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Open Data: A Fundamental Pillar For Establishing Smart Cities

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Abstract:

The study aims to highlight the importance of open data in achieving the efficiency of smart cities. It concludes that open data constitutes a fundamental pillar in enhancing smart city efficiency by supporting transparency and accountability, improving the quality of public services, and activating civic participation. It also contributes to making accurate urban decisions through its integration with artificial intelligence systems, which leads to better resource management and the delivery of more responsive services.

In addition, open data plays an active role in strengthening the economic dynamism of smart cities by fostering innovation and entrepreneurship, attracting investment, and promoting the digital economy, thereby creating a sustainable and continuously evolving urban economy.

Key Words: Open Data, Smart Cities, Service Quality.

Introduction:

In conjunction with rapid technological advancement and the ongoing digital transformation reshaping contemporary societies, smart cities have emerged as a strategic option pursued by governments to enhance citizens' well-being and achieve sustainable development. Access to data represents one of the most critical enabling factors supporting this transformation, as it provides a knowledge-driven environment that empowers various stakeholders to make informed decisions that enhance efficiency, ensure rapid responsiveness to emerging challenges, and facilitate service integration. This is particularly crucial given the growing complexity of modern urban needs, which necessitates the establishment of robust information systems grounded in data sharing as a common technological resource that interconnects the diverse actors and components of the smart city.

Open data is often narrowly perceived as merely providing access to information; however, in reality, it constitutes a supportive framework for stability due to its strong capacity to respond effectively to citizens' needs. It also serves as a vital informational resource for understanding urban challenges and formulating forward-looking strategies to address them. Furthermore, open data reinforces two fundamental pillars—transparency and accountability—between governments and society, thereby enhancing public trust and encouraging active engagement in smart city transition initiatives. In this context, open data emerges as a strategic instrument for developing cities capable of responding swiftly to challenges while adopting innovative and sustainable solutions.

This study seeks to achieve the following objectives:

1. To highlight the importance of open data in strengthening smart city governance.
2. To examine the impact of open data on improving the quality of public services in smart cities.
3. To assess the economic impact of open data within smart cities.

Based on the foregoing, the central research question is formulated as follows:

What role does open data play in the development of smart cities?

In light of the study's objectives and research problem, the paper is structured as follows:

1. Conceptual Approach to Open Data / Smart Cities

1.1 The concept of open data.

1.2 The concept of smart cities.

2. The Importance of Open Data in Building More Efficient and Sustainable Smart Cities

2.1 Enhancing transparency and accountability.

2.2 Quality of public service.

2.3 Activating citizen participation.

2.4 Supporting economic growth and the digital economy.

1. Conceptual Approach to Open Data / Smart Cities

In the context of accelerating global digital transformation, new concepts have emerged that are reshaping the traditional paradigms of urban management and public service delivery. Among the most prominent of these is the concept of smart cities, which seeks to enhance the quality of life in urban areas through the effective use of technology. In parallel, open data has emerged as a fundamental pillar of this transformation, enabling citizens, public authorities, and researchers to access vast amounts of governmental and public information. This, in turn, opens up broader prospects for urban planning, accountability, transparency, and innovation. The complementary relationship between open data and smart cities has become evident in numerous international experiences in public governance.

Building on this significance, this section aims to clarify the conceptual framework of these two notions by reviewing their definitions, characteristics, and objectives, as well as analyzing the interconnections between them. This approach seeks to facilitate a deeper understanding of the role that open data plays in the development of smart and sustainable cities.

1.1 The Concept of Open Data:

Open data is a new concept that appeared in 2009 in the United States and the United Kingdom, where it is considered a new approach to managing and publishing public data, internal cooperation between government agencies, and external cooperation with non-governmental entities to support transparency by enabling the citizen to evaluate government policies [1] .

It is defined as: "Data that can be used, reused, and redistributed freely by anyone, with the commitment only—at a minimum—to the requirement of attribution and ShareAlike"[2] .

The definition indicates that open data is accessible to all individuals without substantial restrictions, reflecting a high degree of openness and transparency in the dissemination of information. Despite this broad accessibility, the definition establishes two minimum conditions governing its use:

- Attribution: This requires that the data be properly credited to the original source in order to preserve the rights of the data provider.
- ShareAlike: Derived from open-source licensing principles, this condition stipulates that if the data is modified or used to produce a new work, the resulting output must be made publicly available under the same terms as the original data, thereby ensuring the continuous flow of knowledge and fostering collective contribution.

It should be clarified that opening data includes non-personal data, data that does not include information about specific individuals. In addition to some government data on which restrictions are imposed for reasons related to national security [3] .

Building a wealthier, fairer, and more equitable society requires governments to operate with greater transparency and accountability, while maintaining regular and effective communication with citizens. Moreover, informational wealth represents a fundamental opportunity to strengthen cooperation on core social issues. Open data refers to "digital data that is made available to the public and is characterized by technical and legal properties that allow anyone, at any time and from any place, to freely use, reuse, and redistribute it" [4] .

Open data is not merely information made publicly available; rather, it must meet specific conditions that ensure its practical usability. This definition provides a comprehensive characterization of open data by highlighting three core dimensions: its digital nature, its public accessibility, and its legal and technical capacity for reuse.

Open data and content are: "Information that anyone can freely use, modify, and share for any purpose, provided they adhere to the following standards:

- Open License: The work must either be in the public domain or made available under an open license that permits its use and reuse.
- Access: The data must be provided in full and made freely available for download via the Internet.
- Machine Readability: The data should be presented in a format that can be directly processed by computers, allowing for easy access, manipulation, and modification.
- Open Format: The data must be provided in a non-proprietary format that imposes no financial or other restrictions on its use and can be fully processed using at least one free or open-source software tool . [5]"

Based on the foregoing, open data can be defined as non-personal data published by official or non-official entities and made publicly available online in a free and accessible format. Such data is machine-readable and suitable for computational processing, allowing for its use, reuse, modification, and redistribution, provided that proper attribution is given to the original source and that any derivative works are shared under the same conditions as the original data. This framework contributes to enhancing transparency, accountability, innovation, and citizen participation.

Among the principles of open data that benefit data publishers with international best practices—when publishing data and enabling the widest possible use of it—are the following[6]:

- Data Completeness: Data should be complete, coherent, and free from missing values or erroneous information. It should also be accompanied by appropriate metadata that clearly describes the dataset, including its source, method of collection, geographic scope, and the time period it covers.
- Timeliness of Data Availability: Data should be released in a timely manner, ensuring that users can access and benefit from it when it is most relevant and useful for analysis and decision-making.
- Primary and Reliable Source: Data should be published by the original authority responsible for its production and oversight, thereby ensuring its credibility, authenticity, and reliability for use.

• Raw Data Publication: Data should be made available in its original, unprocessed form as collected, avoiding unnecessary alterations or modifications prior to publication.
• Technical Reusability: Open data should be provided in machine-readable formats that enable software systems to easily access, process, and analyze the data efficiently.
• Legal Reusability: Open data should be freely accessible for both commercial and non-commercial use. This principle can be implemented through appropriate governmental licensing mechanisms that ensure lawful reuse.
• Accessibility and Discoverability: Data should be easily searchable, identifiable, and accessible, and must be provided freely without discriminatory restrictions or barriers that limit its use.

These principles reflect transparency and efficiency in the management of open data, enabling users to access and utilize data in an effective and reliable manner. They constitute an essential reference framework that guides data publishers toward best practices in open data dissemination.

According to the International Open Data Charter, the correct use of open data aims to:

- Data-driven decision-making based on more comprehensive information: Decisions are grounded in larger volumes of timely data, which enables individuals and institutions to generate new knowledge and innovative ideas that may lead to social and economic benefits, as well as improvements in overall quality of life.
- Linking and comparing datasets: Effective comparison of data from multiple sources across different programs and sectors helps identify social and economic trends and issues, measure the level of progress in public programs and services, and detect patterns of inequality.
- Improving the quality of public services: By supporting the efforts of governments, citizens, and organizations to achieve better outcomes in key areas such as health, education, public safety, environmental protection, human rights, and disaster response.
- Promoting economic development: Through its contribution to the creation of new markets, the stimulation of innovation, and the generation of employment opportunities.
- Enhancing transparency and information flow: Increased transparency leads to higher levels of accountability and good governance, fosters public debate, and supports efforts to combat corruption [7].

The effective use of open data achieves objectives that encompass social, economic, political, and environmental dimensions, as open data is not merely a means of disseminating information, but rather a comprehensive strategic tool that contributes to building a more informed society, a more efficient public sector, and a more resilient economy. This underscores the importance of investing in open data as a strategic choice for the transition toward smart cities.

1.2 The Concept of Smart Cities:

Smart cities are defined as: "urban areas equipped with information and communication technologies (ICT) and modern innovations, aimed at improving the quality of life of their residents and enhancing the effectiveness of governmental services and infrastructure. Smart cities are characterized by the efficient use of data, analytics, and technology to improve the citizen experience while promoting sustainability and operational efficiency" [8] .

The definition highlights three fundamental pillars of smart cities: technology, the improvement of quality of life, and the enhancement of service efficiency. Accordingly, a smart city is not merely a digital environment; rather, it is an integrated system that leverages digital capabilities to achieve comprehensive development and sustainability.

It has also been defined as :"urban areas that rely on advanced technologies and data analytics to enhance the quality of life of their citizens, promote sustainability, and improve resource utilization. Through the application of these technologies, various urban systems are managed and monitored, including transportation, energy, water systems, waste management, public safety, and others" [9] .

This definition indicates that a smart city represents a fundamental transformation in urban governance, where processes and services are redesigned through the use of data and modern technologies in order to establish more efficient cities that take into account both human needs and resource sustainability.

According to the European Commission, "a smart city is not limited to the use of digital technologies to improve resource efficiency and reduce emissions; it also encompasses:

- Smarter urban transport networks;
- Improved water supply systems and waste management facilities;
- More efficient methods for lighting and heating buildings;
- More interactive and responsive urban governance;
- Safer public spaces;
- Addressing the needs of an ageing population" [10] .

A smart city is not limited to the use of digital technologies for improving environmental efficiency; rather, it is a system based on innovation aimed at enhancing quality of life, promoting sustainability, and strengthening societal responsiveness.

Accordingly, smart cities can be defined as urban areas that utilize information and communication technologies, data analytics, and modern innovations to improve citizens' quality of life, enhance the efficiency of public services, and achieve both environmental and economic sustainability.

To further deconstruct the concept of smart cities, its key dimensions can be identified as follows:

- The widespread application of electronic and digital technologies to establish an electronic or digital city based on knowledge.
- The use of information technology to transform ways of working and living.
- The integration of information technology into the city's infrastructure.
- The combination of information technology and human capital to foster innovation and knowledge creation.

According to another initiative by the Centre of Regional Science at the Vienna University of Technology, six core components of smart cities have been identified: smart economy, smart mobility, smart environment, smart people, smart living, and smart governance [11] .

Accordingly, smart cities aim to bring about a qualitative transformation in the lives of residents through a set of integrated objectives, the most prominent of which include:

- Achieving well-being and improving quality of life.
- Ensuring environmental sustainability.
- Strengthening security and public safety.
- Enhancing civic and community participation.
- Supporting economic growth and fostering innovation.

2. The Importance of Open Data in Building More Efficient and Sustainable Smart Cities:

Open data acquires a heightened significance within smart cities, as it represents a key element in establishing urban environments capable of leveraging digital knowledge to enhance quality of life, develop infrastructure, and improve efficiency in the management of resources and services. It also

contributes to fostering civic participation by enabling access to information and encouraging its creative and meaningful use.

Accordingly, this section addresses the importance of employing open data within smart cities by highlighting its role in supporting decision-making processes and facilitating the development of smart services that respond effectively to the needs and aspirations of residents.

2.1 Enhancing Transparency and Accountability:

Smart cities foster civic participation in public governance by providing digital platforms that enable citizens to directly engage with decision-makers through submitting proposals, sharing feedback, and voting on local initiatives. This form of active participation contributes to building a more flexible environment grounded in real-time data analysis and in decision-making processes that respond effectively to the actual needs of society.

On the other hand, digital governance serves as an effective instrument for enhancing transparency and combating corruption, as it enables the recording of all governmental transactions in a traceable digital format, thereby reducing opportunities for manipulation and strengthening oversight mechanisms. Technologies such as (Blockchain) * are also used to protect data and document transactions in a way that cannot be modified, which facilitates their review, increases citizen trust in public institutions, and contributes to building a more integrity [12].

Open data plays a pivotal role in enhancing transparency within smart cities, as it enables citizens to access information related to government performance, budgets, and public projects. Through access to such data, the public gains the ability to assess the effectiveness of policies and hold officials accountable for their outcomes, thereby strengthening the foundations of good governance. Open government data promotes transparency and accountability by empowering citizens to monitor governmental performance and identify shortcomings based on reliable evidence [13] .

Smart cities enhance civic participation through digital platforms that enable direct interaction with decision-makers, thereby allowing the adoption of informed decisions aligned with data-driven insights. In addition, digital governance contributes to strengthening transparency and integrity by relying on open data, which empowers citizens to monitor governmental performance and hold officials accountable.

Open data also plays a significant role in building trust between citizens and governments, as it serves as tangible evidence of the extent to which public authorities are committed to transparency and accountability. This has been confirmed by the Organisation for Economic Co-operation and Development (OECD), which states that the opening of public sector data exposes institutional performance to public scrutiny, thereby enhancing trust and strengthening institutional accountability, particularly within smart urban environments[14] .

Leading smart city experiences highlight the pivotal role of open data in enhancing government transparency and accountability. In Dubai, the “Data First” initiative was launched through the *Smart Dubai Data* platform, which provides detailed information on government performance, including transaction completion times, the number of complaints, and customer satisfaction rates. This allows citizens and media outlets to evaluate the implementation of government policies and the quality of public services provided[15] .

In London, the *London Datastore* platform provides accurate information on public expenditure, environmental performance, and the number of completed projects across different boroughs. This

enables citizens to monitor local performance and raise questions to decision-makers within borough councils[16] .

Singapore also represents another prominent example in this context, where the *Data.gov.sg* portal provides detailed data on the performance of public institutions such as schools, hospitals, and transport services. This strengthens civic oversight through direct comparisons between government institutions and encourages them to continuously improve their performance [17] .

These examples illustrate how open data contributes to establishing a culture of accountability and transparency in the governance of smart cities.

Accordingly, it can be argued that open data contributes to building trust between citizens and governments in smart cities by enhancing transparency and accountability. The experiences of leading smart cities such as Dubai, London, and Singapore demonstrate how open data platforms are used to enable citizens to monitor government performance and encourage institutions to continuously improve their services, thereby consolidating a culture of accountability and governance.

2.2 Quality of Public Service:

Smart city solutions rely on integrated systems that enable the continuous monitoring and analysis of big data, allowing decisions to be made based on accurate and real-time information. The ability to respond instantly to changing conditions is a defining feature of smart cities.

Among the key advantages offered by smart cities is the improvement of lifestyle quality through smart applications available on mobile devices. These applications provide residents with access to a wide range of services, including booking transportation, paying bills, monitoring air quality, reporting infrastructure issues, or submitting suggestions and complaints directly to relevant authorities. This enhances convenience, saves time and effort for individuals, and positively contributes to overall citizen satisfaction[18] .

Data plays a crucial role in the operation of smart systems within cities; however, it should be noted that artificial intelligence cannot function efficiently without the availability of high-quality, open, and reusable data. This is where the integration between open data and artificial intelligence becomes evident.

Within the framework of promoting sustainable urban living through data-driven solutions, data emerges as a key instrument for enhancing societal resilience and efficiency by leveraging the capabilities of artificial intelligence. Among the areas significantly influenced by these innovative technologies are:

- Energy management: through smart grids and automated energy systems that enable the monitoring and reduction of energy consumption.
- Waste management: where Internet of Things (IoT) sensors in waste bins ensure timely collection operations, leading to more efficient resource allocation.
- Water conservation: where smart irrigation systems can detect soil moisture levels and optimize water usage in public parks[19] .
- Crime prevention and improvement of public safety: through the deployment of modern technologies that contribute to reducing fatalities resulting from homicide, traffic accidents, fires, and other incidents. In addition, such technologies can significantly decrease cases of assault, robbery, and vehicle theft as a result of monitoring systems, tracking technologies, and early warning mechanisms.

- Safe and rapid transportation: Smart cities feature intelligent transport systems that rely on the integrated use of sensors, computers, communication technologies, and electronics. The use of digital signage and mobile applications enables real-time information on delays to be provided to passengers, allowing them to adjust their routes accordingly during travel. Moreover, smart parking applications can guide vehicles directly to available spaces, identify occupied and reserved spots, and indicate parking areas designated for persons with disabilities.
- Improving citizens' health conditions: Smart cities are characterized by safer streets, green spaces, cleaner air, improved services for residents, and numerous economic opportunities, all of which contribute to enhancing quality of life. Remote patient monitoring systems also have the potential to reduce the healthcare burden, particularly in high-income cities, as these systems use digital devices to collect vital signs and securely transmit them to physicians elsewhere for evaluation. This data can also alert both patients and doctors when early intervention is required to prevent complications. Mobile health interventions can further deliver life-saving messages during outbreaks of epidemics, viruses, and infectious diseases. Additionally, some applications provide telemedicine services via video consultations, especially in cities facing shortages of medical professionals [20] .

Open data and artificial intelligence technologies contribute to enhancing the efficiency and sustainability of smart cities. The role of these technologies is evident across several domains, including energy, waste, water, transportation, public safety, and healthcare, through intelligent solutions that respond instantly to changes and evolving conditions. Accordingly, data and analytics enable informed decision-making, improve citizens' quality of life, and increase the efficiency of resource utilization.

Furthermore, the integration of artificial intelligence in the development of smart cities contributes to a qualitative transformation of the urban environment by enabling the prediction of future changes and proactively addressing the needs of residents. AI-based analytics allow for the identification of patterns in areas such as traffic flow, waste management, and energy consumption, thereby helping urban planners optimize their strategies in line with societal needs. This not only improves operational efficiency but also enhances environmental sustainability and the overall quality of life in urban areas. The main advantages include:

- Improved resource allocation: Cities can use predictive models to deliver more efficient and effective services.
- Data-driven policymaking: Data-based analytics support more accurate governmental decisions and improved public service delivery.
- Increased citizen satisfaction: By leveraging technology to meet residents' expectations, public trust in government institutions is strengthened [21] .

Experiences of cities such as Barcelona, Helsinki, and New York illustrate the vital role of open data in improving the quality of public services within smart cities. In Barcelona, the *Barcelona Open Data* portal provides citizens with real-time access to air quality information, enabling them to make informed daily decisions based on accurate data. It has also supported researchers in developing innovative solutions aimed at reducing environmental pollution[22] .

In Helsinki, data related to water networks—including consumption, distribution, and service interruptions—has been made available through the *Helsinki Region Infoshare* platform. This has

supported the development of applications that enable residents to monitor water quality and report issues promptly, thereby improving response times and enhancing service efficiency[23] .

In New York, *NYC Open Data* has been integrated into applications such as the *311 Service*, enabling citizens to report issues related to streets, lighting, and waste management. It also allows them to track the status of their requests, thereby ensuring a more efficient and transparent governmental response and facilitating the allocation of resources to areas most in need[24] .

Based on the aforementioned experiences, it can be affirmed that open data, when combined with smart technologies, becomes a strategic tool for developing public services in smart cities and enhancing citizens' trust in their institutions.

2.3 Activating Citizen Participation:

High-quality and user-friendly digital services are among the fundamental characteristics of smart cities. These services include digital collaboration platforms, modern and easily navigable websites, mobile applications and self-service kiosks, as well as citizens' online accounts. This expansion in digital services enhances the citizen experience and makes the city more attractive to residents, while also increasing connectivity and transparency in its interactions with the public.

Key tools for fostering interaction and civic engagement include:

- Open government data
- Interactive maps
- Government performance scorecards
- Budget transparency initiatives
- Live streaming of local council meetings
- Strong presence on social media platforms[25] .

Smart technologies enhance civic participation by facilitating access to data and resources through interactive platforms such as mobile applications and web portals. These tools enable citizens to communicate directly with local governments, provide feedback on community projects, and participate in decision-making processes. This, in turn, facilitates access to services, reporting of problems, and collaboration in developing solutions that improve the urban experience.

Key dimensions of this empowerment include:

- Real-time feedback mechanisms: allowing citizens to express their concerns and suggestions instantly.
- Transparency of data related to city operations and initiatives, which supports informed decision-making processes.
- Accessibility for diverse groups, including persons with disabilities, ensuring inclusiveness in civic participation [26] .

Accordingly, open data plays a pivotal role in enhancing civic participation within smart cities by enabling citizens to engage with public affairs in a more informed and evidence-based manner. This transforms participation from mere opinion expression (symbolic participation) into a meaningful contribution to decision-making processes and the improvement of quality of life.

Initiatives such as "Share Dubai" and open performance scorecards in Taiwan illustrate how open data enhances community interaction and promotes transparency and accountability within smart cities. In Dubai, the "Share Dubai" initiative was launched as part of the city's smart strategy, where the platform provides open government data and allows citizens to submit suggestions and feedback

regarding public services. This has contributed to increasing levels of civic engagement and strengthening transparency in governmental processes [27] .

In Taiwan, an electronic performance scorecard platform has been established, providing government performance indicators based on open data, such as response times to public requests. This enables citizens to compare the performance of different government entities and provide transparent feedback, thereby strengthening civic oversight, accountability, and contributing to improved decision-making processes[28] .

Through these initiatives, it becomes evident that open data plays a significant role in fostering an active civic culture and in supporting urban governance models that ensure effective participation and promote equality in service delivery. These elements constitute fundamental pillars for the success and sustainability of smart cities.

2.4 Supporting Economic Growth and the Digital Economy:

Smart cities contribute to accelerating economic growth through investment in modern digital technologies, attracting investments due to the advanced infrastructure, highly efficient communication networks, and easy-to-use services they provide. These cities also allow for the collection and analysis of population data, giving companies strategic insights that help them make more aware and accurate decisions. Among the most prominent economic effects of smart cities:

A. Enhancing Job Opportunities and Improving Market Efficiency: Smart cities provide technical solutions that enhance local labor market efficiency and lower the cost of living. For example: digital employment platforms contribute to developing more effective mechanisms for obtaining job opportunities, and the digitization of government processes contributes to reducing administrative routine, opening the way for entrepreneurship growth.

B. Rationalizing Consumption and Enhancing Efficiency: Smart cities rely on advanced applications that enable the optimal use of facilities and health services. For instance, smart security systems and personal alarms allow for monitoring consumption behavior and accurately analyzing user needs. Water monitoring technologies also contribute to reducing waste by monitoring leaks and water quality via sensors distributed across the distribution network, in addition to the ability of smart systems to detect faults and repair them automatically. Likewise, smart grids enable monitoring the performance of power transmission lines, improving operational efficiency and reducing interruptions [29] .

C. Promoting the digital economy and innovation: Smart cities support a thriving digital economy by providing advanced infrastructure that enables companies to adopt data-driven and artificial intelligence-based business models. Digital governance also facilitates business registration processes and electronic tax payments, thereby reducing bureaucratic barriers and encouraging investment inflows.

D. Developing smart economic zones: Smart cities enable the creation of economic zones that rely on modern technologies such as blockchain in the management of contracts and transactions, which enhances transparency and increases the efficiency of administrative and financial systems.

E. Supporting e-commerce and digital financial services: E-commerce represents a key driver within the digital economy ecosystem of smart cities, as these cities provide integrated infrastructure for electronic payment systems and smart transport services, ensuring the fast and efficient delivery of products. They also support the development of Financial

Technology (FinTech) applications such as digital wallets and payment platforms, facilitating everyday financial transactions.

F. Stimulating entrepreneurship and research and development: Smart cities foster innovation by providing research and development centers equipped with advanced technologies, enabling startups to design and test future-oriented solutions. They also support flexible work models and remote working arrangements, allowing greater flexibility for employees to perform their tasks efficiently within an advanced urban environment[30] .

Smart cities play a significant role in promoting economic growth by relying on open data and investing in digital technologies and advanced infrastructure, which attract investment and support data-driven decision-making. Among their most notable economic impacts are improving the labor market, rationalizing consumption, supporting the digital economy and e-commerce, developing smart economic zones, and fostering entrepreneurship and innovation within a flexible and adaptive environment.

The experiences of Barcelona, Dubai, and New York highlight the pivotal role of open data—as a strategic tool—in promoting the digital economy and encouraging innovation and entrepreneurship within smart cities. In Barcelona, the *Open Data BCN* platform was launched, providing detailed datasets on tourism, real estate, and trade. This has enabled startups to develop specialized digital solutions and market analytics targeting sectors such as fintech and digital tourism[31] .

In Dubai, innovation and investment have been supported through the *Smart Dubai Data* platform, which provides economic and commercial datasets such as real estate prices and business licenses. This has enabled entrepreneurs to analyse market conditions and identify available investment opportunities, while also contributing to the acceleration of artificial intelligence applications and smart services[32] .

In New York, the *NYC Open Data* portal offers more than 30 categories of open datasets, which have been utilized by startups to develop data-driven services such as improved real estate delivery systems and geolocation-based advertising. This has contributed to fostering entrepreneurship and generating new employment opportunities [33] .

Open data has become a strategic instrument for developing the digital economy and fostering innovation in smart cities. Based on the aforementioned experiences, it is evident that open access to economic and social data creates a supportive environment for the growth of startups as well as smart applications that respond to market needs. Moreover, the use of such data across diverse sectors such as real estate, tourism, and advertising highlights the added economic value of digital transparency. The impact of open data is particularly evident in its support for entrepreneurship, which reinforces the role of smart cities as hubs for innovation and sustainable growth.

Conclusion:

Open data plays a pivotal role in consolidating the principles of transparency and accountability within smart cities by enabling citizens to access accurate information regarding government performance, projects, and budgets. This, in turn, strengthens civic oversight and contributes to holding public officials accountable. Experiences from leading cities such as Dubai, London, and Singapore have shown that open data platforms not only reveal shortcomings in programs and policies, but also encourage governments to improve service quality and strengthen trust between citizens and institutions. This ultimately supports the development of a sound model of urban governance grounded in efficiency and fairness in public administration.

The study has also demonstrated that open data plays an active role in enhancing and improving the efficiency of public services within smart city systems by enabling artificial intelligence-powered systems to make precise real-time decisions based on real-world data. This integration has contributed to improving resource management efficiency and delivering more responsive and context-appropriate services, particularly in sectors such as energy, transportation, waste management, and public health. This positively impacts citizens' satisfaction and their trust in governmental performance.

Open data is also considered an effective tool for fostering civic participation within smart cities by enabling citizens to access accurate information about public policies and services. This transforms their role from passive recipients into active partners in decision-making processes. Interactive platforms based on open data serve as a means of strengthening direct communication between citizens and governments, and establishing transparent and inclusive participatory practices that ensure the expression of opinions, the provision of feedback, and the improvement of urban quality of life.

Furthermore, open data constitutes a fertile environment for attracting investment, enabling innovation, and developing business models based on intelligent data analysis. By facilitating access to economic and social data, open data empowers startups and entrepreneurs to study markets, design solutions tailored to citizens' needs, and accelerate the development of digital services. It also contributes to improving resource efficiency and developing e-commerce infrastructure, which positively impacts economic growth. Experiences from cities such as Barcelona, Dubai, and New York confirm the role of open data in stimulating the digital economy and generating new employment opportunities, thereby reinforcing the position of smart cities as hubs for sustainable growth and future-oriented entrepreneurship.

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