Digital Technological Innovation in the City of Santo Domingo - Ecuador

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***Abstract*—Focuses on the analysis and description of the technological advances and digital transformation that the city of Santo Domingo, located in Ecuador, has experienced. Through a detailed study, the key aspects of the implementation of digital technologies in infrastructure, public administration and citizen services are explored. The impacts, benefits and challenges that this technological innovation has brought with it, both for residents and for the sustainable development of the city, are examined. This article sheds light on how digital innovation is influencing the evolution of Santo Domingo, contributing to its growth and improvement in various aspects**

Keywords— Implementation of digital technologies, Infrastructure, Public Administration, Citizen Services

I. INTRODUCTION (*HEADING 1*)

Latin American urban centers are integral to one of the most remarkable demographic expansions that our planet has ever witnessed, bearing significant implications for the sustainability, quality of life, and competitiveness within the region. Tackling these challenges necessitates advanced governance and decision-making processes, as well as the more efficient utilization of our cities' resources to achieve intelligent urban management.

Information and communication technologies (ICT), with their growing prevalence, have emerged as crucial assets in achieving this intelligent administration. However, it's crucial to view the use of these technologies as a means to further develop our society, rather than an end in itself.

As Henry V. Iglesias, the former President of the Inter-American Development Bank (IDB) from 1988 to 2005, aptly stated: "Merely having smart cities is insufficient; we must also cultivate intelligent citizens" [1].

The Inter-American Development Bank (IDB) defines a "smart city" as one that prioritizes its inhabitants' welfare by seamlessly integrating information and communication technologies into urban governance. These elements serve as tools for promoting effective, participatory governance, including participatory planning processes. By championing inclusive and sustainable development, cities can foster innovation, competitiveness, attractiveness, and long-term sustainability [2].

Currently, our global society is entering the third phase of defining a smart city, with a focus on residents who are evolving and utilizing technology as an enabler rather than an end unto itself. The objective is to construct cities that are not just smart but also livable, centered around the well-being and happiness of their citizens [3].

The technology adoption process can be divided into three simple stages: the identification, choice and validation of technological innovations that can optimize the production procedures used by companies in the province of Santo Domingo de los Tsachilas [12].

Santo Domingo de los Tsáchilas, whose population reached 368,013 inhabitants according to INEC data in 2020, represents the fourth most densely populated city in Ecuador, surpassed only by Guayaquil, Quito and Cuenca. Strategically located between the Costa and Interandina regions, it plays a key role as a connection point for important cities such as Quito, Guayaquil, Portoviejo, Chone, Esmeraldas, Manta, Ambato, Quevedo, among others. However, the lack of an efficient management model compromises the routine maintenance of its infrastructures, which poses challenges to ensure its long-term operation as indicated in the Tsáchilas agenda., 2020 [10].

Maturity levels key indicators of the city of Santo Domingo de los Tsachilas represented in table 1.

TABLE I. MATURITY LEVELS

CÓD.	PROVINCE	CANTON	STRATEGY	INFRASTRUCTURE	DATA	SERVICES AND APPLICATIONS	EVALUATION	MATURITY LEVEL ACHIEVEMENTS	ECONOMICS	ENVIRONMENT	SOCIO-CULTURAL	MATURITY LEVEL KPI
2301	SANTO DOMINGO	SANTO DOMINGO	0.0	0.0	0.0	0.0	0.0	0.0	2.7	3.8	3.5	3.4

II. PROPOSAL TECHNOLOGICAL NEEDS

The Province of Tsáchilas is organized into two districts and a total of thirteen circuits. The first district is located in the Santa Martha cooperative, housing seven circuits that will have a total of 25 Community Police Units (UPC). For its part, the second district has its headquarters in the Provincial Command and consists of six circuits with 23 UPCs. This structure is proposed with the aim of addressing social challenges more effectively.

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decentralizing decision-making and approaching the reality of each cooperative [9].

The Province of Santo Domingo de los Tsáchilas demands the acquisition of knowledge and technological application in various areas, such as textiles and footwear, energy and mining, food and beverages, metallurgical and electronic industry, printing and graphic design, manufacture of forest products and the plastic sector [4], the following technological needs are presented:

1) Connectivity, storage and data processing infrastructure: Smart Cities depend on a robust but flexible base network to interconnect sensors, people and organizations with data and applications. Hire and install your own Fiber Optic network, connectivity is the basis of the construction of smart cities, this connectivity is responsible for receiving and transmitting data to and from the sensors. Public Wi-Fi in urban and rural areas. Public access to Wi-Fi is a key enabler for the success of smart cities because it helps connect local residents, as well as visitors, to general resources.

2) Sensors and connected devices: Sensors are one of the most important pieces of Smart Cities. This layer is made up of sensors that are distributed through an urban area to collect data that in the past was too complex, expensive or time-consuming to be collected. The sensors also allow you to record and record the date and time in real time.

Security cameras with PLATE RECOGNITION: Place at the entrances and exits of the canton to search suspicious vehicles and immediately notify Police, traffic agents.

Security cameras with FACIAL RECOGNITION: Place at the entrances and exits of the canton and also in the central and high-risk places to search the suspects and immediately notify the Police, traffic agents.

- ✓ Smart traffic lights,
- ✓ Speed sensors
- ✓ Parking sensors
- ✓ Noise Level
- ✓ Water quality management
- ✓ Sanitation management

Logical management infrastructure and integrated monitoring, operation and control centers: integrated monitoring, operation and control center.

Design and implementation of a Smart City Operations Center that will provide physical and logical coordination for the monitoring, management and control of the services provided by the GAD, its subsidiaries and cantonal strategic units.

It is a site where information from various Departments and various applications is collected and analyzed for better city planning. It houses the intelligence engine that will process all the information and generate qualified information. This information will be useful to manage incidents throughout the city and better plan their development [6].

The only source of information for all urban functions. It hosts the platform with the ability to receive, correlate and share information intelligently with stakeholders who are in the city's operations and planning to better predict the results.

It acts as the city's emergency and disaster management platform. It is integrated with several IT systems of different stakeholders with the aim of improving security and the provision of better public services in cities [5].

- ✓ Reduction of operating costs.
- ✓ Simplification of Interventions.
- ✓ Prioritization of prevention actions

4) Communication interfaces with the citizen (applications): Once the information technology infrastructure of a smart city is established and becomes part of the fabric of the city, a layer of applications and communication systems must be added that act as interfaces between the administration and citizens, as well as the various structures and departments of the city. These systems can serve as collaboration platforms.

One way to ensure that all city residents have access to digital services in the city center is to work with open platforms that are accessible to the entire population.

Currently these applications are in the new development applications of this direction.

✓ Territorial control alert system: It allows you to record all the incidents suffered by the canton, and then assign them to the management or company for their solution.

✓ APP for reporting problems and complaints: Through this channel the citizen records all the incidents suffered by the canton, and then assigns them to the management or company for their solution. All complaints for decision-making will be seen on a georeferenced interactive map.

✓ Online portal: From this month we begin to implement online procedures and certificates, which will allow the citizen to do everything from home.

✓ Chatbot: Allows the citizen to ask questions, complaints, suggestions, initiate procedures, consult procedures and make payments.

5)Cybersecurity: identify, develop, review, promote and maintain the best cybersecurity practices; Implement the best cybersecurity solutions to prevent and respond quickly to cyber incidents; and build and lead communities to build trust in cyberspace.

You have to hire the cloud backup service that allows to safeguard all the information of the GAD of Santo Domingo, to give continuity to the internal services and online services

III. PEQUIRED TECHNOLOGICAL INFRASTRUCTURE

The Technological architecture that is proposed is of a high level that contributes to a more effective and efficient development of the identified projects, which constitute a reference framework for the construction of a road map, which allows to aggregate the different needs and efforts in order to optimize the achievement of results, by leveraging common investments, the interaction of available data and cost control.

Fig. 1. High-Level Technological Architecture

The main elements of architecture for the Intelligent city of Santo Domingo de los Tsachilas are:

1) Hardware: This would include computers, servers, mobile devices and any other hardware equipment necessary to collect, process and analyze data related to technological innovation in the city.

2) Data analysis software: Tools such as statistical software, data visualization tools and modeling software that can help in the analysis of the collected data.

3) Internet Access and Communication Networks: For real-time data collection and communication with relevant information sources, such as online databases or government information systems.

4) Sensors and Monitoring Devices: Depending on the focus of the study, sensors and monitoring devices may be required to collect specific data, such as information on air quality, traffic, energy consumption, etc.

5) Databases and Data Storage: A data storage system to store and manage the data collected during the study.

6) Cyber Security Systems: Since the study involves sensitive data and digital technologies, cyber security is essential to protect the integrity of data and the privacy of citizens.

7) Collaboration Platforms: Online collaboration tools that allow researchers and collaborators to work effectively and share data and information.

8) Geolocation and GIS software: If the study involves geospatial aspects, geographic information systems (GIS) and geolocation software may be required.

9) Surveillance Cameras and Systems: In case the study involves video surveillance analysis or images.

10) Online Survey Platforms: To collect opinions from residents or users of the city.

11) Social Media Analysis Tools: If the study addresses the influence of social networks on technological innovation.

12) Communication and Dissemination Platforms: To communicate the results of the study to the scientific community and the general public.

IV. ROADMAP-IMPLEMENTATION OF THE RECOMMENDATIONS.

Develop, implement and maintain a plan to implement the listed recommendations. Its permanent update will depend on the available resources, the execution capacity and the actual results obtained.

Although all activities should begin immediately, it is suggested to consider the following stages in a staggered manner with respect to the beginning of actions and the production of results.

The presence of a recommendation at a stage does not speak strictly of its relevance or impact, but of the logical sequentiality of tasks necessary for its maturity. The duration of each Phase depends on multiple elements and they are not necessarily all equally long. Typically, each phase should last between three and six months as explained in table 2..

TABLE II. ROADMAP – IMPLEMENTATION OF THE RECOMMENDATIONS

Hoja de Ruta – Implementación de las Recomendaciones	
PHASE I	• (G) GOVERNANCE MODEL FOR THE DIGITAL CITY AGENDA
PHASE II	• (A) CONNECTIVITY, STORAGE AND DATA PROCESSING INFRASTRUCTURE • (B) LOGICAL MANAGEMENT INFRASTRUCTURE • (C) APPLICATION AND SERVICE IMPLEMENTATION PLAN • (F) COMPUTER SECURITY
PHASE III	• (D) CANTONAL SMART CITY OPERATIONS CENTER • (H) WHITE PAPER/ PROCESS AND TECHNOLOGY DIRECTIVES FOR THE DIGITAL CITY
PHASE IV	• (I) HUMAN RESOURCES DEVELOPMENT, KNOWLEDGE TRANSFER AND LOCAL ADDED VALUE GENERATION • (E) OPEN DATA PROGRAM

If it is analyzed in terms of the model "The Road to the Smart City" / (Inter-American Development Bank) shared on page number 13 [7], it is thought appropriate to make the following implementation routes:

- ✓ Leadership: Designate a competent individual as a leader in charge of supporting the vision of the Smart City project and attracting committed collaborators.
- ✓ Team: Form a diverse team, led by a dedicated manager, that integrates various disciplines and approaches to achieve effective coordination.
- ✓ Citizen Participation: Establish mechanisms to actively listen to the community at each stage of the project, starting with the identification of challenges and needs.
- ✓ Problems: Thoroughly analyze the situation of the city, documenting the most pressing problems that require intelligent solutions..
- ✓ Technology: Identify innovative technological solutions that can respond to previously identified problems.

- ✓ Financing: Identify the sources of financing necessary to carry out and maintain the planned actions.
- ✓ Partnerships: Establish and consolidate collaborations with both government entities and the private sector (companies, universities, NGOs) to maximize the support and available resources.
- ✓ Action plan: Develop a detailed plan that covers the implementation of the proposed solutions, including actions, priorities, schedules, costs and progress indicators.
- ✓ Pilot project: Design pilot projects with well-defined objectives, responsibilities and scope to test the proposed solutions.
- ✓ Execution: Carry out the actions planned in the pilot project and move towards the complete implementation of the project.
- ✓ Metrics: Evaluate the results and possible failures of the pilot project, based on previously established performance indicators, including population satisfaction.
- ✓ Continuity: Use the results obtained to feed back the management areas with lessons learned and encourage modifications in the processes in a motivating way.

V. Results

Impact on Urban Infrastructure: Data could be presented that demonstrates how technological innovation has influenced the city's infrastructure, such as the implementation of intelligent traffic systems, waste management or energy networks [13].

Improvements in Citizen Services: Improvements in public services, such as health care, education or security, that have resulted from the digitization and implementation of advanced technologies, could be highlighted.

Citizen Participation and Empowerment: If online citizen participation platforms have been promoted, information could be made about the levels of participation and their impact on local decision-making.

Administrative Efficiency: Data could be presented that shows how public administration has become more efficient through the automation of processes and the digitization of records and procedures.

Economic and Business Development: Information on the emergence of new technology companies in the city, job growth in the technology sector and how this has impacted the local economy.

Environmental Sustainability: Data on how digital technologies have contributed to environmental sustainability, such as the reduction of carbon emissions, the efficient management of natural resources and the promotion of sustainable mobility.

Challenges and Obstacles: The challenges encountered in the implementation of technology, such as cybersecurity issues, lack of equitable Internet access or economic barriers to the adoption of technology.

Benefits for the Community: How residents have experienced improvements in their quality of life, accessibility to services, and comfort thanks to technological innovation.

Long-Term City Evolution: If possible, projections or analyses could be provided on how the city could evolve in the coming years as a result of technological innovation.

Comparisons and Case Studies: Comparisons with other cities that have implemented similar technological innovation initiatives, as well as specific case studies that illustrate the success of certain projects.

VI. Conclusions

When companies are ready to present projects related to Smart City and monitoring centers, it is highly recommended that they use this proposal as a basis. In addition, they are expected to present a clear and detailed business model that not only guarantees the viability of the project, but also allows the canton to benefit directly from the services offered.

In this sense, it is essential that the business model demonstrates how the proposed services will contribute in a concrete way to the development and improvement of the quality of life in the canton. This could include explanations on how greater efficiency in resource management will be achieved, how public services will be optimized and how technological innovation will be promoted for the benefit of the community.

In addition, the inclusion of a strategic plan that addresses collaboration with local authorities and citizen participation is valued. This could strengthen the acceptance and adoption of the proposed solutions, by ensuring that the needs and concerns of the community are taken into account.

To achieve an effective presentation, it is essential that companies highlight the unique and differentiating aspects of their projects. This could involve the implementation of innovative technologies, innovative approaches to environmental and social sustainability, as well as long-term scalability strategies.

In summary, companies are expected not only to focus on technology and technical solutions, but also to present a complete and solid vision that covers financial, social and environmental aspects. This will ensure that the canton not only benefits directly from services, but also moves towards a smarter, more sustainable and connected future."

The recommendations included in this report are ultimately intended to be a contribution to the continuous development of the City of Santo Domingo in its vision of becoming a Digital City that "Relying on Information and Communication Technologies as a tool, with the citizen as the raison d'être of the Project, contribute to the development and modernization of Santo Domingo respecting its heritage and identity; promoting inclusion, efficiency in public services and improvement in the quality of life of citizens."

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REFERENCES

[1] La ruta hacia las smart Cities: Migrando de una gestión tradicional a la ciudad inteligente, Banco Interamericano de Desarrollo (BID/IDB), Maurício Bouskela, Márcia Casseb, Silvia Bassi, Cristina De Luca y Marcelo Facchina, (2021)

[2] United Nations Commission on Science and Technology for Development, "Smart Cities and Infrastructure," (2018), http://undocs.org/sp/E/CN.16/2018/2

[3] Deloitte, "Smart Cities – The importance of a smart ICT infrastructure for smart cities," (2018)

[4] Ministerio de Telecomunicaciones y sociedad de la información, Libro Blanco de Territorios Digitales en Ecuador, (2019) http://www.observatoriotic.mintel.gob.ec/index.php/men-documentacion/lb-tde,

[5] AT&T and BSR, "Smart Cities for All: A Vision for an Inclusive, Accessible Urban Future", (2021)

[6] Norma UNE 178104:2017, Sistemas Integrales de Gestión de la Ciudad Inteligente. Requisitos de interoperabilidad para una Plataforma de Ciudad Inteligente, (2019)

[7] IDC, Smart City Maturity Model – The Stages, (2021).

[8] Ecuador, P. N. (24 de octubre de 2020).

[9] http://www.policiaecuador.gob.ec/index.php?id=166&tx_ttnews%5Btt_news%5D=107 9&cHash=6d223d25639e601a4f7becd365581135. Obtenido de http://www.policiaecuador.gob.ec/index.php?id=166&tx_ttnews%5Btt_news%5D=10 79&cHash=6d223d25639e601a4f7becd365581135: http://www.policiaecuador.gob.ec/index.php?id=166&tx_ttnews%5Btt_news%5D=10 79&cHash=6d223d25639e601a4f7becd365581135

[10] INEC. (1 de JUNIO de 2020). http://www.ecuadorencifras.gob.ec/. Obtenido de http://www.ecuadorencifras.gob.ec/: http://www.ecuadorencifras.gob.ec/

[11] Tranasferencia Tecnologica ¿Que podemos aprender de la experiencia internacional? Journal of Tecnology Management & Innovation, 1-3. Obtenido de http://www.redalyc.org/articuloBasic.oa?id=84710301 Noriega, M. S. (2016).

[12] PLAN ESTRATÉGICO DE DESARROLLO TURÍSTICO DE LA PROVINCIA DE SANTO DOMINGO DE LOS TSÁCHILAS . Santo

[13] Domingo de los Tsáchilas,: PLANDETUR. Tsáchilas., P. d. (2012). Texto tomado del Plan de Ordenamiento Territorial de la Provincia de Santo Domingo de los Tsáchilas. . Santo Domingo de los Tsáchilas: SENPLADES Santo Domingo de los Tsáchilas. (2020-2025).

[14] Principales resultados sobre la pertinencia de las carreras de la Universidad UNIANDES Ext Santo Domingo Ecuador, II Congreso Científico Internacional De La Universidad Regional Autónoma De Los Andes "Uniandes" Ponencia, pg. 2-27-ISBN:978-9942-9919-6-6 Alarcón Piedad; Castelo Angel,(2020).