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A Survey of Smart City infrastructure via Case study on New York

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Abstract

The population is proliferating, but the resources are not increasing. To scatter to needs to people and improve their standard of living, the concept of Smart City s introduced. The Smart City aims to make optimal and sustainable use of all resources while maintaining an appropriate balance between social, environmental, and economic costs. The emerging technology of the Internet of Things (IoT) is used in the development of smart cities. Sensors are deployed at many places to gather data. This, in turn, is sent to the cloud where it is processed, and the generated output is used for planning strategies for the smart city. This paper will explore the technologies and projects implemented in New York City of the USA to make it a smart city.

Keywords: Smart City; LinkNYC; NYCDot; Soofa Benches; Big Belly

1. Introduction

Technology and data is used by Smart Cities to create efficiencies, improve sustainability, enhance economic development, and upgrade the quality of life factors for people living and working in the city. With the increasing population of the world, many cities are moving towards becoming smart cities to improve the lives of its citizens. The development of the Internet of Things (IoT) has formed a basic model for many data-driven models that collect data from sensors and analyze their readings and generate a result.

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The New York has population of 8,398,748 (in 2018) and it is the most populous city in the United States [1]. It was awarded the "2016 Best Smart City" by the Smart City Expo World Congress, an award that recognized NYC's cutting-edge smart city initiatives as able to resolve urban challenges and benefit residents and the city itself. Many plans and programs have been implemented in NYC to transform it into a smart city. The government and the citizens are involved together in this project.

This paper focuses on the areas where NYC has implemented smart solutions for better utilization of resources and improved experiences for the citizens. The topics covered in this paper will be waste management, water management, air quality control, lightning in the city, improvement in parks, LinkNYC program, NYCDot.

2. Waste management

New York City has always been a populous city. Waste disposal has always been a challenge. Initially, waste was dumped in the ocean till the year 1935. After that, landfills and incinerators were used for waste disposal, but due to environmental issues, they were closed down after 1992. By the late 1990s, the only way out for residential and public waste was Fresh Kills. Fresh Kills was shut down in December 2001[2]. Later, the City Council adopted a plan for transporting waste to neighboring states, recycling facilities, and waste-to-energy plants via the truck-based system.

In 2014, the generation of waste in NYC increased to 4 million tons of waste and recyclables per year. Keeping in mind the volume, the waste is handled by two distinct teams – public and private. The waste from residential buildings, government offices, and nonprofit organizations is served by the public agency - the New York City Department of Sanitation (DSNY). On the other hand, private firms have to pay private agencies for their waste collection. Several different strategies to improve management of waste are being deployed by the New York City, including increasing rates of recycling captures; encouraging citizens and businesses to divert organic material from landfills; and overcoming obstacles of permission related to waste-to-energy.

As a smart city initiative, the government has deployed a smart trash can named 'Big Belly' throughout NYC. These trash cans contain a wireless sensor that is used to monitor the trash level, which is useful in planning pick-up trips efficiently. There is also a trash compactor in these trash cans which runs on solar power. With the help of the trash comparator, the garbage container can hold up to 500% more waste than a conventional trash can.

3. Air quality control

A problem can be well solved only if its actual cause is known. For improving the air quality in NYC, air quality surveys are being conducted by the NYC Department of Health and Mental Hygiene, since 2008. 75 temporary monitoring stations does the monitoring of the air quality, along with the eight permanent air monitors that are responsible for reporting data in the intervals of 15-minutes. This program helped in determining that low-cost heating oil, employed in just 1% of NYC buildings was responsible for the cause of more pollution than all the vehicles in the city combined. With the assistance of this air monitoring program, sulfur dioxide emissions have plummeted by more than 70% in New York City since 2008.

In recent years, NYC has undertaken several actions to reduce emissions from several sources. The vehicles used in the municipal fleet are light-duty and medium-duty vehicles only. Attractive rebates for converting heating systems from oil to natural gas have been introduced by Con Edison, to address the issue of air pollution.

4. Water management

Being the most populous city in the US, New York uses a billion gallons of water each day. To ensure that citizens use water wisely, a large-scale AMR (Automated Meter Reading) has been deployed by the NYC Department of Environmental Protection to get a clearer picture of water consumption. The effective methods for using water wisely are 'Greywater' and 'Rainwater Harvesting.' Greywater comprises of all the wastewater apart from that from toilets, and it can be further utilized in non-potable activities namely - irrigation or flushing in toilets. The NYC properties are required to limit their release of rainwater to the sewage system to prevent spillage.

For providing drinking water to people roaming in the streets, several portable water fountains are deployed under the 'Water on the Go' scheme. The water in these fountains contains zero calories, zero sugar, and zero fat.

5. LinkNYC

In November 2014 NYC Mayor Bill de Blasio announced the installation of 'Links.' There are over 2200 Links in NYC. Each Link provides fast, free public Wi-Fi (100 times faster than average public Wi-Fi), free phone calls anywhere in the US, device charging and a tablet for access to city services, maps, and directions. People can also access the 311 apps for government information and nonemergency services. LinkNYC is completely free as it is funded through advertising. The companies can advertise on the screens in LinkNYC. Its digital outdoor advertising network will enable companies to reach residents and visitors.

Each Link is built strong enough that it can withstand extreme heat and cold, rain, snow and flooding, earthquakes, vandalism, and theft. They also have internal sensors that are used to understand the environmental impact on the structures.

6. Smart Lighting

Since the 1930s, the Sodium bulbs were used, which are not very energy efficient and have low life (6 years). The existing streetlight systems were replaced with an energy-efficient LED which has longer lives (20 years). By changing to LEDs, municipalities can save taxpayer dollars, provide better lighting to their community, reduce energy use, and subsequently decrease a community's impact on the environment [3]. LEDs are more efficient, give off cleaner, more illuminating light.

LED lamps allow for better dimming control than standard street lights. The connected digital LED lighting can be used to create dense network of sensors and actuators. The smart lighting grid can be used for real time data collection on traffic, pollution, crime and more. The networked lighting infrastructure can be used to enable a smart city.

Many projects in NYC are LED lighting retrofits, and they contribute to savings of more than $800,000 per year and prevents more than 900 metric tons of GHG emissions. Savings of lightings can be achieved by either using them for lesser time every day or by ameliorating the amount of power consumed:

- LED installations help in reducing lighting power, achieving savings that in turn are directly proportional to the reduction in power.
- Lighting power can be further reduced using Smart Controls through dimming, and can also assist in the reduction in the hours of operation via scheduling or occupancy sensing.

7. Park management

Smart parks are created so that the people of the city can reconnect with the public spaces and the outdoors. NYC Parks Commissioner Mitchell J. Silver with Soofa announced the launch of a new pilot program in May 2016. In this pilot, NYC Parks and Soofa collaborated to install multi-purpose benches. This benches will improve for the day-to-day experience of a park. It will provide free mobile charging and additional seating, and more information on how people are using the park. The information provided by systems like the Soofa benches can help Parks to manage the city's public spaces more effectively and efficiently [4]. Using the information collected through the benches, the government can also decide upon the budget they should plan for a particular park.

8. Smart public transport

The traffic in NYC is always a major problem. The average speed of public transport buses is about seven miles per hour, which makes them the slowest bus system in the nation. To increase the speed of the buses to improve the lives of 1.9 million daily bus riders, Better Buses Action Plan was introduced by Mayor Bill DeBlasio. The main objective of the plan is to improve bus speeds by a quarter (25%) in one year.

For increasing the speed of the buses, the government is planning to use technology instead of just creating separate lanes for buses. Transit Signal Priority (TSP) is a combination of hardware and software that enables the traffic signal to turn to or remain green whenever a city bus is approaching the signal. By giving priority to the city buses, their average speed could be increased, and they would better adhere to time schedules. TSP technology has already been installed in the city at 594 intersections, involving 12 different bus routes. Installing TSP is a very

complicated and delicate task. To make TSP work properly, the DOT (Department of Transportation) must meticulously study traffic patterns at a given intersection.

The DOT has also installed and operates 750-speed cameras in 750 school speed zones. These cameras use radar and laser technology to measure vehicle's speed, if the speed is above 10 miles than the image of the vehicle with the image of the license plate is recorded which are further checked by the trained staff at DOT. If the vehicle is found to be speeding above the safe limit, then the notice of liability will be issued to the person on whose name the car is registered.

There is a project in NYC called 'citibike'. There are 13,000 bikes at nearly 800 stations. These bikes can be used under 'Unlock, Ride, and Return.' Firstly, the bike should be unlocked from one of the stations, and then it can be ridden for 30 or 40 minutes depending upon the users' pass, after that the bike has to be returned to any one of the stations.

9. Future plan

Many technologies have already been implemented in New York City as an initiative to make it a smart city. Several pilot projects have been launched to improve people's lives. The Mayor and the governing bodies are always trying to implement new technology to improve and upgrade. There are several meets where local companies, start-ups, and citizens can also give their views, ideas, or solutions to make NYC a smart city and a better place to live.

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