	1
Vizalytics	1
Urban X	1
Con Edison	1
Schools/ Institutions	
NYU	6
Rutgers University	1
Columbia University	1
Rutgers University	1
Columbia University	1

- Smart City Contributors Table

Type	Technology	When	Who	Description
GPS, Web	311 Application	2003	DoITT, NYC 311	New Yorkers can submit select quality-of-life complaints to 311 via their iPhones.
a city wide wireless system	NYCWiN	2006	DoITT	a government-dedicated broadband wireless infrastructure created to support public safety and other essential City operations
Sensor	Air Quality Monitoring	2008	The NYC Department of Health and Mental Hygiene	sulfur dioxide emissions have been reduced by more than 70% in New York City since 2008.
Sensor	Transit Signal Priority (TSP)	2008	DOT, MTA	a method used to coordinate transit vehicles and traffic signals to reduce the time buses are stopped at traffic lights along a corridor and therefore improve bus travel times.
Sensors	Gun shot detection sensors	2009	NYPD	

Automated Meter Reading (AMR) system.. Wireless	Smart Water Metering	2009	NYC Department of Environmental Protection	one of the largest IoT deployments in the City. Since 2009, it has saved residents tens of millions of dollars by connecting them to water usage data online.
Competition	NYC BigApps challenge	2009	NYCEDC	the flagship civic innovation challenge in New York City for designers, developers, academics, entrepreneurs, and New Yorkers at large to apply their know-how to improve the Big Apple.
Internet Access	NYC Connected Communities	2009	NYCHA, DoiTT	to increase access to computer centers centers in neighborhoods with the highest concentrations of poverty
IT Infrastructure	IT Infrastructure Service (NYCitiServ) Initiative	2010	DoITT	initiative, an ambitious effort led by DoITT to unify the City's information technology operations for the first time
GPS signal and website	snow plow tracking	2010	New York City Department of Sanitation	map out routes based on the GPS data
Sensors, Cameras	Mdtown in Motion (Responsive traffic management)	Jul-11	NYCDOT	This project proceeded with implementation of traffic sensors, cameras and EZ – Pass Readers.
Data Infrastructure	Open Data Law	2012	MODA (Mayor's Office of Data Analytics) and DoITT	
Internet Access	Harlem Wifi	2013	Technology Development Corporation and DoITT	For 80,000 Harlem residents, including 13,000 public housing residents, as well as businesses and visitors in the area
Sensors	Smart Waste Management	2013	NYC sanitation department, NYC Department of Small Business Services	It is equipped with a wireless sensor that monitors trash level, allowing pick-up trips to be scheduled more efficiently. The system includes a trash compactor that runs with solar power, allowing the garbage bin to hold five times more waste than a conventional one.
Bike sharing program	Citi Bike	2013	NYCDOT	
Smart Lighting	LED lighting, smart control	2013	New York City Department of Citywide Administrative Services	Smart controls can further reduce lighting power through dimming, and can also reduce the hours of operation through scheduling or occupancy sensing
City's initiative, competition	Call for Innovation	2014	MoTI	An open solicitation of ideas and proposals that aims to help provide innovative solutions to challenges facing our city and find new ways of improving the lives of all New Yorkers.
urban Innovation hubs	The Urban Future Lab	2014	NYCEDC partnered with New York University's Polytechnic School of Engineering	a facility designed to assist entrepreneurs in the energy and clean technology sectors

Sensors	Monitor Water Quality	2014	NYC Department of Environmental Protection	
Internet Access	ParksWifi	2014	NYCParks, AT&T	
Communication Network	LinkNYC	2014 (Announcement), 2016 (Install)	CityBridge, Mayor Bill de Blasio, DoITT	Each Link provides fast, free public Wi-Fi, phone calls, device charging and a tablet for access to city services, maps and directions,
urban Innovation hubs	Urban Tech NYC	2015	NYCEDC	An accelerator program providing 9,300 square meters of affordable space and prototyping equipment to help entrepreneurs build smart and sustainable solutions.
Guideline	NYC Strategy for Building to Smart + Equitable City	September, 2015	Mayor's Office of Technology and Innovation	first in a series of informational resources about New York City's efforts to leverage new technologies to build a smart and equitable city.
Initiatives	Drive Smart Initiative	2015	DoT	Uses Technology Innovations to Help NYC Drivers Save Money, Save Time, And Drive More Safely
GPS location	connected-vehicle pilot	2015	NYCDOT, NYC DOT IT Department, DoITT, NYCDOT Fleets, Taxi and Limousine Commission and Taxi Fleets, MTA, New York City Transit, NYC Department of Sanitation, UPS, Pedestrians for Accessible and Safe Streets Coalition	NYCDOT's planned deployment provides an ideal opportunity to evaluate connected vehicle technology and applications in tightly-spaced intersections typical in a dense urban transportation system and is anticipated to be the largest connected vehicle technology deployment to date
Energy management technologies	Smart Grid Demonstration at Brooklyn Army Terminal	2015	NYCEDC, Con Edison	To demonstrate the viability of innovative energy management solutions to the private sector, NYCEDC partnered with Con Edison to develop a Smart Grid installation at the Brooklyn Army Terminal, including solar and battery storage systems.
Initiatives (education)	CS4All (Computer Science For All)	2015	NYC Department of Education	A 10-year initiative to scale computer science education to 100% of the city's public schools
Sensors, GPS	Real time gunshot detection (ShotSpotter)	2015 Spring	New York City Police Department, ShotSpotter	First tested as a demonstration project in the Bronx and Brooklyn in the spring of 2015
Initiatives	Digital Project Consulting	2015	Mayor's Office of the CTO	It helps agencies meet the growing complexity of digital work, offering consultation on issues including user-centered+ design, digital analytics, accessibility, social media, and content strategy.
Website (Application)	Neighborhoods.nyc	2016	Mayor's Office of the CTO, Vizalytics	Neighborhood websites with hyper-local info that affects residents, like leaking hydrants, transit conditions and restaurant grades

Digital Discovery tool (Application)	Marketplace.nyc	2016	MOTI, Brooklyn-based product studio Fictive Kin, White House	A tool to help government agencies discover smart city solutions
Guidelines	Guideline for the IoT	2016	MOTI and White House	A set of comprehensive guidelines for ensuring the responsible and equitable development of smart city technologies
Sensors	Soofa	2016	Soofa, NYC Parks	A new pilot program that will install five solar powered benches in Highbridge Parks
Sensors	SONYC sensors	2016	NYU, Ohio State University	SONYC research initiative combines sensors, big data, and machine learning to understand, model and influence NYC's acoustic environment.
Internet Access	Digital Van	2016	The Mayor's Office, New York City Housing Authority and Department of Information Technology and Telecommunications (DoITT)	New efforts to bring free high-speed Internet service into the homes of tens of thousands of low-income New Yorkers
Application	ParkNYC (smart parking)	2016	DOT and operated by Parkmobile, LLC,	It motors to remotely pay for parking using an online system that links registered license plate numbers to NYPD traffic enforcement agents' handheld devices that confirm payment
urban Innovation hubs	URBAN-X	2016	URBAN-X	The URBAN-X accelerator program provides 20 immersive weeks of customer development, product development, network-building and expert guidance for startups – all in preparation for fundraising
urban Innovation hubs	Brownsville Innovation Lab	launched March 2017	Mayor's office of the CTO	This innovative step was taken to unite the tech companies, community members, government authorities, educators and private agencies to discuss and solve the city concerns by giving rise to a resonance that co-creates advanced technology.
Challenge	Brownsville: Zero Waste in Shared Space	2017	NYCx, NYC Mayor's Officeof the Chief Technology Officier, NYC Department of Sustainabiligy, NYC Housing Authority, NYC Department of Sanitation, NYCEDC, Center for Urban Science + Progress, Brownsville Tech Board	The City of New York is seeking to test creative solutions that: Reduce litter and improper waste disposal in public housing Increase resident participation in recycling waste-reduction opportunities Promote waste-free common spaces through increased community stewardship
Challenge	Governors Island Connectivity Challenge	2017	Mayor's office of the CTO (NYCx)	It seeks the world's most inventive thinkers to provide high-speed, low-cost internet connectivity on Governors Island.

sensor	Lower Manhattan Smart Neighborhood Pilot	2017	NYCEDC	This will create an integrated, scalable sensor network to support the measurement and analysis of neighborhood conditions, social behavior, and sustainability metrics.
Initiatives	Digital Health Initiatives (Digital Health Marketplace, Digital Health Breakrhough Netowork)	2017	NYCEDC	To support both growth-stage and early-stage startups and grow the digital health sector in New York City
Competition	NYC Open Data Program	2018	MODA (Mayor's Office of Data Analytics) and DoITT	An opportunity to engage New Yorkers in the information that is produced and used by city government.
Challenge	Climate Action Challenge	2018	NYCx, NYC Mayor's Office of the Chief Technology Officer, NYC Office of Sustainability, NYCDOT, NYC Citywide Administrative Service	Track 1: Emerging technologies for fast charging and smart charging EVs. Track 2: Immediately commercialize EV charging technologies.
Challenge	Brownsville: Safe and Thriving Nighttime Corridors	2018	NYCx, NYC Mayor's Officeof the Chief Technology Officier, NYC Criminal Justice, NYCEDC, Center for Urban Science + Progress, Brownsville Tech Board	Looking for creative technology solutions that enhance the experience and use of public spaces at night and increase night-time activity in neighborhood corridors
wireless communication	NYC Connected Vehicle Project	2018	DOT, U.S DOT	A connected vehicle program involving up to 8,000 vehicles, including cars, taxis, trucks, pick-up trucks and buses To accomplish Vision Zero, which aims to reduce fatality by car accidents
website	NYC Housing Portal	2018	DoITT, HPD	A website that makes it easy to find the City's affordable housing resources in one place
sensor	Power-Monitoring Sensor Network	2018	The New York Power Authority	New technologies to perform online monitoring of power plants, substations and power lines to increase efficiency and productivity and improve resiliency of New York's statewide public power network.
sensor	heat sensors to track heat and hot water conditions	2018	Heat Seek NYC., elected official (City council members)	Heat sensors to track heat and hot water conditions in real time in New York City apartment buildings with extensive heat violations

Mobile Wireless Testbed	COSMOS	2018	a technology partnership between Rutgers University, Columbia University and New York University, collaborating with New York City, Silicon Harlem, City College of New York, University of Arizona and IBM	"ultra-high-bandwidth and low-latency wireless communications, with tightly coupled edge computing," including millimeter-wave exploration and dynamic optical switching technologies. That project is the Cloud Enhanced Open Software-Defined Mobile Wireless Testbed for City-Scale Deployment (COSMOS),
urban Innovation hubs	The Grid	2019	NYCEDC, CIV:LAB, a global nonprofit dedicated to connecting urban innovation ecosystems around the world	The Grid will consist of over 70 organizations from various industries, led by a steering committee of startup incubators, businesses and other organizations. It will look to help build organization's networks; increase public awareness of urban technology; promote its innovations; and host events and tailored programs for the industry.
Initiatives	Blockchain Initiative	2019	NYCEDC	The center will serve as a physical hub for the industry, building public awareness for blockchain technology through education, and connecting entrepreneurs to business support, mentorship, advisory services, and a community of peers to help them launch and scale new ventures. The center will also convene industry stakeholders, government, consumer advocates, and investors to begin a conversation around how New York City can create a regulatory environment that will support both consumer safety and innovation.
blockchain technology, Smart City IoT Standard	NYC Smart City Program	2019	Berlin based Blockchain company MXC, Citiesense, MatchX GmbH	
sensor	First Quantified Community	mid 2020	NYU Center for Urban Science and Progress, NYC Hudson Yards Neighborhood, developers	This community will embody 17 million square feet of commercial and residential land that can measure and analyze environmental attributes of the development. It will track data on air quality, pedestrian traffic, energy production and consumption, as well as the health and activity levels of workers and residents.

Communication-based train control (CBTC) technology	Communication-based train control (CBTC) technology	by 2029	MTA	This is a massive undertaking, as CBTC technology will control the speed, starting and stopping of trains. This will ultimately reduce train traffic and increase train frequencies for the impatient New York rider. However, only newer trains can use CBTC systems, and the subway currently runs on a largely vintage nexus of machines.

- Smart City Contributors Evaluation table

Projects	Environment	Mobility	Economy	Living	Governance	Infrastructure	People
311 Application				Well-being	Online Service		Inclusion
NYCWiN						Internet infrastructure	
Air Quality Monitoring	Resource management			Well-being			
Transit Signal Priority (TSP)		Efficient transport					
Gun shot detection sensors				Safety			
Smart Water Metering	Resource management			Well-being			
NYC BigApps Challenge		Efficient transport	Entrepreneurship & Innovation		Open government	Data infrastructure	Creativity, Education, Inclusion
NYC Connected Communities						Internet infrastructure	Inclusion
IT Infrastructure Service (NYCitiServ) Initiative						Internet infrastructure	Inclusion
Snow plow tracking	Sustainable urban planning			Safety			
Mdtown in Motion (Responsive traffic management)		Efficient transport					
Open Data Law						Data infrastructure	
Harlem Wifi						Internet infrastructure	Inclusion
Smart Waste Management	Resource management			Health			
Citi Bike		Efficient transport					
LED lighting, smart control	Resource management						
Call for Innovation	Resource management	Efficient transport	Entrepreneurship & Innovation	Well-being		Data, Internet infrastructure	Creativity, Inclusion
The Urban Future Lab			Entrepreneurship & Innovation				

Monitor Water Quality	Resource management			Health			
ParksWifi						Internet infrastructure	Inclusion
LinkNYC			Entrepreneurship & Innovation			Internet infrastructure	Inclusion
Urban Tech NYC			Entrepreneurship & Innovation				
NYC Strategy for Building to Smart + Equitable City							
Drive Smart Initiative		Efficient transport		Safety			
Connected-Vehicle Pilot		Efficient transport		Safety			
Smart Grid Demonstration at Brooklyn Army Terminal	Resource management		Entrepreneurship & Innovation				
CS4All (Computer Science For All)			Entrepreneurship & Innovation			Internet infrastructure	Inclusion
Real time gunshot detection (ShotSpotter)				Safety			
Digital Project Consulting						Internet infrastructure	Inclusion
Neighborhoods.nyc						Data infrastructure	Inclusion
Marketplace.nyc			Entrepreneurship & Innovation, Industry Expansion & Cultivation		Open service		
Guideline for the IoT				Safety	Privacy		
Soofa			Entrepreneurship & Innovation	Well-being		Internet infrastructure	Inclusion
SONYC sensors	Resource management		Entrepreneurship & Innovation	Well-being			
Digital Van						Internet infrastructure	Inclusion
ParkNYC (smart parking)					Online service		
URBAN-X			Entrepreneurship & Innovation				Creativity
Brownsville Innovation Lab			Entrepreneurship & Innovation				Creativity
Brownsville: Zero Waste in Shared Space	Resource management			Health			
Governors Island Connectivity Challenge						Internet infrastructure	Inclusion
Lower Manhattan Smart	Resource management			Well-being			Inclusion

Neighborhood Pilot							
Digital Health Initiatives (Digital Health Marketplace, Digital Health Breakrhough Netowork)			Entrepreneurship & Innovation	Health			
NYC Open Data Program						Data infrastructure	
Climate Action Challenge	Sustainable urban planning		Entrepreneurship & Innovation				
Brownsville: Safe and Thriving Nighttime Corridors			Entrepreneurship & Innovation	Safety			Creativity
NYC Connected Vehicle Project		Efficient transport, Vision Zero		Safety			
NYC Housing Portal						Data infrastructure	
Power-Monitoring Sensor Network	Resource management						
Heat sensors to track heat and hot water conditions	Resource management			Well-being			
COSMOS						Internet infrastructure	
The Grid			Entrepreneurship & Innovation				Creativity
Blockchain Initiative			Entrepreneurship & Innovation				Education, creativity
NYC Smart City Program			Entrepreneurship & Innovation			Data infrastructure	
First Quantified Community	Resource management	Efficient transport		Well-being			
Communication-based train control (CBTC) technology		Efficient transport					

- The number of projects per agencies

Actors	**Number of Projects**
City Agencies	
Mayor's Office of Technology and Innovation (MOTI)	6
Mayor's Office of the CTO (NYCx)	6
Mayor's Office of Data Analytics (MODA)	2
NYC Department of Information Technology & Telecommunication (DoITT)	11
NYC 311	1
NYC Department of Health and Mental Hygine	1
NYC Department of Transportation (DoT)	3

New York Police Department	1
NYC Department of Environmental Protection	2
NYC Housing Authority (NYCHA)	3
NYC Department of Sanitation	4
NYC Department of Small Business Services	1
NYC Department of Citywide Administrative Services	1
NYC Economic Development Corporation (NYCEDC)	9
NYCParks	2
NYC Taxi and Limmousine Commission	1
NYC Department of Education	1
NYC Criminal Justice	1
NYC Housing Preservation & Development (HPD)	1
New York Power Authority	1
NYC Department of Sustainability	1
Private Companies	
AT & T	1
CityBridgea	1
ShopSpotter	1
Fictive Kin	1
Soofa	1
Parkmobile, LLC	1
Vizalytics	1
IBM	1
MYC	1
Citisense	1
Matchx GmbH	1
Urban X	1
Silicon Harlem	1
Heat Seek NYC	1
Schools/ Institutions	
New York University	6
Rutgers University	1
Columbia University	1
City College of New York	1
University of Arizona	1
Others	
Metropolitan Transportation Authority	1
United Parcel Service (UPS)	1
US DoT	1
Pedestrian for Accessible and Safe Streets Coalition (PASS)	1

- Smart City Contributors Actors list

Organization	Environment	Mobility	Economy	Living	Governance	Infrastructure	People	Projects
City Agencies								
Mayor's Office of Technology and Innovation (MOTI)	o	o	o	o	o	o	o	Call for Innovation, Marketplace.nyc, Guideline for the IoT, NYC Strategy for Building to Smart + Equitable City

Mayor's Office of the CTO (NYCx)	○		○	○		○	○	Brownsville Innovation Lab, Governors Island Connectivity Challenge, Digital Project Consulting, Neighborhoods.nyc, Brownsville: Zero Waste in Shared Space, Climate Action Challenge
Mayor's Office of Data Analytics (MODA)						○		NYC Open Data Program, Open Data Law,
NYC Department of Information Technology & Telecommunication (DoITT)			○	○		○	○	311 Application, NYCWiN, NYC Connected Communities, NYCitiServ, Open Data Law, Harlem Wifi, Urban Tech NYC, Connected-Vehicle pilot, Digital Van, NYC Open Data program, NYC Housing Portal,
NYC 311				○	○		○	311 Application
NYC Department of Health and Mental Hygine	○							Air quality monitoring
NYC Department of Transportation (DoT)		○	○	○			○	Midtown in Motion, CitiBike, Drive Smart Initiative, NYC Connected Vehicle Project
New York Police Department				○				Gun shot detection sensors
NYC Department of Environmental Protection	○	○	○	○				Monitor Water Quality, Smart Water Metering
NYC Housing Authority (NYCHA)	○			○		○	○	NYC Connected Communities, Digital Van, Brownsville: Zero Waste in Shared Space
NYC Department of Sanitation	○	○		○				connected-vehicle pilot, Brownsville: Zero Waste in Shared Space, snow plow tracking, Smart Waste Management
NYC Department of Small Business Services	○			○				Smart Waste Management
NYC Department of Citywide Administrative Services	○							LED lighting, smart control

NYC Economic Development Corporation (NYCEDC)	o		o	o		o	o	NYC BigApps challenge, The Urban Future Lab, Urban Tech NYC, Smart Grid Demonstration, Brownsville: Zero Waste in Shared Space, Lower Manhattan Smart Neighborhood Pilot, Digital Health Initiatives, The Grid, Blockchain Initiative
NYCParks								ParksWifi, Soofa
NYC Taxi and Limmousine Commission		o		o				Connected-vehicle pilot
NYC Department of Education			o			o	o	CS4All
NYC Criminal Justice			o	o			o	Brownsville: Safe and Thriving Nighttime Corridors
NYC Housing Preservation & Development (HPD)						o		NYC Housing Portal
New York Power Authority	o							Power-Monitoring Sensor Network
NYC Department of Sustainability	o		o					Climate Action Challenge
Private Companies								
AT & T						o	o	ParksWifi
CityBridgea						o	o	LinkNYC
ShopSpotter				o				Real time gunshot detection
Fictive Kin			o		o			Marketplace.nyc
Soofa			o	o		o	o	Soofa
Parkmobile, LLC					o			ParkNYC
Vizalytics								Neighborhoods.nyc
IBM						o		COSMOS
MYC			o			o		NYC Smart City Program
Citisense			o			o		NYC Smart City Program
Matchx GmbH			o			o		NYC Smart City Program
Urban X			o					Urban X
Silicon Harlem						o		COSMOS
Heat Seek NYC	o			o				Heat sensors
Schools/ Institutions								
New York University	o	o	o	o			o	The Urban Future Lab, SONYC sensors, COSMOS, Brownsville: Zero Waste in Shared Space, Brownsville: Safe and Thriving Nighttime Corridors, Quantified Community
Rutgers University						o		COSMOS
Columbia University						o		COSMOS

City College of New York						○		COSMOS
University of Arizona						○		COSMOS
Others								
Metropolitan Transportation Authority		○						Transit Signal Priority, connected-vehicle pilot, Communication-based train control technology
United Parcel Service (UPS)		○		○				Connected-vehicle pilot
US DoT			○	○			○	NYC Connected Vehicle Project
Pedestrian for Accessible and Safe Streets Coalition (PASS)		○		○				Connected-vehicle pilot

- **Interview Summary**

1. Official leading a technology program for the City of New York

- **Do you think NYC is a smart city? In what points?**
    - The city does a pretty good job by opening up the data

- **How do you define "smart city" in NYC? By considering different contexts in New York?**
    - Using new approaches and new technology
    - Gather more useful data about how the city operate, how the city resident use city services, how transportation
    - Essential make people life easier, more convenient in many ways -- lower the friction
        i. Help people to access to the necessary information
            1. Transportation means
            2. Parking option
            3. Education
        - Make city more equal and equitable by using technological tool

- **Do you think the city offer enough source or help to make a city smart?**
    - Working class or working poor don't have equal access to the convenience brought by the technologies, while middle class or wealthy don't have to worry
    - City need to do a lot more for these people
    - Any types of services that the city offices operate still require paper, instead of mobile
    - These ways of services prohibit poor people from accessing services since they might don't have printer, time etc, but they do have cell phone

- **How do you think your projects help to make NYC smart?**
    - Moonshot program
        1. Developing policy proposals
            - Conducted background research on new technologies
        2. Thinking about really challenging problems that the city is facing
            - Adopt newer emergent technological approaches or business model
                - Purpose: Lower the friction, make something more efficient, useful for people and also for the City
    - Example) NYCx Climate change challenge with Mayor's office of sustainability, DoT
        - Winner: Germany company
        - Install physical infrastructure with electrical vehicle charger stations
            - Integrated nicely with neighborhood
            - More convenient than gas station
        - Summary:
            - Taking something that are inconvenient and making them much more convenient and less stress
            - No authorization for transaction, no need for swiping credit cards, Payment will be included in your electricity bill

- **Have you had any difficulties during developing your projects?**
    - Working with difference agencies and lot of people
    - Culture of agencies or principles are willing to try something new and take risk
    - Problems need to be so big which need new approaches

- **Others? What to remember?**
    - Not just what is smart, but who is smart for? It is crucial important in the City like New York.
    - Connection between public infrastructure, public government VS public services VS private infrastructure and private uses
        - Uber, lift bring more accessibility to people, but also cause dramatic congestion and make the city less efficient
        - Down side effects brought by new technologies

2. Daniel E. Alam, Economic Development and Technology Policy Analyst at Office of Manhattan Borough President

- **Do you think NYC is a smart city? In what points?**
    - Starting 2010, when passed the open data law, New York City has become more smart city. When passed the open data law. New York City has done a great job in terms of establishing open data environment. More and more people with the background in technology started running though office and getting involved in policy and becoming great assets of the government, unlike before. Now, we are

about to enter the second wave accelerating New York into becoming more Smart City in numbers of different areas.

- Yes and No
- Yes: We've done a lot of great work, when it comes to, specifically for open data. We have the most robust open data offering of any city in North America. We have infrastructure and our own department of information & technology, Mayor's office of data analytics and so many of structures that can be utilized, which other cities don't have. We've got a basis for smart city, but we need to build on that.
- No: There is a lot of things we need to do more. For example, there are massive digital devices in New York City, but some households in Harlem have no access to the Internet. They don't have machine and subscription. They rely on going to public libraries or another source. In my mind, the Internet is basic utilities to everyone and one of the equalized things in our society.

- **Who is the city being smart for?**
  - Right now, the city has been focusing more on being smart for the public or the voters. Personally, I think having smart bureaucracy and smart government infrastructure is in many ways more important. Our city's government budget is the size of Canada's, proper smart city can provide those services with greater efficiency and greater involved. So, there needs to be more done. City agencies use open data to communicate with one and another to create more data driven responses, which is important. Data is a compass and you need people to actually use it, so you need provide people to train how to use it. It’s great that we provide the compass, we also have to provide people to train how to use the compass, otherwise they are gonna sail into the rocks. Focuses for a long time has been on transparency, which does many great things, including improving government's functionality. If you wanna be truly smart city, that comes from truly preparing your workforce to take advantages of the capabilities.

- **How do you define “smart city” in NYC? By considering different contexts in New York?**
  - Smart city in New York is the integration of number of technological progressions that happened past decades or so into city function to improve the quality and the breath of city services. There are thousands of different ways, such as website design, services design, IoT capability, data driven policy decision for operational or functionality decisions. In short, smart city is about adopting technologies that may have been developed in private sectors or elsewhere and creating civic focuses.

- **Do you think the city offer enough source or help to make a city smart?**
  - Yes. One of the big areas we need to invest more is open data coordination team, as well as training for city employee. We offer a lot of these resources and they are great, but I don't think they would be truly maximized until we have consistent and

continuous training for all levels of tech skills or knowledge within the city government. They will go into to create more flexible workforce. The emphasis on digital training and upskilling with city government needs to be in a higher level. That will in tern leave to better offering form the government to provide better recourse to citizens. That's says, there are plenty of missing resources that we have. NYC EDC just opened the block chain center in Midtown. Open data portal is the most robust open data offering at least in North America and western Europe. We've got so many amazing resources to that end and there is also natural resources, such as tech venture capital and numbers of startups within New York City. We have phenomenon offering of tech education, such as educational institution level and job training program. New York is quickly emerged as the leading tech city in the US. Silicon Valley is a dust, we have more people who are involved in tech world in New York. New York is a financial center and economic center of the country and that is a good advantage that we can rely on. There are lots of resources provided by the government and also by the environment itself. But we need to expand on this.

Bibliography

R. Kitchin, "The Real-Time City? Big Data and Smart Urbanism," GeoJournal 79:1 (2013) 1-14.

IDC "Worldwide Semiannual Smart Cities Spending Guide"
https://www.idc.com/tracker/showproductinfo.jsp?prod_id=1843

Smart City Expo World Congress
http://media.firabcn.es/content/S078016/SCEWC_Report2016.pdf

Dietmar Offenhuber, Carlo Ratti (2014) "Decoding the City Urbanism in the Age of Big Data"

Kristian Kloeckl , Oliver Senn & Carlo Ratti (2012). "Enabling the Real-Time City: LIVE Singapore!"
https://www.tandfonline.com/doi/pdf/10.1080/10630732.2012.698068?needAccess=true

ITU-T Focus Group on Smart Sustainable Cities (2014) "Smart sustainable cities: An analysis of definitions" https://www.itu.int/en/ITU-T/focusgroups/ssc/Documents/Approved_Deliverables/TR-Definitions.docx

Anthopoulos, Leonidas G. (2017) Understanding Smart Cities: A Tool for Smart Government or an Industrial Trick?

“Smart Cities and Sustainability.” American Planning Association. Accessed October 29, 2018. https://www.planning.org/ontheradar/smartcities/.

Hallands, R. (2008) “Will the real smart city stand up? Creative, progressive, or just entrepreneurial?”

Victoria Sazonchik (2018). “From Smart Technologies To Smart Cities” https://www.smartresilient.com/smart-technologies-smart-cities

Teena Maddox (2016). “Smart Cities: 6 Essential Technologies.” TechRepublic. Accessed October 30, 2018. https://www.techrepublic.com/article/smart-cities-6-essential-technologies/.

Elizabeth Woyke (2018). “A smarter smart city” MIT Technology Review https://www.technologyreview.com/s/610249/a-smarter-smart-city/

NYC gov 2017 “New York Named “2016 Best Smart City,” NYC To Host 2017 International Conference On Urban Technology At Brooklyn Navy Yard” https://www1.nyc.gov/office-of-the-mayor/news/909-16/new-york-named-2016-best-smart-city-nyc-host-2017-international-conference-urban

The Open University (2016). “A Tale of Evaluation and Reporting in UK Smart Cities” http://oro.open.ac.uk/46008/7/ userdata documents4 ctb44 Desktop Tales Smart Cities Final 2016.pdf

NYC Government (2015). “NYC Smart Equitable City Final” https://www1.nyc.gov/assets/forward/documents/NYC-Smart-Equitable-City-Final.pdf

Trindade, Evelin Priscila, Marcus Phoebe Farias Hinnig, Eduardo Moreira da Costa, Jamile Sabatini Marques, Rogério Cid Bastos, and Tan Yigitcanlar. (2017). “Sustainable Development of Smart Cities: A Systematic Review of the Literature.” Journal of Open Innovation: Technology, Market, and Complexity 3 (1). https://doi.org/10.1186/s40852-017-0063-2.

Stratigea, Anastasia, Chrysaida-Aliki Papadopoulou, and Maria Panagiotopoulou. (2015). “Tools and Technologies for Planning the Development of Smart Cities.” Journal of Urban Technology 22 (2): 43–62. https://doi.org/10.1080/10630732.2015.1018725.

Bis (Department for Business, Innovation and Skills) (2013) Global Innovators: International Case Studies and Smart Cities. Research paper No. 135 [Online]. Available at

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249397/bis-13-1216-global-innovators-international-smart-cities.pdf

GSMA (Groupe Speciale Mobile Association) (2013), Guide to Smart Cities: The Opportunity for Mobile Operators Version 1.0, Feb. http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/cl_sc_guide_wp_02_131.pdf http://www.smart-cities.eu/

Smart Cities Council (2014), Smart City Index Master Indicators. Survey 7, By B. Cohen http://smartcitiescouncilalert.com/resources/smart-city-index-master-indicators-survey

Zygiaris, S. (2013) 'Smart City Reference Model: Assisting Planners to Conceptualize the Building of Smart City Innovation Ecosystems', Journal of Knowledge Economy, Vol. 4, pp.217–231 https://search-proquest-com.ezproxy.cul.columbia.edu/docview/1324656418?OpenUrlRefId=info:xri/sid:summon&accountid=10226

One New York The Plan for a Strong and Just City https://onenyc.cityofnewyork.us/wp-content/uploads/2018/04/OneNYC-1.pdf

Sally P. Caird & Stephen H. Hallett (2018) "Toward evaluation design for smart city development" https://www.tandfonline.com/doi/full/10.1080/13574809.2018.1469402

Arry Akhmad Arman, Antragama Ewa Abbas, Ratih Hurriyati (2015) https://www.researchgate.net/publication/315652587_Analysis_of_Smart_City_Technology_Initiatives_for_City_Manager_to_Improve_City_Services_and_Quality_of_Life_Based_on_ISO_37120

Vaia Moustakaa, Zenonas Theodosioub, Athena Vakalia, Anastasis Kounoudesb, Leonidas G. Anthopoulosc " Enhancing social networking in smart cities: Privacy and security borderlines" (2018) https://www.sciencedirect.com/science/article/pii/S0040162518307728

Ola Soderstrom, Till Paasche and Francisco Klauser "Smart Cities as corporate storytelling" (2014) https://www.tandfonline.com/doi/pdf/10.1080/13604813.2014.906716?needAccess=true

Sotirios Paroutis, Mark Bennett, Loizos Heracleous "A Strategic view on smart city technology: The case of IBM Smarter Cities during a recession" https://pdfs.semanticscholar.org/1177/5b072e8ee116947f18aa5f4409aa835c8e3f.pdf

IBM Industry Solutions "IBM Smarter City Solutions" (2011) ftp://ftp.software.ibm.com/la/documents/imc/la/cl/news/events/infrastructuresummit/smarter_city_solutions.pdf

Cisco “What is a Smart City?”
https://www.cisco.com/c/en/us/solutions/industries/smart-connected-communities/what-is-a-smart-city.html

Cisco “Smart + Connected Communities” (2010)
https://www.cisco.com/c/dam/en_us/solutions/industries/docs/scc/09CS2326_SCC_BrochureForWest_r3_112409.pdf

Yoshihito Yoshikawa, Atsutoshi Sato, Shigeki Hirasawa, Masato Takahashi, Mayuko Yamamoto “Hitachi’s Vision of the Smart City” (2012) http://intic.org/wp-content/uploads/2018/03/Hitachis-Vision-Of-A-Smart-City.pdf

William D. Eggers, John Skowron (2018). “Force of changes: Smart cities”
https://www2.deloitte.com/insights/us/en/focus/smart-city/overview.html

Dylan (2017). “Unfolding the Smart City Label: Definition and Application of Performance Measurement System for Smart Cities”
https://pdfs.semanticscholar.org/0e08/5870dd884114ccbf846e6354fbdeef61a3ed.pdf

Computer Science for All: Fundamentals for Our Future https://www1.nyc.gov/office-of-the-mayor/education-vision-2015-computer-science.page

Richard L. Florida (2002) “The Rise of the Creative Class”

- Standards, indicators, framework

Smart Cities Council “Smart City Index Master Indicators” (2014)
https://smartcitiescouncil.com/resources/smart-city-index-master-indicators-survey

BSI Standards Publication, “Smart cities overview Guide” (2015)
http://shop.bsigroup.com/upload/Shop/Download/PAS/30313208-PD8100-2015.pdf

BSI, Imperial College London Consultants “Mapping Smart City Standards”
https://www.bsigroup.com/LocalFiles/en-GB/smart-cities/resources/BSI-smart-cities-report-Mapping-Smart-City-Standards-UK-EN.pdf

The Scottish Government, Scottish cities alliance, Urban Tide (2014) “Smart Cites Maturity Model and Self-Assessment Tool Guidance note for completion of Self-Assessment Tool”
https://www.scottishcities.org.uk/site/assets/files/1103/smart_cities_readiness_assessment_-_guidance_note.pdf

UrbanTide “Overview of the Smart Cities Maturity Model” (2014)

https://static1.squarespace.com/static/5527ba84e4b09a3d0e89e14d/t/55aebffce4b0f8960472ef49/1437515772651/UT_Smart_Model_FINAL.pdf

William D. Eggers, John Skowron (2018). “Force of changes: Smart cities” https://www2.deloitte.com/insights/us/en/focus/smart-city/overview.html

PwC (2017) “The Future is Coming: Index of Cities’ Readiness” https://www.pwc.ru/ru/assets/the-future-is-coming-english.pdf

ISO /IEC JTC 1 “Smart Cities” (2014) https://www.iso.org/files/live/sites/isoorg/files/developing_standards/docs/en/smart_cities_report-jtc1.pdf

Kamel Jouili & Abdurahman Al Furjani & Isam Shahrour & Kent Washington, “ The Smart City How to Evaluate Performance” (2017) https://www.researchgate.net/publication/324519873_The_Smart_City_How_to_Evaluate_Performance

Hongbo Shi, Sang-Bing Tsai , Xiaowei Lin and Tianyi Zhang “How to Evaluate Smart Cities’ Construction? A Comparison of Chinese Smart City Evaluation Methods Based on PSF” (2017) https://www.researchgate.net/publication/322067160_How_to_Evaluate_Smart_Cities'_Construction_A_Comparison_of_Chinese_Smart_City_Evaluation_Methods_Based_on_PSF

Juniper Research “SMART CITIES – WHAT’S IN IT FOR CITIZENS?” (2018) https://newsroom.intel.com/wp-content/uploads/sites/11/2018/03/smart-cities-whats-in-it-for-citizens.pdf

GSMA “Guide to Smart Cities” (2013) https://www.gsma.com/iot/wp-content/uploads/2013/02/cl_sc_guide_wp_02_131.pdf

European Smart Cities Initiatives “Measuring the success of smart cities” (2017) https://www.designingbuildings.co.uk/wiki/Measuring_the_success_of_smart_cities

IEEE “Smart Cities Community, IEEE” https://www.ieee.org/membership-catalog/productdetail/showProductDetailPage.html?product=CMYSC764&N=4294861850&tcType=General

ASEAN Smart Cities Framework “ASEAN Smart Cities Framework” (2018) https://asean.org/storage/2012/05/ASEAN-Smart-Cities-Framework.pdf

Mckinsey & Company “SMART CITIES: DIGITAL SOLUTIONS FOR A MORE LIVABLE FUTURE” (2018) https://www.mckinsey.com/~/media/mckinsey/industries/capital%20projects%20and%20infra

structure/our%20insights/smart%20cities%20digital%20solutions%20for%20a%20more%20livable%20future/mgi-smart-cities-full-report.ashx

Sally P. Caird & Stephen H. Hallett “Towards evaluation design for smart city development” (2018)
https://www.tandfonline.com/doi/pdf/10.1080/13574809.2018.1469402?needAccess=true

CITYkeys “CITYkeys indicators for smart city projects and smart cities” (2017)
http://nws.eurocities.eu/MediaShell/media/CITYkeysD14IndicatorsforsmartcityprojectsandsmartcitiesD14.pdf

ERICSSON “Networked Society City Index” (2016)
https://www.ericsson.com/assets/local/trends-and-insights/consumer-insights/reports/city-index/2016-networked-society-city-index.pdf

Dylan van der Hoeven (2017) “Unfolding the Smart City Label: Definition and Application of Performance Measurement System for Smart Cities”
https://pdfs.semanticscholar.org/0e08/5870dd884114ccbf846e6354fbdeef61a3ed.pdf

NYC Mayor’s Office of Technology and Innovation “NYC Strategy for Building to Smart + Equitable City” (2015) https://www1.nyc.gov/assets/forward/documents/NYC-Smart-Equitable-City-Final.pdf