Transitioning from a Smart City to a Cognitive City - The Role of Artificial Intelligence and Advanced Technologies

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Abstract

The objective of this article is to explore the emergence of cognitive cities as the next step in urban development and to provide insights to city planners and administrators on how to create a connected and efficient physical environment that serves its citizens. By examining the key features and benefits of a cognitive city, which leverage technologies such as artificial intelligence, IoT, and other smart technologies, this article aims to inform readers about the evolving urban development needs and the opportunities presented by these cutting-edge tools and techniques.

Around a decade ago, the term "Smart City" became a popular buzzword because it envisioned a city that felt unimaginable for many. For instance, it envisioned a city with problem-free intelligent urban transport networks, modernized water and electricity infrastructure, improved waste management, and increased efficiency of public services. Additionally, it involved the city administration's ability to monitor public services and quickly respond to challenges as they arise. Unfortunately, it has since lost some of its hype.

Concept of a Smart City

The smart city concept was a futuristic vision that aimed to harness technology to enhance the quality of life for urban residents. The objective was to employ technological breakthroughs to foster sustainability and efficiency in cities.

The smart city vision aimed to provide residents with essential services such as power, water, and electricity while developing sustainable transportation infrastructure to reduce congestion and promote greener travel. By emphasizing efficient healthcare through advanced health records and telemedicine, as well as e-governance for streamlined public services, the goal was to create a technologically advanced, eco-friendly, and efficient urban environment that would ultimately improve the quality of life for its residents. Access to education, affordable transportation, and high-speed internet were also considered crucial components in achieving this vision.

In essence, the smart city vision centred on utilizing technology to boost the efficiency and sustainability of urban environments while granting residents access to basic services, effective healthcare, and education. Though the smart city concept has evolved since then, its core principles remain the same: leveraging technology to improve residents' quality of life.

Numerous countries and their smart city projects have encountered various obstacles in achieving their smart city visions. Many city administrations faced financial constraints, while others with ample financial resources inadvertently created lifeless ghost towns, lacking the vital connection between people and their city.

What happened to the smart city projects

Many city administrations initiated projects that brought together administrative bodies, key officials, industries, SMEs, investors, banks, planners, and other smart city stakeholders. Governments worldwide launched initiatives, but only a few cities realized their visions, while the most lost sight of their original objectives. Examining many smart city initiatives reveals that sustainability was often not a priority in city development projects.

In 2014, the Indian government announced an initiative to construct 100 new smart cities, focusing on addressing urbanization challenges like effective traffic management, public transportation, waste removal, pollution control systems, and establishing a rapid government response system. However, this project also encountered a lack of adequate financial resources and numerous operational challenges. As a result, the project has struggled to gain momentum, with no clear resolution in sight.

Similarly, in the United States, Boston's Smart Cities Playbook has experienced delays due to funding issues and other challenges, while budget constraints and additional factors have hindered Los Angeles' smart city initiative.

Even in China, where the government has heavily invested in smart city development, some projects have faced delays due to funding issues and political challenges.

Abu Dhabi had an ambitious plan to create the world's first zero-carbon city. However, due to financial constraints and other obstacles, the target completion date had to be pushed from 2016 to 2024, raising the question of whether it will be a smart city for all or a luxury for those who can afford it.

South Korea also took the initiative to create Songdo, its model smart city, and had all the necessary financial resources. However, it ended up creating a ghost town.

It is evident that while smart city development is challenging, continued investment and innovation can lead to more successful projects in the future. Not all outcomes are bleak; many cities have achieved considerable success. For example, cities like Tel Aviv and a few cities in the USA have some noteworthy success stories to share.

What is a Cognitive City

According to Webster's dictionary, the term cognitive refers to conscious intellectual activity such as thinking, reasoning, or remembering. In the context of cities, a cognitive city is a concept that leverages real-time data and technologies like the Internet of Things, artificial intelligence, machine learning, and smart data gathering. By doing so, a cognitive city connects city infrastructure with the people who use it and constantly operates to address issues in real time.

In the transition from a smart city to a cognitive city, citizen needs are collected in real-time and applied to optimize issues ranging from traffic blockages to power outages, and even issues related to utility services, supply chain management, theft, and healthcare.

In a cognitive city, real-time data would be leveraged to manage a variety of issues including traffic, health hazards, and events. Furthermore, the city would become even smarter by using patient data to adjust treatment plans and optimize equipment maintenance schedules. This would ultimately lead to improved patient care and reduced costs for healthcare providers.

So what are the key pillars of a Cognative city which make it a better version of a smart city? These are the key and the most important component

Cognitive Computing / Artificial Intelligence: This involves the use of advanced technologies like natural language processing and machine learning algorithms to make sense of vast amounts of data generated by sensors and other sources. Cognitive computing allows the city to gain insights into the behaviour of citizens, predict potential problems, and take proactive measures to prevent them.

Community Involvement: A cognitive city aims to engage citizens in decision-making processes by using advanced technologies like social media and crowdsourcing platforms. This allows the city to gather feedback and insights from citizens, which can be used to shape policy decisions and improve city services.

interconnected Sytems: A cognitive city integrates multiple systems and services to create a seamless experience for citizens. This includes integrating public transportation, public utility services, healthcare services, and emergency services, among others.

Publicly Accessible Data: A cognitive city makes data publicly available to citizens, businesses, and other organizations, which allows them to develop innovative solutions to urban challenges. Accessible data promotes transparency and

accountability and helps to foster a culture of innovation within the city.

How does it benefit me as a citizen?

Let's consider a water leakage problem and compare how a smart city resident would approach it versus a cognitive city resident.

Smart City: Customer experience in a Smart City: Suppose a resident of a smart city wants to report a water leakage on a busy street. They would typically have to navigate through multiple websites or apps to find the correct department, and then fill out a form to report the issue. The report would then be added to a backlog of other complaints, and it could take several hours or days before the water pipe leakage issue is fixed.

Cognitive City: Customer experience in a Cognitive City: In a cognitive city, the resident can simply take a picture of the water leak using their smartphone and upload it to a citizen engagement platform. The platform uses cognitive computing to analyze the picture and determine the exact location and severity of the water leak. The system then generates a work order and sends it directly to the appropriate department responsible for repairs. The resident can track the progress of the repairs in real time through the platform, which also provides updates on when the leak will be fixed. In the meantime, the traffic department can guide people on using alternate routes to avoid congestion.

Example 1 - Customer experience in a Smart City: In a smart city, a person with 10 suitcases would likely have to call a taxi or a ride-sharing service to arrange for transportation to the airport. They would have to manually input their pickup and drop-off locations and indicate the number of passengers and suitcases. There would be no guarantee that the driver's car would be able to accommodate all 10 suitcases, and the person might have to pay extra fees for additional luggage or request a larger vehicle.

Example 2 - Customer experience in a Cognitive City: In a cognitive city, a person with 10 suitcases could simply use a voice-enabled assistant to arrange for transportation to the airport. The assistant would use natural language processing and machine learning to understand the person's request and ask for additional details such as the pickup location, drop-off location, and the number of suitcases. The assistant would then automatically search for and book the best transportation option that can accommodate all 10 suitcases, such as a minivan or an SUV. The person would receive real-time updates on the driver's location, estimated time of arrival, and the cost of the ride.

As you can see, in a cognitive city, the customer experience is much more personalized and convenient, as the system can use AI and other advanced technologies to automate many of the steps in the process. This allows individuals to travel with ease and comfort, while also enabling the city to optimize transportation resources and reduce traffic congestion.

Who has taken the early lead in building Cognitive City?

Saudi Arabia has recently announced its plan to build a cognitive city called NEOM, which prioritizes people over infrastructure. Instead of relying on traditional forms of transportation like cars and taxis, essential services such as hospitals, medical facilities, leisure centres, parks, and schools will be located within walking distance to promote walkability as a defining aspect of daily life. The primary goal of this new city is to cater to the needs of its citizens and empower human interaction.

Cognitive cities utilize advanced information and communication technologies (ICTs) to automate daily urban processes and integrate learning systems into their infrastructure. This allows the city to learn from past behaviours and adapt to changes in the environment and user requirements. By collecting and analyzing data provided by citizens through available ICT, both the city and its residents benefit from ongoing interaction and learning, which enhances collective intelligence[1] within the city.[2]

The future

[1] *Malone, T.W., Bernstein, M.S.:* Handbook of Collective Intelligence. *MIT Press, Cambridge, 2015*

[2] *D'Onofrio, S., Portmann, E.(in print):* Cognitive Computing in Smart Cities, *Informatik Spektrum, "Special Issue Smart Cities", Heidelberg, Deutschland: Springer, 2016*

Some players are already developing virtual cognitive cities to provide more efficient and intelligent ways for people to interact with physical cities, regardless of their efficiency. A virtual cognitive city can complement a physical smart city by improving community processes through collaboration among members in a virtual environment[3], utilizing gathered data to identify patterns and facilitate growth.

More and more countries are recognizing the importance of building truly smart cities by adopting information and communication technology (ICT) and implementing cognitive city models.

- Toronto, Canada - the city is developing a new waterfront district called "Quayside" in collaboration with Google's Sidewalk Labs. The district will serve as a testbed for advanced technologies, including artificial intelligence (AI), to create a more sustainable and livable community.
- Helsinki, Finland - the city is working on a project called "Cognitive City" that aims to integrate AI and machine learning into urban planning and management. The project focuses on using data and algorithms to optimize public services, reduce energy consumption, and enhance citizen engagement.
- Tokyo, Japan - the city is working on a project called "Tokyo Cognitive Neuronet" that aims to create an AI-powered platform to connect various public services and improve urban planning and management.
- Columbus, Ohio, USA - the city is working on a project called "Smart Columbus" that aims to create a connected and intelligent transportation system using data and AI.
- Helsingborg, Sweden - the city is working on a project called "Cognitive Helsingborg" that aims to create a sustainable and connected city using data and AI.

It's important to remember that technology, especially artificial intelligence (AI), is evolving at a rapid pace. This means that any long-term city development projects or delays could result in outdated plans and increased costs. Therefore, all city planning must include a continuous approach to building infrastructure that is adaptable to new technologies, much like updating software on a phone, computer, or electric car.

[3] *Schechter, Aaron, et al.: "Step by step: Capturing the dynamics of work team process through relational event sequences." Journal of Organizational Behavior, 2017, Special Issue, Nov 27, 2017*