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Looking for Improving the Urban Areas: the Case of Costa Rican Cantons in Their Path to Become Smart

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Abstract

The process of becoming a smart city (SC) is still diffuse due to the contextual factors and urban challenges that local governments must face, so it is necessary to visualise new options and city strategies to implement them. This study contributes to prior research offering new insights concerning patterns used by small-sized cities in a developing and emerging country in the Latin American context (LATAM) in their early stages of becoming smart, analysing the dimensions to be developed, their pursued goals, their desired economic and/or social impacts, and the time frames expected to reach them. Our findings, based on cluster analysis and Kendall's TAU C correlation, confirm differences in city strategies according to the contextual challenges faced by cities emphasising three different governance models to become smart based on the different significance given to the three components of the smart governance concept. The different city clusters point out different correlations among their priority goals and the smart dimensions, showing a different position of the cities in the smart dimensions' development and goals. Also, differences in expected time frames to reach the aspired goals are identified. These findings allow us to derive new theoretical and managerial implications for cities on their path to become smart.

Keywords Smart city · Social/economic impact · Cluster analysis · Urban studies · Time frames · Strategy

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Introduction

Cities have undertaken the process to transform themselves into inclusive, safe, resilient, and sustainable places (SDG 11-United Nations, 2018), seeking to increase the citizens' quality of life (QL) and the urban sustainability (Meijer & Rodríguez Bolívar, 2016; Bifulco et al., 2016). To achieve this end, local governments (LGs) have taken some steps passing by different constructs such as the creative city, knowledge city, innovation city, sustainable city, resilient city, and "15-min Cities" (Cocchia, 2014; Moreno et al., 2021; Yigitcanlar et al., 2008; Ziozias and Anthopoulos, 2022), which have limited capacity and led to partial urban approaches focused on specific orientations to solve these challenges (technology, mobility or environment), ignoring the implementation of a comprehensive and holistic response to the urban challenges.

This way, many cities have opted for implementing a comprehensive urban approach—the smart city (SC) model (Ramírez-Moreno et al., 2021)—based on three main pillars (technological innovation to improve PS, to build managerial and organizational capacities, and to reform public governance models for addressing urban challenges (Nam & Pardo, 2011)), across six main dimensions: smart governance (SG), smart economy (SE), smart mobility (SM), smart people (SP), smart living (SL), and smart environment (SENV) (Giffinger et al., 2007; Sotirelis et al., 2022).

However, the levels of 'smartness' achieved by cities are different (Kummitha & Crutzen, 2017) depending on their priorities (Alcaide-Muñoz & Rodríguez Bolívar, 2021) and the urban context (Pereira-Piedra et al., 2023), existing no consensus on the concept of SC and the benefits a city could reach from achieving it (Kummitha & Crutzen, 2017). Moreover, the development of SC in each city is dynamic and changing (Kim, 2022), leading to different positions of urban sustainability (Kutty et al., 2022; Wang & Zhou, 2022) and different levels of urban knowledge (Bresciani et al., 2018), having an impact on the economic and social benefits for the cities (Kourtzanidis et al., 2021; Toli & Murtagh, 2020; Zhu et al., 2022).

In this regard, the SCs discourses have become enrolled in the imaginaries of the sustainability concept, making current SC research to be moving to the intersection of urban smartness and sustainability (Rejeb et al., 2022; Wang & Zhou, 2022). Some prior research has emphasised that the technological-determinist approach of the SCs (Colldahl et al., 2013; Odendaal, 2016; Tura & Ojanen, 2022) has led them to fail on the promotion of sustainability development (Ahvenniemi et al., 2017), while others advocate their capacity for improving the technical and managerial issues favouring long-term urban sustainability (Angelidou, 2017; Komninos et al., 2020; Townsend, 2013; Gupta and Hall, 2020; Kumar et al., 2021; Wang & Zhou, 2022). This lively debate has originated current research concerning SCs evaluation using new models of sustainability indicators, and it is expected to increase this research trend in the coming future (Petrova-Antonova and Ilieva, 2018; Abu-Rayash & Dincer, 2021).

As for the urban knowledge, based on the role of human and social capital (Angelidou, 2016), it is considered both a central part of the cities' transformative

capacity to become smart (de Hoop et al., 2022; Stenvall et al., 2022) and as a powerful engine for economic growth (Angelidou, 2016). SCs should therefore provide a good ground for supporting the exchange of knowledge and collaborative governance models (Rodríguez Bolívar, 2018a, b), although it depends on factors like trust in technology and self-concern to the greatest extent (Przysucha, 2023).

To analyse the SC model, prior research has been mainly focused on experiences already implemented in cities located in developed countries (Boon et al., 2020b; Mora et al., 2018), examining case studies of cities with over three million inhabitants—considered as small-sized cities—(Azlal et al., 2020; Ben Letaifa, 2015; Cabello, 2022; Calderon et al., 2018; Gupta & Hall, 2020; Irazábal & Jirón, 2020; Margherita et al., 2023; Nusir et al., 2023), using both first level strategic planning approaches (Armijo, 2011; ISO, 2019; Kaufman & Herman, 1991; Kummitha & Crutzen, 2017; Mora et al., 2018) and global approaches to the topic performing literature reviews and some correlations but of macroconcepts such as smart dimensions (SDi) or SC axes among others (Alawadhi et al., 2012; Alderete, 2021; Dessai & Javidroozi, 2021; Dessai & Javidroozi, 2021; Kummitha & Crutzen, 2017).

Nonetheless, as Alcaide Muñoz and Rodríguez Bolívar (2021) and Loureiro et al. (2021) point out, developing and developed countries have divergent SC conceptions leading to different SC construction. This makes relevant to focus our analysis on examining the SC model and its impact on the economic and social benefits in cities located in developing countries due to their economically undeveloped context, being more focused on the SC's microlevel construction in which private–public partnership is needed in terms of ICT infrastructure (Kar et al., 2019; Wang & Zhou, 2022). This focus is needed to understand their biography on their way to become smart, improving their sustainability and urban knowledge impacting finally on their economic and social benefits (Kourtzanidis et al., 2021; Wang & Zhou, 2022).

In particular, the emerging LATAM countries context has been unexplored (World Bank, 2023) even more in small-sized cities (population less than 500,000 inhabitants). These LATAM cities are strong promising candidates for transformation processes on their path to becoming a SC (Duygan et al., 2022), and the analysis of this process remains relatively unexplored and poorly understood (Boon et al., 2020a, b), possibly due to its complexity, heterogeneity, and idiosyncrasies (Chourabi et al., 2012). Thus, there is a need to delve into the strategies used by cities in these countries to become smart and the orientation of public policies and actions for implementing the SC model.

In addition, to understand well why a city can be labelled as "smart", the motive behind this city aspiration, which smart technologies are implemented into the urban areas and used for, or even how the generation of knowledge and knowledge diffusion were taken place into the urban space, a process-oriented method is required (Treude, 2021). This kind of analysis gets into the social innovation biography method (Butzin & Widmaier, 2016) and will help us to understand the narrative of an innovation process from conception to implementation, analysing the dynamics of the process from a micro-level perspective and, in doing so, capturing the "social relations, contextual settings, and the cross-sectoral and multi-local reach of knowledge developed and applied in innovation processes" (Butzin & Widmaier, 2016).

Therefore, with the aim at filing the research gap identified previously both in terms of the research object and the method used, this research examines, from the beginning, the process of economically undeveloped cities in a LATAM country as being promising candidates for an innovation biography (Butzin & Widmaier, 2012). Considering the wide array of methodological solutions provided by the social innovation biography method (Kleverbeck and Terstriep, 2017), using an electronic survey (e-survey) sent to ICT managers of Costa Rican cities, this paper aims to offer new insights concerning patterns used by these cities in their early stages of becoming smart, analysing the dimensions to be developed (Giffinger et al., 2007), their pursued goals, their desired economic and/or social impacts, and the time frames expected to reach them.

Costa Rica was selected because it is considered an emerging and developing country (Valenciano-Salazar et al., 2022; United Nations (CEPAL), 2023) whose central government is supporting, through inter-institutional policies at different levels (https://www.presidencia.go.cr/comunicados/2018/11/ifam-y-micitt-unidad-con-el-objetivo-de-transformar-costa-rica-en-una-sociedad-conectada/), the implementation of the SC model by issuing national policies addressed to achieve digitalised, decentralised, and decarbonised cities (MIDEPLAN, 2020), with a common technological infrastructure investment (MICITT, 2018, 2023). In addition, there is a national development plan to promote the training of highly-qualified science and technology-oriented professionals (CONARE, 2023) as an instrument to consolidate the country's plans and to increase the citizen skills to take advantage of it. Finally, at the local level, Costa Rica cantons (cities) are on their way of performing actions and steps to implement the sustainable development goals (SDGs) to achieve, among other goals, social outcomes, like social protection (https://press.un.org/en/2023/gaef3590.doc.htm), and economic growth (United Nations (CEPAL), 2023). Therefore, the Costa Rican cities are in their incipient process of becoming smart to achieve these SDGs (Bustillos-Ortega and Murillo-Gamboa, 2022), which could be an appropriate case study for using the social innovation biography method to understanding well the motive behind the city aspirations to become smart from their conception to their implementation (Butzin & Widmaier, 2012).

As for the findings of this research, based on cluster analysis and Kendall's TAU C correlation, findings confirm differences in city strategies according to three different governance models to become smart. These different city clusters point out different correlations among their priority goals and the smart dimensions, showing a different position of the cities in the smart dimensions' development and goals. Also, differences in expected time frames to reach the aspired goals are identified.

The structure of this paper is as follows. The second section analyses the contexts, expected impacts, time frame analysis, and strategies used by cities to become smart using prior research to identify the research gaps which are the basis for the hypotheses tested in the research. Subsequently, the empirical study is described, setting the sample selection and the description of the methodology used. After that, this paper discusses the descriptive results and the hypotheses testing analyses, highlighting the lessons learned. The main findings of the research are discussed in the discussion section analysing the implications of findings for public policies. Finally, in the conclusion section, this research includes information concerning

the theoretical and managerial contributions of the findings of this research and put emphasis on both the limitations and the future research directions of this study.

SC Development Patterns in the Search of Goals and Expected Time Frames to Reach Them: Hypothesis Formulation

Socio-technical problems faced by cities due to demographic changes in recent decades (Jiang et al., 2020; United Nations-DESA, 2022a, b) have been addressed by city models based on the intensive use of technologies (ICT) to initiate the process of smartisation in urban areas (Musa, 2016). Mainstream research has highlighted the SC model as suitable for promoting economic prosperity, ecological integrity, and social equity (Kunzmann, 2014). Nonetheless, there is no single standard procedure for applying the SC model due to the multidimensionality of objectives, the plurality of actors (Manes-Rossi et al., 2020), and the heterogeneous, dynamic, and complex nature of cities, leading to its inconsistent use in different settings (Chourabi et al., 2012; Nam & Pardo, 2011). Despite this, recent research has identified some patterns in the strategic planning processes of smart initiatives providing direction and clarity of the desired goals (Alcaide-Muñoz et al., 2023).

Concretely, research streams in the last decade can be characterised by three main aspects. The first one is its tendency to analyse specific case studies of a city, or a group of cities, both belonging to the same geographical location or context (country, continent) and mainly on developed countries (Tekin Bilbil, 2017; Boon et al., 2020b; Cabello, 2022; Calderon et al., 2018, Carayannis et al., 2021; Gupta & Hall, 2020). Nonetheless, prior research indicates that the macroeconomic context of cities (i.e., whether they are in developed or developing nations) undeniably differentiates the growth perspectives in smart cities (Nicolas et al., 2021). Therefore, the development paths of smart cities are highly dependent on urban-specific contextual conditions (Dirks et al., 2010; Schwab, 2017; Dameri et al., 2019; Nicolas et al., 2021); this kind of research make us to link the findings to the context in which the study is applied, showing partial or limited views of the SC implementation process.

The second one is that most of the cities analysed in prior research could be considered as large-sized cities with a population size over 3 million inhabitants (Azlal et al., 2020; Ben Letaifa, 2015; Cabello, 2022; Calderon et al., 2018; Gupta & Hall, 2020; Irazábal & Jirón, 2020; Margherita et al., 2023; Nusir et al., 2023). Nonetheless, the smart transition is a reality across cities of all sizes and latitudes, existing current challenge to better engage small-sized cities which have a more limited access to both networks and resources to promote smart city solutions, even in the developed countries context (Macaluso et al., 2023). Indeed, a special attention should be given to small-sized cities and developing economies because they show rapid rates of urban growth (World Bank, 2022), and their urbanization's pace is projected to be the fastest and the shift in the living standard for citizens the most explicit (OECD, 2015; United Nations Habitat, 2016). In this regard, prior research has not gathered information concerning the difficulties and expectations of small-sized cities, as those located mainly in developing countries, which could show other different needs and traces for making their cities smart.

Finally, the approach used in prior research is aimed at identifying first-level strategies (ISO, 2019; Kummitha & Crutzen, 2017; Mora et al., 2018), ignoring tactical and operational issues of the cities to become smart as well as the analysis of the initial stages of SC implementation process for identifying a developmental trajectory for SC globally (Shi & Shi, 2023). Nonetheless, according to Manjón-Antolín and Crutzen (2023), the first and primary decision of cities on their path to become smart is to determine which factors to target and pursue in these SC initiatives. Else, it may result in misleading efforts and jeopardise the effectiveness in achieving the SC outcomes they strive for (Manjón-Antolín & Crutzen, 2023).

In brief, although the findings of prior research so far are valuable, they have not considered other different contexts and development stages in the path of cities to become smart, which could be especially relevant to understand the motivation and expectations behind the SC implementation process, especially in the small-sized and developing countries context in which the maturity of enablers is lagging behind that in developed nations due to the lack of advanced technology, digital-skilled people, and effective management tools and strategies (Lazaroiu & Roscia, 2012; Yadav et al., 2019). In this regard, the Latin American context could be a good ground for research since this region is composed by emerging and developing countries whose increasing population has produced serious problems due to infrastructure limitations and economic conditions which are much different from those of developed countries (United Nations, 2020, 2022a, b; World Bank, 2023).

With the aim at performing this analysis to get new insights, recent research has concluded that cities usually share some patterns in their strategic planning processes of smart initiatives providing direction and clarity of the desired goals (Alcaide-Muñoz et al., 2023). This uniformity in the actions reflects how institutions respond to environmental pressures and cultural expectations in situations of uncertainty in a uniform way, using mimetic mechanisms that increase the homogenization (concept of isomorphism) (DiMaggio & Powell, 1983). Therefore, grouping cities into clusters could help to identify common implementation strategies of the cities to become smart which could help to collectively guide smart cities toward a more comprehensive, transferable, adaptive, and impactful trajectory of development (Junjan, 2015; Shi & Shi, 2023).

Based on these previous arguments, this research is focused on the analysis of the strategies taken by cities located in an emerging and developing country into the LATAM context in their path to become smart, identifying common patterns of these cities to group them into clusters. To gather all the information, using an e-survey, this research examines the operational goals pursued, expected impact, and time frames to reach them. Based on prior research (Lombardi et al., 2012; Neirotti et al., 2014) and on the three widely accepted international SC rankings (European Smart Cities version 4.0 (Giffinger & Gudrun, 2010), the IESE Cities in Motion 2022 (Berrone & Ricart, 2022), and the Easy Park The Cities of the Future Index 22 (https://www.easyparkgroup.com/studies/cities-of-the-future/en/), an initial list of 11 intended goals was identified for cities in their process to become smart. These goals were also linked to the different SDi, which were defined according to the European project carried out by Asset One Immobilienentwicklungs AG (Giffinger et al., 2007) due to its widely acceptance in the SC research field.

Additionally, tourism is an urban activity with complex interactions with the social, environmental, and economic context of the cities, due to its constant at the intersection of other urban activities (Ashworth & Page, 2011). It makes tourism activities to require, from a planning point of view, smart initiatives that implement efficient governance processes and tools for supporting additional urban load expressed by the tourism demand (La Rocca, 2014) and, in general, for reducing the tourism impact on the urban liveability (La Rocca, 2013) and achieve a sustainable urban development (Dabeedooal et al., 2019; Zorba, 2023). Indeed, technology plays a relevant role in both better tourist experiences and the perception of residents' quality of life (Santos-Júnior et al., 2020). Under the smart city framework, tourism would use the technological infrastructure of smart cities to meet the needs of both tourists and residents through the supply of urban and tourist services (Santos-Júnior et al., 2023).

In this regard, Costa Rica is globally known as a green country and ecotourism destination and hosts diverse ecosystems and about 6% of the world's species, which supports the country's florid nature–based tourism, agriculture, and fisheries (OECD, 2023). In fact, the promotion of the so-called green economy in Costa Rica through tourism (Bina, 2013) generates income in a range from 6.3 to 8% of Costa Rican GDP (Benavides Vindas, 2019; ICEX Spain, 2023; ICT, 2023), which demands the attraction of private business investment, especially in developing countries, for public–private cooperation (Begmatovna, 2023; Novolodskaya et al., 2018; Trusova et al., 2020). This attraction of private business investment, or orange economy (Zaldívar, 2022), promotes development through intellectual capital, which is another strength that the country possesses, and which has been strongly promoted since the early 2000s, reaching eighth place in Latin America and first in Central America (CINDE, 2021).

Based on these arguments, this research has included three goals linked to the two previous major significant economic activities in Costa Rica: (a) tourism, represented by the demand for tourist applications and the increase of tourists (G5 and G13) and (b) the attraction of private business investment (G12) (see Table 1). Therefore, after classifying the sample of Costa Rican cities that expressed interest in becoming SC into clusters using the hierarchical and *K*-means methods, we proceeded to analyse the statistical characteristics and test in each group which objectives correlate with SDi, deriving the following hypothesis:

H1. There is no correlation between the goals pursued in each city cluster and the different smart dimensions in the groups of cities interested in becoming smart.

On the other hand, SCs are addressed to public value creation (Benington & Moore, 2011; Moore, 1995, 2013) with the ultimate aim at improving the citizen's quality of life (Rodríguez Bolívar, 2016, 2019). Two key goals of the SC model to achieve this aim (Alawadhi et al., 2012; Zhao & Zhang, 2020) are focused on producing both economic growth (Kim et al., 2016; Caragliu & Del Bo, 2018; Caragliu et al., 2023) and social change to achieve higher levels of social well-being (Dameri, 2013, 2017a; Pinzone et al., 2020). This is especially relevant in developing countries

Table 1 Variables and descriptive statistics by each one of the clusters

Question	Variable	Definition	Indicator	Source	C1		C2		C3	
					Median	SD	Median	SD	Median	SD
Are you as Director or head in charge of Information and Communication Technologies (ICTs) interested in having your city included in one of the SCs rankings?	Interest in becoming a SCs	Interest in becoming a SCs	Likert Scale: Not at all interesting (1). Slightly interesting (2). Moderately interesting (3). Very interesting (4). extremely interesting (5)	Own survey	5.00	0.46	4.00	0.67	3.00	0.85

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1		C2		C3	
					Median	SD	Median	SD	Median	SD
Goals										
Please indicate to what extent you agree with the following goals that a city can have by being in a CS ranking (please answer separately if you do not plan to apply this type of model)	G1) Increased citizen participation in ICT project requirements	Benefits intended by the city from the point of view of technology use in becoming smart and identified in previous research and SCs indexes	Likert Scale: Strongly Disagree (-2). Disagree (-1). Neutral (0). Agree (1). Strongly Agree (2)	Giffinger et al., 2007, 2010; Nasrawi et al., 2016; Smith et al., 2021; Nam & Pardo, 2011; EasyPark, 2022; Giffinger et al., 2010; Issa, 2021; OECD, 2019; European Commission, 2018; Viale Pereira et al., 2017	1.00	0.67	2.00	0.42	1.00	0.60

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1		C2		C3	
					Median	SD	Median	SD	Median	SD
	G2) Increased participation of the private sector in ICT project requirements				1.00	0.66	2.00	0.52	1.00	0.55
	G3) Increased participation of social organisations in ICTs project requirements				1.00	0.83	2.00	0.48	1.00	0.55
	G4) Increased budget allocation for ICTs needs				2.00	0.58	2.00	0.48	2.00	0.63

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1		C2		C3	
					Median	SD	Median	SD	Median	SD
	G5) Increased demand and development of applications for tourists				1.00	0.64	1,50	0.82	2.00	0.52
	G6) Increased satisfaction of citizens with the use of technologies				2.00	0.50	2.00	0.52	2.00	0.44
	G7) Increased generation of new ideas for uses of technology for citizens				2.00	0.50	2.00	0.52	2.00	0.52

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1		C2		C3	
					Median	SD	Median	SD	Median	SD
	G8) Increased use of social media for information dissemination and accountability				2.00	0.51	1.50	0.82	1.00	0.65
	G9) Improvement in the lifestyle and quality of life of citizens. due to the facilities provided by technology				1.00	0.67	1.50	0.70	2.00	0.51

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1		C2		C3	
					Median	SD	Median	SD	Median	SD
	G10) Improved technological infrastructure (Internet, bandwidth and others)				2.00	0.50	2.00	0.52	2.00	0.51
	G11) Improvement in mobility through public transport. with the use of technology				2.00	0.60	2.00	0.71	1.00	0.73
	G12) Increase in the arrival of private investment				2.00	0.74	2.00	0.71	1.00	0.85

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1		C2		C3	
					Median	SD	Median	SD	Median	SD
	G13) Increase in tourism				2.00	0.60	2.00	0.84	2.00	0.66
	G14) New technological means for tax and fee collection				2.00	0.44	2.00	0.71	2.00	0.38

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1			C2			C3		
					Median		SD	Median		SD	Median		SD
Impacts					**Social**	**Economic**	**Both**	**Social**	**Economic**	**Both**	**Social**	**Economic**	**Both**
When establishing the projects to be developed in your local government, higher priority is given to those that have an impact: social, economic or both?	Type of impact intended for the projects (Social. economic. both)	Type of impact. or combination of these. expected for projects	Quantitative attribute: Number of sample cities that think that of these. expected for projects the expected impact of smart projects is going to have an influence on the social. economic or both areas	(Bokhari & Myeong, 2022; Caragliu & Del Bo, 2019; Vinod Kumar, 2020); (Bokhari & Myeong, 2022; Caragliu & Del Bo, 2019; Cocchia, 2014; Giffinger et al., 2007; Vinod Kumar, 2020)	5.00	1.00	15.00	2.00	3.00	5.00	3.00	3.00	7.00

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1				C2				C3			
					Median		SD		Median		SD		Median		SD	
Time frame					**ST**	**MT**	**LT**	**AT**	**ST**	**MT**	**LT**	**AT**	**ST**	**MT**	**LT**	**AT**
ICT projects related to economic and social issues, to be implemented in your city, intended to have an effect in the short, medium, long term or a combination of these (select one option)	Timeframe for economic impact	Expected time-frame to achieve economic impact	Quantitative attribute: Number of sample cities that indicate the expected impact at short term. medium term. large term. All Term	(Alcaide-Muñoz et al., 2023; Alcaide Muñoz et al., 2022; Tarafdar & Gordon, 2007) (Bonnefoy & Armijo, 2005; Da-Fonseca et al., 2014; Sánchez-albavera, 2003)	3.00	2.00	3.00	3.00	2.00	4.00	2.00	2.00	3.00	4.00	4.00	2.00

Table 1 (continued)

Question	Variable	Definition	Indicator	Source	C1				C2				C3			
					Median		SD		Median		SD		Median		SD	
	Timeframe for social impact	Expected time-frame to achieve social impact			3.00	10.00	5.00	3.00	3.00	4,00	1,00	2.00	2.00	7.00	3.00	1.00

Source: Own elaboration using SPSS software

SD Standard deviation, *ST, MT, LT, AT* short, medium, long, all term

in which there is a need for deploying an integrated and inclusive development model of SCs to deliver social and economic outcomes (Gil-García and Aldama-Nalda, 2013; Joia & Kuhl, 2019).

Nonetheless, to achieve these outcomes, cities are not only implementing smart initiatives with the intensive use of ICTs, but also assessment frameworks to gather information concerning both the performance and the impact of these initiatives on the urban area (Airaksinen et al., 2017). In this regard, there is a long record of research analysing these assessment frameworks mainly using holistic and multiple-criteria decision–based performance measurement frameworks and composite indexes for smart sustainable cities but failing in gathering the dynamics of interactions in smart city assessment dimensions and indicators, ignoring the short- and long-term effects of smart city dimensions on urban development (Hajek et al., 2022).

Indeed, although monitoring the performance of the smart initiatives could be relevant (Sotirelis et al., 2022), the impact evaluation of SC implementations is extremely valuable (Airaksinen et al., 2017) and strongly needed for the characterization of achieved levels of performance according to a certain target goal, having future implications for the strategic planning of the city (Patrão et al., 2020). Concretely, the evaluation of the impact of the SC model on the urban planning process, risk mitigation, and urban development is especially relevant in developing countries (Lacson et al., 2023), but it implies the introduction of different time frames (short-, medium-, and long-term) in this evaluation since prior research has demonstrated that the impacts of smart initiatives on the urban development mainly appear in the medium (Dameri, 2017c) and/or long term (Dirks et al., 2010).

In this regard, although under the SC model, real-time actions are required emphasising short-term urban management (Kitchin, 2015) to produce cost savings and increased efficiencies, improving urban performance (Dirks et al., 2010), the impact of the investments in making a city's core systems smarter on the economic growth and the social well-being will especially take place in the long term (Dirks et al., 2010). Therefore, considering both the medium- and long-term impact of the smart initiatives (Dameri, 2017c; Dirks et al., 2010), especially in developing countries (Lacson et al., 2023), and the method used by the CITYKeys performance measurement framework which indicates the possibility of impact indicators to be either estimated in the beginning of a project through simulation (Airaksinen et al., 2017), in this research, we captured information of a key stakeholder concerning the expected impact (economic, social, or both), and expected time frame to reach it, of the implementation of smart initiatives on the urban area.

In addition, as the way cities become smart depends on the context (Dameri et al., 2019), mainly on their historical, institutional, and cultural dimension and the interconnected challenges they face (Dirks et al., 2010; Schwab, 2017) , each city could implement individual strategies for embedding the desired economic and/or social impacts (Alawadhi et al., 2012; Zhao & Zhang, 2020) to facilitate the process on their way to become smart (Dameri, 2017b; Noori et al., 2020). Nonetheless, this individual behaviour can be shared in cities with similar patterns in terms of cultural values, beliefs, principles, and spatial and socio-economic configurations that could lead to a shared understanding of SC development models (Duygan et al., 2022;

Hofstede, 2001), especially if we focus our analysis on cities within the same country to monitor them with the same macroeconomic and political framework (Duygan et al., 2022). Therefore, it is expected that cities within the same macroeconomic and political framework undertake smart initiatives using similar patterns in SC development, seeking to reach similar goals, impacts, and time frame. This way, the following hypothesis is derived:

H2. There is no correlation between individual goals, impacts and time frames of cities with similar SC development patterns.

Empirical Research on Costa Rican Cities

Sample Selection

According to Lacson et al. (2023), under the developing countries context, new potential research avenue could be to examine the benefits and impacts of SC development projects in various cities worldwide to conduct research on the assessment of dimensions and indicators of a SC. Nonetheless, as noted previously, prior research has mainly focused on analysing specific case studies only comprising one or a few number of cities in the developed countries context with a population size of millions of inhabitants, a very different reality from that of cities located in developing countries. In addition, many cities around the world are nowadays in the early or initial stages of SC development, but there is still a lack of consensus on a clear definition and developmental trajectory for SC globally (Shi & Shi, 2023).

Therefore, it could be interesting to focus our analysis in small-sized cities located in developing countries to analyse their strategy to become smart. So, this research was formulated to evaluate the strategy used in small cities (< 500,000 inhabitants) in a LATAM country in their path to become smart—those with the lowest Local Online Services Index (LOSI) values (United Nations-DESA, 2022a)—and include, as a sampling framework, all the cities in the country according to their administrative structure. For this purpose, 82 cantons (cities) were selected in Costa Rica as an emerging and developing economy (United Nations-DESA, 2024) where the central government supports the smartification process of its cities by issuing national policies and promoting inter-institutional coordination to support these initiatives (MIDEPLAN, 2020; United Nations (CEPAL), 2023).

Costa Rican cities have all the necessary conditions (technology, institutions, and people (Nam & Pardo, 2011)) to implement the SC model. In fact, Costa Rica has an outstanding ICT performance (MICITT, 2018) with a very high score in the UN E-Government Index 2022 (United Nations-DESA, 2022a). Nonetheless, although Costa Rica is included in the leading group of LATAM countries, together with Uruguay, Chile, Argentina, and Brazil concerning the EDGI score, showing a high Online Service Index (OSI) score due to both its very high Telecommunication Infrastructure Index (TII) and very high Human Capacity Index (HCI), there are no cities included in the very high LOSI category (United Nations-DESA, 2022a). Due to its Digital Transformation Strategy 2018–2022 and 2023–2027 (MICITT, 2018,

2023), it promotes higher levels of digitalisation by applying technology as a transversal axis to drive innovative solutions to the challenges of a sustainable future.

Furthermore, in the institutional axis, Costa Rica is one of the LATAM countries that have reached the institutional stability, achieving a high position in institutional quality in the LATAM context (RELIAL, 2023). Nonetheless, there are great differences concerning the Social Development and Human Development Index among the Costa Rican cantons according to their geographical location, while the Central region (Great Metropolitan Area) is the one that concentrates the districts with the greatest social advantages, those located in the Chorotega and Central Pacific regions occupy the second and third positions respectively, maintaining a significant gap with respect to the Central region (Estadística and de la Universidad de Costa Rica Programa de las Naciones Unidas para el Desarrollo –(PNUD), 2023).

Therefore, it is necessary to strengthen subnational mechanisms because there are asymmetries concerning the capacities and SDG commitments at the different levels of public administrations (Secretaría Técnica de los ODS en Costa Rica, 2020). In this regard, Costa Rica is strengthening its regulatory framework. It improves the management and competence of state-owned enterprises (OECD, 2020) through the Territorial Economic Strategy 2020–2050 of the Ministry of National Planning and Economic Policy (MIDEPLAN), in which the government promotes the three Ds strategy (digitalisation, decentralisation, and decarbonisation) and mandates the articulation of the Institute for Municipal Development and Advisory Services (IFAM) and the MICITT for digital transformation and the development of smart cities. Also, from 2022, IFAM will implement a training, promotion, and advisory programme for LGs on digitalisation and smart territories to strengthen their economic activities, including attracting foreign direct investment (CINDE, 2021) and tourism (ICEX España, 2023; ICT, 2023; MIDEPLAN, 2020).

On the people axis, Costa Rica shows a high well-being index (Helliwell et al., 2021) with high investment in human capital (8% of its budget in Education) and a national development plan that emphasises ICT education (CONARE, 2023). It also has an economy that is increasingly diversified in value-added productive processes and democratic institutions that promote respect for human rights (United Nations-DESA, 2022b).

Finally, Costa Rican cantons are in their first steps towards becoming smart (Bustillos-Ortega & Murillo-Gamboa, 2022) and have created a Network of Cantons Advocating the Sustainable Development Goals (Cantones PrODS) requiring LGs to perform a set of actions based on the intensive use of ICTs to implement the SDGs (United Nations (CEPAL), 2023), which has led them to undertaking smart initiatives that are consolidated (28.07%), under implementation (25.43%) and, finally, planned (46.49%) according to the data collected in this research. Based on these characteristics, it would be of particular interest to pay attention to Costa Rican cities and collect evidence on the strategy used from an e-survey on the goals, the impact pursued and the expected time frame to achieve them. This research strategy could fill the research gaps identified previously in prior literature providing relevant findings and accumulative knowledge about the SC implementation process for cities located in other developing countries in the same or similar LATAM context.

Data Collection and Research Methodology

Recently, SC research is incorporating the innovation biography method as an appropriate method for understanding the SC process and its impact on some outcomes like sustainability (Treude, 2021) or smart specialization (Gedminaitė-Raudonė, et al., 2023). However, the idea of SC without any other connections with other concepts, defined as an innovation process in the urban area, can be understood as a regional innovation system (Treude, 2021), and therefore, it could be of interest for the innovation biography method with the aim at understanding the process of cities to become smart (Butzin & Widmaier, 2012; Treude, 2021). Indeed, the process of becoming a SC remains relatively unexplored and poorly understood (Boon et al., 2020a, b), especially in both the emerging LATAM countries context which keeps unexplored (World Bank, 2023) and in technological transformation processes in small-sized cities (< 500,000 inhabitants) (Duygan et al., 2022).

This way, putting the focus on all cities located in an emerging and developing country in the LATAM context (Costa Rica), this paper uses the innovation biography method to examine how a SC process is planned in its initial stage, examining the smart initiatives planned, undertaken, consolidated, and ongoing, in which SDi these smart initiatives are included in as well as the motivation behind this process through the analysis of their aspired goals and expected time frames to reach them. In this regard, each Costa Rican city has a local government with similar functions, and they are responsible for both providing public services and leading the process of becoming a SC. The information was collected from Costa Rican cities, and a draft e-survey was designed and sent to five responsible ICT managers for validation, receiving recommendations that were considered in the final version of the survey.

The final e-survey includes three main sections. The first one mainly seeks to capture information on the interest of their cities in becoming smart. This section encompassed some questions about the advantages their cities will have if they were included in a SC ranking as well as the smart projects that their cities have planned, undertaken, consolidated and ongoing into each SDi (Giffinger et al., 2007). In addition, it included questions on the budget allocated to each of these smart projects, the goals pursued and, finally, the challenges existing in the context of their city. All these questions were designed as yes/no questions or as a 5-point Likert scale (Table 1).

The second section of the e-survey was specifically aimed at getting knowledge about the expected impact (and its existing measurement instruments) of the different smart projects, as well as the expected time frame to reach them. Based in previous research (Kim et al., 2016; Caragliu & Del Bo, 2018; Caragliu et al., 2023; Dameri, 2013, 2017a; Pinzone et al., 2020), these impacts are mainly classified as economic, social, or both, considering different time frames (short, medium, and/or long term) to reach them (Dameri, 2017c; Dirks et al., 2010; Zhao & Zhang, 2020).

The third section only collects information regarding the profile of the different e-survey respondents (university degree, experience in the ICT department, gender, age, and contact details, among others).

Finally, in all sections of the e-survey, we offer open questions to include more different goals, time frames, and impacts to capture different possibilities depending on the city context, adding these new perceptions to the research instrument. In this paper, only a part of all the information collected in the survey is shown, using only the information needed to answer the research issues and hypothesis posed in the aim of this paper (Table 1).

As noted previously in Sect. 2 of the paper, to design the e-survey and to include the goals displayed in Table 1, this research analysed the indicators used in three of the most-widely accepted international SC rankings: the European Smart Cities version 4.0 (http://www.smart-cities.eu/) (Giffinger & Gudrun, 2010), the IESE Cities in Motion 2022 (https://citiesinmotion.iese.edu/indicecim/) (Berrone & Ricart, 2022), and the Easypark The Cities of the Future Index 22 (https://www.easyparkgroup.com/studies/cities-of-the-future/en/). It helped us to obtain an initial list of 11 expected goals (non-exhaustive list) pursued by cities in their process to become smart, to which three more goals were adding based on the contextual characteristics of the country under study (G5, 12, and 13).

On the other hand, ICT managers were selected due to their main role as actors for managing and coordinating all technology initiatives aimed at solving the problems and challenges faced by the sample cities (Smith et al., 2021). Moreover, their role in the organisation is broader than just technology design and implementation of technology, as they are enablers in processes and performance achievement (Pawlowski & Robey, 2004; Smith et al., 2021). In any case, they were asked to provide an institutional response to the questionnaire in coordination with the rest of the departments of their LG and clear instructions on how to complete the survey was included at the beginning of the e-survey. Therefore, the information gathered could be a good source of information for understanding the process of implementing the SC model, the goals to be achieved and the expected time frame for reaching them.

Subsequently, the e-survey was sent to a total of 82 responsible ICT managers of the sample cities. Forty-six responses were received, but 44 (response rate of 53.66%) were finally selected based on the interest shown in implementing the SC model (they answered that they are extremely interested, very interested or interested in this issue). The high response rate obtained is sufficient for getting solid and valid findings of the research (Benitez et al., 2018; Gao et al., 2020; Mikalef & Pateli, 2017; Rodríguez Bolívar, 2016).

As for the data processing tasks, as we used categorical variables, stratification methods were applied to identify patterns of behaviour. Firstly, the hierarchical method was used, taking as a reference the interest in being SC and the smart initiatives developed in the different SDi. In the second step, the sample cities were grouped into three clusters performing the *K*-means method using SPSS software (Jung et al., 2003; Rapkin & Luke, 1993). Table 2 shows the main characteristics of both the cities included in each one of the three clusters and the respondents of the e-survey.

In addition, the Shapiro–Wilk normality test (sample selection less than 50 subjects) was performed (Royston, 1992). As the data do not have a normal distribution, Kendall's Tau-C correlation test was applied due to its use for non-square contingency tables and bivariate and multivariate analyses (Brossart et al., 2018).

Table 2 Characteristics of respondents and characteristics of sample selection by cluster

Characteristics of Cities							Smart initiatives				Characteristics of respondents		
City	Cluster	Population	% Young people	% of highly educated people	No. of enterprises	No. Univ	Consolidated	Running	Planed	Number of projects	Attribute	Value	%
San José	C1 (21)	351,958	38%	13%	4,807	56	18 56%	16 55%	29 55%	63 55%	Gender	Male	84%
Cartago		166,204	42%	11%	1,361	6							
Heredia		146,020	40%	16%	3,336	10						Female	16%
Tibás		86,065	42%	15%	525	1							
Turrialba		73,546	43%	8%	480	6					Age range (years)	From 20 to 30	7%
Liberia		79,610	46%	10%	445	7							
Santa Cruz		71,284	45%	10%	332	3							
Montes de Oca		62,844	37%	24%	949	6						From 31 to 40	32%
Nicoya		57,624	40%	9%	227	5							
Upala		55,466	39%	4%	85	1							

Table 2 (continued)

Characteristics of Cities							Smart initiatives				Characteristics of respondents		
City	Cluster	Population	% Young people	% of highly educated people	No. of enterprises	No. Univ	Consolidated	Running	Planed	Number of projects	Attribute	Value	%
Carrillo		47,756	47%	8%	159	0						From 41 to 50	52%
Coto Brus		44,280	55%	5%	117	2							
Cañas		33,393	49%	7%	132	6							
Osa		31,383	44%	5%	140	2						From 51 to 60	7%
Atenas		29,880	41%	11%	133	1							
Belén		26,853	40%	16%	347	2							
Bagaces		24,847	49%	6%	56	1						From 61 to 70	2%
Acosta		22,257	44%	5%	50	1							
Zarcero		14,629	47%	8%	126	0					Years of experience	From 1 to 4	7%

Table 2 (continued)

Characteristics of Cities							Smart initiatives				Characteristics of respondents		
City	Cluster	Population	% Young people	% of highly educated people	No. of enterprises	No. Univ	Consolidated	Running	Planed	Number of projects	Attribute	Value	%
Nandayure		11,838	44%	5%	53	3							
Dota		8,041	48%	7%	52	1							
Sub total		1,445,778			13,912	120						From 5 to 8	18%
Grecia	C2 (10)	96,182	44%	9%	634	2	6 19%	8 28%	17 32%	31 27%			
Curridabat		80,677	43%	18%	654	2							
Aserrí		64,480	44%	7%	104	6						From 9 to 12	14%
Paraíso		63,796	46%	7%	174	1							
Santa Ana		61,853	43%	15%	582	1							
San Rafael de Heredia		56,560	43%	13%	136	1							
San Rafael de Oremuno		50,595	45%	9%	168	0						More than 12	61%

Table 2 (continued)

Characteristics of Cities							Smart initiatives				Characteristics of respondents		
City	Cluster	Population	% Young people	% of highly educated people	No. of enterprises	No. Univ	Consolidated	Running	Planed	Number of projects	Attribute	Value	%
Santo Domingo		49,835	39%	16%	341	1							
Palmares		41,805	42%	11%	202	1					Professional Profile	Tec ICTs	7%
Sarchí		22,596	44%	7%	100	10							
Sub total		588,379			3,095	25							
Alajuela	C3 (13)	321,872	43%	10%	2,038	16	8 25%	5 17%	7 13%	20 18%		Bach ICTs	25%
Pococí		154,674	48%	5%	634	3							
Puntarenas		143,875	45%	6%	821	9							
Perez Zeledón		143,282	44%	7%	766	7						D ICTs	46%
Vázquez de Coronado		72,932	42%	13%	328	0							
Tejar del Guarco		46,959	46%	8%	179	0							
Esparza		39,244	45%	9%	103	2							

Table 2 (continued)

Characteristics of Cities							Smart initiatives				Characteristics of respondents		
City	Cluster	Population	% Young people	% of highly educated people	No. of enterprises	No. Univ	Consolidated	Running	Planed	Number of projects	Attribute	Value	%
Mora		30,759	41%	11%	106	0						DA ICTs	7%
Garabito		27,404	44%	5%	284	0							
Tilaran		21,984	44%	7%	103	4							
Parrita		20,984	46%	4%	71	1						DA	5%
San Marcos de Tarrazú		18,787	40%	6%	101	1							
San Mateo		7,276	44%	7%	19	4							
Sub total		1,042,756			5,534	43							
TOTAL		3,076,913			22,541	188	32 (28.07%)	29 (25.43%)	53 (46.49%)	114 100%)		MCs	11%

Source: own elaboration. *C1* cluster 1, *C2* cluster 2, *C3* cluster 3. *N* 82, *n* 44

Professional profile: *Tec ICTS* ICTs technician, *Bch ICTs* bachelor in ICTs, *D ICTs* degree in information technology, computer science, or systems, *DA ICTs* degree in administration technology, *DA* degree in administration with emphasis on public accounting, *MCs* master in computer science

This method is the most appropriate test for samples over ten subjects and small sample sizes, providing more robust results than Spearman's test (Bonett & Wright, 2000). Finally, the (1-β) statistical power test was performed to determine whether the results obtained can be generalised to the population, provided that (1-β) > 80% (Leung, 1998).

As for the analysis of the results, a three-stage process was followed. Firstly, the interest in being a SC was correlated with the dimensions. Then, the dimensions were linked to the selected goals identified. And finally, the goals in each SDi were correlated with the expected impacts (economic and social) and the expected time frame.

Analysis of the Results

Cluster Characterization

Overall, results show that all sample cities pursue six common goals: increase in ICT budget allocation (G4), increased citizen satisfaction with the use of technologies (G6), increased generation of new ideas for the use of technology by citizens (G7), improved technological infrastructure (G10), increased tourism (G13), and new technological means for the collection of taxes and fees (G14). Furthermore, the results show a tendency of cities to reach both social and economic impacts, preferably in the medium term.

Nonetheless, as Oliver's (1991) noted, the strategic response of organizations to institutional pressures is not always the same and organizations may have the capacity to discretionally alter their structures with proactive actions in response to these external pressures (Child, 1972). In this regard, although all sample cities work in a similar and homogeneous institutional context, our results identify statically significant differences among sample cities according to their urban challenges, interests, and motivations to become smart, allowing us to group them into three clusters using the hierarchical and *k*-means method (Table 2). This finding confirms the existence of the strategic choice view of isomorphism since the isomorphic forces do not always have the same effect on organizations, but these effects may depend on different organizational attributes (Oliver, 1988), which could explain the different inclination of sample cities towards technology, economy or collaborative issues (stakeholder involvement).

Technology Cluster (C1)

The first cluster is composed of 21 cities that have expressed a strong interest in becoming smart (Table 1), and it is characterised by a medium percentage of both young and highly educated population, and the highest number of companies and universities in urban areas. They are also implementing the highest number of smart initiatives (a total of 63—18 consolidated, 16 under implementation, and 29 planned), and most of them are working in the 6 or 5 SDi of the SC model, which

makes them to be considered as the group with the highest degree of SC progress. In addition, these cities have good institutional quality and show a high population density, especially, Tibás, San José or Montes de Oca. San José, for example, scored 0.8889 in the institutional framework index of the United Nations E-Government Survey 2022, although it has a low level of compliance of service provision among the criteria used in the LOSI index (see https://publicadministration.un.org/egovkb/en-us/Data/City/id/168-San-Jose/dataYear/2022).

The LGs of these cities pursue the goals G4, 6, 7, 8, 10, 11, 12, 13, and 14, which are particularly related to technology perhaps following a strategy of the improvement the efficiency and effectiveness of city services and infrastructures, as has been noted recently by Marchesani (2024), and it is derived by the low level of compliance of service provision in some of the cities included in this cluster. The most relevant goals in C1 are the improvement of technological infrastructures (G10), the generation of new ideas for uses of technology (G7), the increased satisfaction of citizens using technologies (G6), the use of social media networks for information transparency and accountability (G8) (Grossi et al., 2020), and the use of new technological means for tax and fee collection (G14) (Table 1). This behaviour and the citizens' profile of the city seem to confirm the rationalistic school of thought concerning for the enhancement of skills and capabilities of citizens to be involved in the active creation and usage of technologies (Kummitha & Crutzen, 2017).

In addition, although in a non-homogenous way, the goals associated with increasing mobility in the city with technology (G11), budget allocation for ICT (G4), attracting private investment (G12), and tourism in the city (G13) are important in C1. In summary, C1 is characterised by encouraging greater use of technology by the citizen and improving economic revenues through more efficient tax collection (technological cluster).

Collaborative Cluster (C2)

This second cluster is composed of 10 cities characterised by the highest percentage of highly educated population, but the lowest number of companies and universities (Table 2) and medium level of population density (for example, Paraiso, Grecia, or Palmares). These cities are the second ones on implementing smart initiatives carrying out a total of 31 (6 consolidated, 8 under implementation, and 17 planned—intermediate stage of SC development) involved into 4, 3, or 2 SDi (mainly smart governance), and their pursued goals are associated with stakeholder participation (G1, 2, and 3), ICT budget allocation (G4), and the issues of mobility in the city and attracting private investment (G11 and G12). Therefore, this group of cities emphasises that technology enhances the capabilities of citizens to innovate and participate in public decisions with the aim at solving major problems and create collective common good, which is characteristic of the reflective school of thought (Kummitha & Crutzen, 2017).

In addition, these SCs show an average median in the goals of increased satisfaction of citizens with the use of technologies (G6), increased generation of new ideas for the uses of technology (G7) and improved technological infrastructures (G10). In

summary, this group focuses on increasing stakeholder participation, improving mobility and increasing private sector investment (collaborative cluster).

Economic Cluster (C3)

Finally, cluster 3 is composed of 13 cities characterised by a medium number of both firms and universities but the lowest percentage of highly educated people (except for Alajuela, Vasquez de Coronado, and Mora) and the highest percentage of young population. In addition, these cities have good institutional quality but very low population density and a medium Multidimensional Poverty Index (Mora, Pococí or Parrita—see Estadística and de la Universidad de Costa Rica Programa de las Naciones Unidas para el Desarrollo –(PNUD), 2023). The institutional quality is relevant because strong institutions are required in the least economically developed areas to undertake public policies for promoting employment opportunities and poverty eradication (Abid et al., 2022).

These cities are undertaking a total of 20 SC initiatives (8 consolidated, 5 under implementation and 7 planned—the initial stage of SC development) focused only on 2 SDi (mainly SG and SM) addressed to improving technological infrastructures (G10), increasing the satisfaction of citizens with the use of technologies (G6), increasing the generation of new ideas for the uses of technology (G7), increasing the demand and development of apps for tourists (G5), improving tourism activities (G13), and the use of new technological means for tax and fee collection (G14) (Table 2). Consequently, this group of cities seeks to strengthen citizen satisfaction using ICTs and to increase urban economic activity with both improvement of tourism activities and increased electronic tax collection (economic cluster).

However, the percentage of highly educated people living in this group of cities barely reaches 10%, and the fixed broadband penetration and, even more, the fibre optics in homes are very low (Peralta, 2021), which makes us think in an exclusion risk of various sections of the populace and high possibility of digital divide. In addition, although this group of cities emphasises the economic growth based on the tourism activity as the motivation to be smart, this tourism activity currently relies on small and medium enterprises (SMEs) (ICT, 2023) providing tourism services around nature but with low technological capacities. In fact, most tourist Costa Rican SMEs (67%) have less than 10GB broadband capacity which is lower than the requirements of the tourism sector (Peralta, 2021), and recent research, under the Costa Rican context, indicates that commitment to digital maturity does not influence participants' training and digital skills and development level directly (Gonzalez-Tamayo et al., 2023). All this makes difficult to use ICTs in an efficient manner, and it is possible that these SC fall short of the promises made around creating Utopian city contexts, which is a concern expressed by the critical school of thought (Kummitha & Crutzen, 2017).

Hypothesis Testing

As for the hypothesis testing analysis, results show that there are statistically significant low and medium negative correlations between the city's priority goals

and smart economy (SE), smart governance (SG), and smart environment (SENV) dimensions in C1 cities (H1, Table 3). In this group of cities, goals pursued are linked to improving technological infrastructure, as well as to increasing the ICT budget (G4 and 10) in the SE and SG dimensions, which means that the allocation of resources in the budget for ICT needs does not imply a strengthening in the process of these SDi. This result does not seem to support recent prior research that indicates SE as a key factor of smart development (Sotirelis et al., 2022), at least in small-sized cities in developing countries.

In the case of SENV, there is also an inverse correlation with the goals of increasing the use of social networks for the dissemination of information and accountability (G8) and increasing the arrival of private investment (G12)—these goals do not support improvement on SENV. This result seems to confirm prior research conducted in developed cities, where goals included into the SENV dimension are less prioritised on their initial path to becoming smart (Akande et al., 2019; Chatti & Majeed, 2022).

Also, results show the interest of C1 cities in increasing stakeholder participation using ICT (G6 and G7), confirming prior research indicating that citizen participation is important for the city development (Anthopoulos et al., 2019; Bokolo & Petersen, 2019; Rodríguez Bolívar, 2018a).

As for C2 cities, results show that there is a medium, positive, and moderately significant correlation between the goals related to the participation of citizens, the private sector, and social organizations (G1, 2, and 3), and the SM and SL dimensions. This result is evidence of their orientation towards more collaborative governance models (Anthopoulos et al., 2019; Giffinger et al., 2007; Tahir & Abdul Malek, 2016) to foster innovative city development (Bokolo, 2023; Carayannis et al., 2021; Cortés-Cediel et al., 2019).

By contrast, there is an inverse correlation between increasing private investment (G12) and the SG dimension, as well as between the use of technology for ICT-enabled tax collection (G14), improving technological infrastructure (G10), increasing the generation of new ideas for ICT-based services (G7), and increasing citizen satisfaction with the use of technology (G6) and the SENV dimension. These results confirm prior research that highlighted these aspects as relevant (Zhu et al., 2022), and the pattern identified for C2 cities showing the relevance of involving stakeholders in establishing ICTs requirements (Rodríguez Bolívar, 2018a) and boost city management (Demirel & Mülazımoğlu, 2022).

Finally, in the case of C3 cities, three SDi (SE, SG, and SL) show a positive correlation with different economic-approach goals. Specifically, SE is correlated with the increase in tourism, the development of tourism apps and the increase in the use of social networks by citizens (G5, 8, and 13), as well as the improvement of mobility and transport through apps and the increase in the attraction of private investment (G11 and 12). SG is correlated with the increase in citizen satisfaction and the improvement of technological infrastructures (G6 and 10). And finally, SL is correlated with the increase in the budget for ICT investments and the improvement of technological infrastructures (G4 and 10).

The other two SDi, smart people (SP) and SM are highly inversely correlated with infrastructure improvement (G10 with SP) and lowly inversely correlated with

Table 3 Correlation between dimensions and goals pursued in each one of the clusters

Dimension	Goal	T (Tau C)	*p*		1-β	*f*
Cluster 1						
SE	G10) Improved technological infrastructure (Internet, bandwidth and others)	−0.372	0.077	*	0.907	0.609
SG	G4) Increased budget allocation for ICTs needs	−0.252	0.083	*	0.752	0.501
SENV	G4) Increased budget allocation for ICTs needs	−0.340	0.013	**	0.650	0.583
	G8) Increased use of social media for information dissemination and accountability	−0.381	0.067	*	0.905	0.617
	G10) Improved technological infrastructure (Internet, bandwidth and others)	−0.372	0.077	*	0.907	0.609
	G12) Increase in the arrival of private investment	−0.428	0.006	**	0.728	0.654
Cluster 2						
SG	G12) Increase in the arrival of private investment	−0.420	0.079	*	0.690	0.663
SM	G1) Increased citizen participation in ICT project requirements	0.560	0.042	**	0.749	0.748
	G2) Increased participation of the private sector in ICT project requirements	0.600	0.021	**	0.702	0.774
	G3) Increased participation of social organisations in ICTs project	0.760	0.000	***	0.560	0.871
SENV	G6) Increased satisfaction of citizens with the use of technologies	−0.480	0.065	*	0.710	0.692
	G7) Increased generation of new ideas for uses of technology for citizens	−0.480	0.065	*	0.710	0.692
	G10 Improved technological infrastructure (Internet, bandwidth and others)	−0.480	0.065	*	0.710	0.692
	G14) New technological means for tax and fee collection	−0.390	0.046	**	0.514	0.624
SL	G1) Increased citizen participation in ICT project requirements	0.560	0.042	**	0.749	0.748
	G2) Increased participation of the private sector in ICT project requirements	0.600	0.021	**	0.702	0.774
	G3) Increased participation of social organisations in ICTs project	0.760	0.000	***	0.560	0.871

Table 3 (continued)

Dimension	Goal	T (Tau C)	*p*		1-β	*f*
Cluster 3						
SE	G5) Increased demand and development of applications for tourists	0.497	0.015	**	0.658	0.704
	G8) Increased use of social media for information dissemination and accountability	0.355	0.070	*	0.517	0.595
	G11) Improvement in mobility through public transport, with the use of applications (Apps)	0.592	0.011	**	0.774	0.769
	G12) Increase in the arrival of private investment	0.355	0.070	*	0.517	0.595
	G13) Increase in tourism	0.497	0.029	**	0.755	0.704
SP	G10) Improved technological infrastructure (Internet, bandwidth and others)	−0.686	0.001	***	0.653	0.828
SG	G6) Increased satisfaction of citizens with the use of technologies	0.379	0.097	*	0.768	0.615
	G10) Improved technological infrastructure (Internet, bandwidth and others)	0.804	0.000	***	0.903	0.897
SM	G4) Increased budget allocation for ICTs needs	−0.213	0.095	*	0.493	0.461
SL	G10) Improved technological infrastructure (Internet, bandwidth and others)	0.568	0.010	*	0.723	0.753
	G4) Increased budget allocation for ICTs needs	0.160	0.095	*	0.394	0.400

Source: Own elaboration using SPSS software

SENV Smart environment, *SE* smart economy, *SP* smart people, *SG* smart government/T (Tau C): −0.30 to −0.10 or 0.10 to 0.30 low correlation −0.60 to −0.40 or 0.40 to 0.60 medium correlation, −0.90 to −0.70 or 0.70 to 0.90 high correlation −1 or 1 perfect correlation/*p* ***0.001 very significant ** ≤0.005 medium significant * ≤0.010 low significant/power: 1 −β > 0.80/effect *f* = 0.10 low, 0.30 medium, 0.50 high

the increase of the budget for ICT investments (G4 with SM). Nonetheless, it should be noted that some previously mentioned results show lower statistical power than 80% (< 0.8) which means that these correlations cannot be generalised.

In brief, the statistical test confirms the identified patterns of sample cities in the cluster characterization section (although the statistical power test does not sometimes reach 80%), meaning the search of different goals in different dimensions, except for the SENV dimension which is relevant in both C1 and C2 cities. Therefore, H1 is not supported.

However, in both C1 and C2 cities, ICT managers think that the goals pursued do not contribute to the implementation of SG and SENV, especially in the latter dimension where the results show an inverse correlation in 7 of the 14 goals analysed. Besides, the increase of the budget for ICT needs (G4) is not a goal to help improve the SG, SENV, and SM dimensions according to the ICT managers of the C1 and C3 sample cities. Also, in all identified clusters, the attraction of private investment in cities (G12) is relevant, especially in C3 cities for enhancing SE. Finally, the improvement of technological infrastructures such as the internet, bandwidth, and others (G10) is considered an important factor in strengthening the implementation of SG in all sample cities.

On the other hand, in terms of impacts and temporality, H2 is not supported by the data collected because not all goals are significantly correlated with all time frames and impacts (Table 4). Indeed, the social impacts are not generally relevant (except for G12 in C2 cities), and in terms of the economic impact, negative correlations are detected suggesting that investing time and effort in the significant goals will not necessarily contribute to the achievement of economic impacts at the desired time frames.

Concretely, in C1 cities, the correlation is inversed between economic impacts and medium-term (MT), with the promotion and use of social networks for the dissemination of information (H2, Table 4), which implies that achieving adequate digital communication or promotion of the city using social networks does not favour economic impacts in MT. This finding is novelty and interesting because prior research has only focused on the analysis of how social networks can help citizen engagement in governance models of smart cities (Parusheva & Hadzhikolev, 2020; Rodríguez Bolívar, 2018c), but no one has put the emphasis on analysing the link among social media, SC, and economic impact to test our results.

In C2 cities, the increase in the participation of the private sector and social organizations in ICT requirements, the increased generation of ICT-related ideas and citizen satisfaction, the increase of private investment, the tax collection through technological means and the improvement of technological infrastructure (G2, 3, 6, 7, 10, 12, and 14), do not favour the achievement of economic impacts mainly at MT. In the case of increasing tax revenue using technology (G14), results confirm previous research (Purnomo et al., 2016), indicating that the use of technology does have an impact on an increase in tax revenue. Also, G12 shows a negative correlation and social impact.

These results confirm the desire of cities to increase information transparency and accountability through ICT (Grossi et al., 2020), which could drive the implementation of Open Government technology projects (Vinod Kumar, 2020). At the

Table 4 Correlation between goal and timeframe and impact pursued in each one of the clusters

Goal	No. of cities and term	Impact	T (tau C)	*p*		1-β	*f*
C1							
G8) Increased use of social media for information dissemination and accountability	3 ST, 12 MT, 3 LT, 3 AT	Econ	− 0.390	0.065	*	0.910	0.624
C2							
G2) Increased participation of the private sector in ICT project requirements	2 ST, 4 MT, 2 LT, 2 AT	Econ	− 0.800	0,000	***	0.296	0.800
G3) Increased participation of social organisations in ICTs project		Econ	− 0.640	0.013	**	0.695	0.800
G6) Increased satisfaction of citizens with the use of technologies		Econ	− 0.640	0.018	**	0.740	0.800
G7) Increased generation of new ideas for uses of technology for citizens		Econ	− 0.640	0.018	**	0.740	0.800
G10) Improved technological infrastructure (Internet, bandwidth and others)		Econ	− 0.640	0.018	***	0.740	0.800
G12) Increase in the arrival of private investment	2 ST, 4 MT, 2 LT, 2 AT	Econ	− 0.660	0.000	***	0.332	0.812
	3 ST, 4 MT, 1 LT, 2 AT	Soc	− 0.660	0.000	***	0.332	0.812
G14) New technological means for tax and fee collection	2 ST, 4 MT, 2 LT, 2 AT	Econ	− 0.480	0.015	**	0.448	0.692
C3							
G13) Increase in tourism	3 ST, 4 MT 4 LP, 2 AT	Econ	− 0.568	0.001	***	0.390	0.753

Source: Own elaboration using SPSS software

T (Tau C): − 0.30 to − 0.10 or 0.10 to 0.30 low correlation − 0.60 to − 0.40 or 0.40 to 0.60 medium correlation, − 0.90 to − 0.70 or 0.70 to 0.90 high correlation − 1 or 1 perfect correlation/*p* ***0.001 very significant ** ≤ 0.005 medium significant * ≤ 0.010 low significant/power: 1 − β > 0.80/Effect *f* = 0.10 low, 0.30 medium, 0.50 high

same time, the aspired goals of these cities are similar to those in other European and Asian latitudes (Demirel & Mülazımoğlu, 2022; Tekin Bilbil, 2017; Zhu et al., 2022), which could indicate that some strategies can be shared by large and small-sized cities, this is, the population size could not be a factor for the strategies used in both kind of cities.

Finally, only G13, aimed at increasing tourism, shows an inverse correlation with economic impact in MT and LT. The C3 cities show a trend to seek project development through technology-supported tourism activity management and to attract new business. This orientation is in line with relevant economic activities in Costa Rica, such as tourism (ICEX España, 2023; ICT, 2023) and capital attraction (CINDE, 2021) and it is consistent with prior research (Habeeb & Weli, 2020; Jasrotia & Gangotia, 2018) as a means for reaching economic growth—especially in developing countries, like India (Gupta & Hall, 2020)—and improving city's competitiveness to obtain better economic and social conditions (Alawadhi et al., 2012).

In summary, results identify different cities patterns on their way to become smart, which could be relevant for other cities in similar contexts to focus their effort and attention on the necessary goals to reach, the desired impacts (mainly economic impacts) and an estimation of the time frame to reach them. Overall, the results seem to indicate that ICT managers are aware of the contextual challenges faced by cities (Cao & Kang, 2022), thus providing insights into different strategies for becoming smart.

Discussions

Our results confirm the strategic choice view of isomorphism (Oliver, 1988) based on different urban challenges, interests, and motivations, which has given place to three different groups of strategies used by sample cities on their path to become smart (technological, collaborative, and economic approaches). These three different setting of goals at the initial stage of smart development make us think in the Hollands' claim (Hollands, 2008) considering that the smart progressive city is not only that which ICT implementation itself, but it needs and requires changes in the urban settings and in the citizenry living conditions. Under this framework, we should ask ourselves whether all city clusters identified here could be identified as real city strategies 'on their path to become smart', since a smart city should also address issues of power and inequality in the city (Harvey, 2000), as well as respect diversity and build a democratic pluralism (Sandercock, 1998).

In any case, the three identified city clusters seem to emphasise three different governance models to become smart based on the different significance given to the three components of the smart governance concept (Meijer & Rodríguez Bolívar, 2016; Tomor et al., 2021). This way, whereas cluster 1 (technology cluster) mainly seeks to improve technological functions that optimise city management (urban infrastructural and management systems), cluster 2 (collaborative cluster) highlights the role of different actors to define the visions and resources needed to set collective goals (Camboim et al., 2019). Finally, cluster 3 (economic cluster) puts emphasis on the societal goals mainly driven to reach all or some aspects of urban sustainability

-in this empirical study, the economic aspect- which are linked to tailor-made ambitions fitting local-specific circumstances (Castelnovo et al., 2016).

These three different foci lead to three different perspectives that could make us understand the context of smart city building. So, while C1 is based on the rationalistic school investing in citizens and communities to enable them to invent and advance technologies, the C2 is based on the reflective school emphasising that the investments in technology enhance community skills and knowledge. Finally, there seems to be a high risk in C3 cities by reducing smart city building to a neoliberal project.

In brief, our research results make us think in the different city strategies on their path of become 'smart' and the relevance of the smart governance components at the initial stages of SC implementation models. It also makes relevant the use of the innovation biography method to analyse cities not only from the beginning on their path to become smart, but also from a dynamic perspective, because smart governance models are not static systems over time. Recent research in The Netherlands and Brazil has demonstrated how governance elements of governance structures in smart city ecosystems evolve and varies across the phases of evolution of the smart city ecosystem (Ooms et al., 2020; Przeybilovicz & Cunha, 2024). Therefore, the innovation biography method used in this research could be useful to trace the evolution of the smart governance systems in the different SC in the coming years.

On another hand, all city clusters show negative correlations among some goals pursued and smart dimensions. Concretely, our results indicate that the SENV dimension shows statically significant inverse correlation with sample cities' priority goals, which confirms recent research in both developed countries (Akande et al., 2019; Chatti & Majeed, 2022) and emerging economies when SC are at their initial stage of becoming smart, perhaps because the top-level design is not effective and urban data integration and governance is shorted (Shan et al., 2021; Yao et al., 2020). By contrast, our research differs from the findings obtained in a recent study in the Moroccan context since this dimension was linked to the successful implementation of smart city projects (Hanine et al., 2021) . Considering the relevance of achieving the SDGs, future research could analyse this behaviour deeply and to gain insights how to reverse it.

In addition, the different city clusters point out different correlations among their priority goals and the smart dimensions, showing a different position of the cities in the smart dimensions' development and goals. This finding confirms recent research of initial smart city development in China where the city performance in different dimensions was imbalanced and widely divergent (Shan et al., 2021; Zhang et al., 2022).

In this regard, C1 cities are not aimed with their priority goals to advance in the SE and SG dimensions. This finding confirms prior research indicating that technology determinism limits both economic growth (Bidart, 2019) and local embeddedness and community participation, putting no relevance on removing poverty and/or implementing collaborative governance mechanisms, which can be a challenge for achieving equality in the smart city framework (Singh et al., 2023). On another hand, C2 cities approach to collaborative governance show that their priority goals are addressed to the SL and SM dimensions, but not to SG dimension. This finding

is coherent with Meijer & Rodríguez Bolívar's conception of smart dimensions (Meijer & Rodríguez Bolívar, 2016) -mix what smart cities are (smart people, smart governance) and what they aim to achieve (smart economy, smart mobility, smart environment and smart living)-, and it confirms recent smart cities research in both developing countries (Derlukiewicz et al., 2023) and developed countries (Koutra et al., 2020) indicating that the successful implementation of SM solutions necessitates the cooperation and coordination of multiple stakeholders. Also, Estevez et al. (2016) indicated that SL is the most common SC dimension in developing countries, but SL projects must be based on longitudinal and structured strategic planning to promote successful partnership collaborations amongst stakeholders (Jung et al., 2015). Finally, C3 cities approach to economic growth show that their priority goals are addressed to the SG, SE and SL. Prior research indicates that SC with economic growth are those implementing smart projects driven to SE in three different perspectives: a) the productions and innovations influences the economic growth; b) the smart city itself as an economic driver; and c) the economics behind the smart cities (Wahab et al., 2020). At the same time, SE is told to be linked to SG and SL because all these dimensions are interrelated for achieving citizen quality of life (Dash, 2023; Kumar, 2020). In any case, there is no empirical evidence on these issues, because the interrelationship and links among the different SDi is not still clear or understood, which is a great avenue for future research.

In brief, in general, findings show a disconnection between goals and smart dimensions. This finding provokes a lively debate concerning the different SC conceptions, challenges, and complexity of the urban contexts to implement the SC model in developing vs. developed countries (Alcaide-Muñoz & Rodríguez Bolívar, 2021; Gupta & Hall, 2020), as well as the lack of both a widely accepted sound SC framework (Yigitcanlar et al., 2018) and a comprehensive and an integrated SC conceptual model in developing countries (Fernandez-Anez et al., 2018).

Finally, as noted previously, the evaluation of the impact of the SC model is highly relevant in developing countries (Lacson et al., 2023) but this impact mainly appears in the medium- (Dameri, 2017c) and/or long-term (Dirks et al., 2010). Our findings do not confirm this prior research concerning the social and economic impact. Whereas the social impact is not expected to achieve at medium-term in C2 cities when pursuing the G12 goal, nor so do the economic impact at all terms (short, medium, or long- term) regarding different goals and city clusters. These findings are especially relevant for public managers and politicians for designing public policies in the SC implementation both to acquire a clear understanding of the process and to make decisions concerning the strategic planning processes of smart initiatives providing direction and clarity of the desired goals and the timing for reaching them (Alcaide-Muñoz et al., 2023).

In any case, this finding differs according to the city cluster. In this regard, the C2 cities (collaborative approach) are those with the higher number of goals not expected to reach the social and/or economic impact at medium-term. Indeed, technological impact is not always positive (Mao et al., 2023) and it depends on the contexts (geographical characteristics, weaknesses of regional development, local governance, etc.) to be considered obtaining, as a result, different smart city construction (Mao et al., 2023; Ezeudu and Ismail, 2023). This finding opens

avenues for future research to deeply analyse the interaction between the different governance model components and the goals pursued and its impact on the different time frames. To achieve this aim, future research could use the innovation biography method to examine how the different approach to the components of governance could change over time (as noted by prior research—Ooms et al., 2020; Przeybilovicz & Cunha, 2024-) with the aim at writing the narrative of the complete trace of the strategic planning processes followed by cities to become smart in an efficient or inefficient way (measured by smart city indicators and citizen quality of life indexes).

Conclusions and Future Research

As noted previously, the path to becoming a SC remains diffuse (Boon et al., 2020a) due to the complexity of the issue and the changing and contextual nature of cities, making it difficult to identify a single strategy. In addition, isomorphism decreases as combinatorial complexity increases (Haberberg, 2005), leading in our research to identify three different city strategies when analysing their motivations to become smart based on three main attributes: smart dimensions to develop, aspired goals and time frames to reach them.

In the past, to simplify the process, case study research focused on both first-level strategies of strategic planning processes in developed country context and large-sized cities—over one million inhabitants—and on explaining the peculiarities of implementation and diffusion of successful social innovation without considering the time and context in which the process took place (Kleverbeck & Terstriep, 2017). Nonetheless, the process followed by cities to become smart are not unique to developed countries and their large cities (United Nations-DESA, 2022b), but it's also necessary to identify what is happening in other contexts and other approaches. Besides, it's time to use other different research methods, as that provided by the innovation biography method, to trace and understand the strategies and process implemented in cities to become smart as well as its impact on some outcomes from the beginning of their process as promising candidates for an innovation biography (Butzin & Widmaier, 2012).

Bearing in mind all these considerations, we could obtain knowledge to understand the process of building effective smart cities in the real-world, as required by Mora et al. (2017). Therefore, our research seeks to fill all the research gaps in prior research by providing knowledge at the operational strategy level in all small-sized cities (population less than 500,000 inhabitants) located in a developing an emerging country (Costa Rica) on their path to become smart analysing, using the innovation biography method, the three different components of governance used in their strategy, the main SDi to develop, their aspired goals and the expected time frames to reach them. By doing so, our research contributes to prior research in different directions: theoretical implications, managerial implications and providing useful future research avenues.

Theoretical Implications

This research provides a new research approach to identify the operational strategy used to become a SC in small-sized cities in developing countries. Our research identifies the relevance of analysing the components of the smart governance concept (Meijer & Rodríguez Bolívar, 2016; Tomor et al., 2021) in the strategy of cities to become smart, not only at the beginning of the SC implementation processes, but also from a dynamic perspective, because smart governance models are not static systems over time. To understand and learn lessons about this process, the biography innovation method could be used, which has recently been used in the smart city domain.

In addition, another theoretical contribution of our research lies on the confirmation of the strategic choice view of isomorphism (Oliver, 1988, 1991). This way, the higher differences in organizational attributes (Oliver, 1988) and the higher combinatorial complexity (Haberberg, 2005), the lower isomorphism. The organisational attributes are represented by organisational forms, management action and environmental conditions, all of which includes management expectations concerning the effect of the ICTs on the organisations in the contextual environment (Gil-Garcia, 2012).

These theoretical contributions of our research, applied to our empirical evidence, indicate that the three components of governance, based on the three main axes of the SC concept pointed out by Nam and Pardo (2011)—technology, human and institutional dimensions—have demonstrated to have an impact on the different models of city strategies identified in sample cities. This way, in C1 cities, the technology axis is at the heart of their strategy, showing a trend in investing in citizens and communities to enable them to invent and advance technologies (rationalistic school). C2 cities emphasize the human dimension, showing a trend in engaging different actors to set collective goals (reflective school). Finally, C3 cities put emphasis on the institutional axis with a trend in achieving societal goals and, particularly in the smart growth (critical school). Therefore, our research put the attention on new theoretical reflections based on the governance models, organisational attributes and strategies used by cities in their process to become smart.

A third theoretical contribution lies on the need of efficient strategic planning processes in the SC implementation process. As noted by Yigitcanlar et al. (2018), desired outcomes from the smart city initiatives must be identified and articulated at the initial stage of the planning process, since it could provide direction and clarity of the desired goals and the timing for reaching them (Alcaide-Muñoz et al., 2023). In addition, an efficient strategic planning process could align the objectives and actions of the different SDi to create a cohesive and synergistic approach trod smart city development (Marchesani, 2024). This is highly-relevant for smaller, low-income cities because if they do not have effective plans, their opportunities to reap future returns from large infrastructure investments may fade (World Bank, 2021).

Finally, findings confirm prior research in developed countries concerning the scarce relevance of SENV dimension at the initial stages of cities in their path to become smart (Akande et al., 2019; Chatti & Majeed, 2022). Nonetheless, recent research has indicated the higher significant impact of SE and SENV on citizen

quality of life (Rodríguez Bolívar, 2021) and the positive impact of SE on SENV (Popova & Popovs, 2022). These findings open new avenues for building new theories on SC construction examining the interrelationship among the different SDis into the urban area and its impact on SC construction. As the characteristics of the neural network are suitable for data processing in which the relationship between the cause and its results cannot be exactly defined (Aoyama et al., 1990), perhaps new theories on building SC could be based on the neural networks as the method to untangle relationship among the different SDis and their impact on SC development. This analysis should also include the time frames of the expected impacts as another main attribute to provide clear directions in efficient urban strategic planning processes in their initial stage of cities to become smart (Yigitcanlar et al., 2018; Alcaide-Muñoz et al., 2023).

Managerial Implications

The findings of this research allow public managers and politicians in developing countries to focus on several management aspects requiring the implementation of public policies at different levels of government (national, regional and local) to foster SC development. First, our findings reflect the importance of the national ICT policies for developing SC and the application of the concept of economies of scale (Silberston, 1972; Stigler, 1958). This aspect is embedded into the improvement of technological infrastructure and the attraction of private investment (G10 and G12), which are shared among the different clusters and managed jointly at national level in Costa Rica.

At local level, cities can reinforce this process through two main public policies: a) improving their inhabitants' capacity to use ICTs; and b) involving stakeholders in public decision-making process (collaborative models), especially, concerning ICT needs. The first one confirms prior research indicating the need for SP in the municipality to foster SC adoption (Bokolo & Petersen, 2019) and the need of implementing public policies to attract private investment from technological companies creating high-quality labour markets with highly technologically skilled citizens (Kourtit et al., 2012). As for the second one, sample ICT managers seem to be aware of the public value created by involving stakeholders in city governance models (Cao & Kang, 2022) based mainly on both citizen and social organisation participation in ICT project requirements (G1 and G3 in C2 cities), and in transparent and collaborative governments, which is confirmed by the C1 cities promoting the use of social networks for information dissemination and accountability (G8).

In addition, our findings concerning the different aspired goals and time frames to reach them have pointed out the need for efficient and collaborative strategic planning processes in SC implementation models, not only to identify and articulate the desired outcomes at the initial stage of the planning process (Yigitcanlar et al., 2018), but also to monitor both the performance and the impact of the SC implementation process on the urban area over time (Airaksinen et al., 2017), putting emphasis on the expected time frames for the real achievement of the initially planned outcomes.

Collaborative models and monitoring of strategic planning process in SC implementation models could be benefit of the implementation of Open Government projects. These technological projects are being used as a strategy for government reform especially in developing countries to address misinformation challenges, reduce corruption and government monitoring purposes to lead to a more accurate and realistic assessment of government actions (Pirannejad & Ingrams, 2023). So, city governments should implement these technological projects for facilitating, not only the access and participation of stakeholders in the city affairs, but also a transparent assessment of the SC implementation process which could help to increase trust in LGs (Beldad et al., 2012).

Finally, recent research has indicated that the implementation of sustainable policies is essential in the urban areas at short, medium, and long term (Bokolo, 2023). Indeed, SC strategies in 29 different countries all around the world, although depending on the local context, strongly support the localization of only some specific SDGs (mainly SDGs 7, 8, 9, and 11). Nonetheless, our findings reveal the low importance given to SENV in the identified city strategies, which requires national and local public policies driven to promote and include sustainability policies in all SC strategy models.

Limitations of the Research and Future Research Directions

Despite its numerous contributions, this study has limitations. First, due to the qualitative character of this research, the generalizability is limited. Nonetheless, as noted by Gobo (2004) and Collingridge and Gantt (2019), the concept of generalizability is based on the idea of social representativeness—analytical generalization—which goes beyond the limits of statistical representativeness—automatic algorithm of a statistical rule or probability sampling theory. Indeed, based on the similarity model (an example of analytical generalization), generalizability depends on the extent to which a study's context is similar to the natural context of the phenomenon in question. Therefore, future research could undertake the research performed in this paper but in other LATAM countries with the aim at checking the generalizability of our findings. To achieve this aim, cities in LATAM countries with similar characteristics in ICTs infrastructure and performance, citizens' level of education, and economic and social development to those already reached by Costa Rican cities could be of interest.

A second limitation of our research is that our respondents work in Costa Rican cities (in the Latin America context) which could affect the responses gathered due to the influence of contextual national and local factors, when comparing with other cities located in different countries at an international scene. Indeed, while prior research findings confirm the pivotal role of technological conditions, we further underscore the importance of social and institutional conditions in understanding government behaviour of SC models adoption and, especially, of e-participation adoption (Lee-Geiller, 2024). Therefore, with aim at testing general patterns in SC construction in developing countries across different technological, social, and institutional factors, our research could be replicated in other

small-sized cities located in other developing countries with dissimilar contextual factors and regulatory frameworks with the aim at analysing similarities and differences in SC construction.

A third limitation of our research is that the research is performed at the initial stage of the process of sample cities to become smart, but there is still a great distance from real intelligence and wisdom (Yao et al., 2020). This initial stage of the SC process makes us think, on one hand, in the need of efficient strategic planning processes on SC construction not depending upon political course adhered to a particular city manager (Vishnivetskaya et al., 2019) and, on the other, in the necessary longer and in-depth experience in Costa Rican cities for promoting and coordinating smart technologies, smart industries, social entrepreneurs and activists, high-quality universities, smart city governments, and smart citizens—penta-helix framework in SC—for building more smart and democratic societies (Calzada, 2020). Therefore, as noted previously, to gain more insights about this process, future research could trace the evolution of the strategic planning processes and smart governance systems, including the role played by the different stakeholders in the SC framework, in the coming years using the innovation biography method.

Finally, another limitation concerns the statistical power of the results. Some of the results mentioned above show a statistical power less than 80% (<0.8). This means that some of these correlations cannot be generalised to all cities in developing countries. Nevertheless, the statistical power of the results is enough consistent to draw general lessons from our results so that they can be applied to similar cities (Lupova-Henry et al., 2021). In brief, although findings of this study are notably, further analysis in other time frames and contexts, as well as using other methods would be useful to evaluate the findings presented above.

On another hand, some other new avenues for future studies have been discussed previously and others are generated by the research design of this study. First, up to now, SC research was mainly focused on both case studies and large-sized cities in developed countries. By contrast, our research has been focused on all small-sized cities in a developing and emerging country. Therefore, future research could examine, in a comparative manner, the SC construction of different cities concerning population size, developed vs. developing countries, and other contextual factors that could influence on different SC model construction.

Second, considering the commitment of all countries to achieving the UN SDGs, future research should deeply examine the behaviour of cities at their initial stage to become smart concerning the impact of their public policies and smart initiatives on the environmental protection and sustainable development. Also, our findings have pointed out that each city clusters showed preference for achieving a set of SDis. Nonetheless, prior research has indicated that SDis are interrelated for achieving citizen quality of life (Dash, 2023; Kumar, 2020), but, up to now, there is no empirical evidence on these issues. Therefore, future research could analyse these links (direct and indirect impacts) among the different SDi in the SC construction using econometric models, including backwards-looking indicators, to gather information on the influence of past smart projects undertaken in specific SDis on the current SDis in other areas. This information could help policymakers and public managers to improve their decision-making processes.

Based on the innovation biography method, a fourth avenue for future research is to deeply examine the interaction between the different governance model components and the goals pursued and its impact on the different time frames. As the urban governance models are not static over time (Ooms et al., 2020; Przeybilovicz & Cunha, 2024), this issue should not be only investigated at the beginning of the city process to become smart, but also at medium and long term, with the aim at gaining relevant insights for implementing efficient strategic planning processes of cities in their path of smartness.

On another hand, rethinking organizational behaviour from the perspective of the stakeholder concept in management is closely linked to organisations searching for ways to ensure stakeholder engagement in the management process and structure and related decision-making processes (Freeman, 1984; AccountAbility AA1000 Stakeholder Engagement Standard, 2015; Maksimtsev et al., 2023). As noted in this research, the SC model introduces the need for more collaborative models of urban governance (Rodríguez Bolívar, 2018b), encouraging the stakeholder participation in the smart city development process (Anthopoulos et al., 2019; Bokolo & Petersen, 2019; Giffinger et al., 2007; Tahir & Abdul Malek, 2016). To achieve this aim, LGs should promote smart citizen training programmes in municipalities. Future research should therefore analyse these training programs and its impact on the use and assessment of ICTs and smart services, seeking an impact on both efficiency of public services and confidence in public entities.

Nonetheless, not all stakeholders have the same needs or interest in improving their technological capacities nor do they have the same role in SC development (Šiurytė, 2015). Therefore, future research could also investigate, in a deeper way, the skills needed for citizens to develop smart cities according to their role in this process.

Finally, it would be beneficial to contrast the political and managerial points of view of the SC construction process to identify commonalities and reinforce the overall project strategy so that it is not limited to meeting only political or managerial objectives but both. In summary, future research could replicate our research in other small-sized cities in an international scheme by incorporating other different point of views, other goals included in the different SDi and SC axes, time frames, and impacts.

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Data Availability Data is available upon request to the authors of this research.

Declarations

Competing Interest The authors declare no competing interests.

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