Examining Experiences Concerning Goals Pursued and Smart Dimensions to Develop in Cities on their Path to Become Smart. The Case of Costa Rican Cities

Prof. Isabel Cristina Pereira-Piedra
University of Granada, Spain
ipereirap@correo.ugr.es

Prof. Manuel Pedro Rodríguez Bolívar
University of Granada, Spain
manuelp@ugr.es

Prof. Laura Alcaide Muñoz
University of Granada, Spain
lauraam@ugr.es

Abstract

The rapid growth of the population in cities has given rise to major urban challenges. This has led city governments to use technical solutions based on Information and Communication Technologies (ICTs), arising the concept of smart city (SC). However, the strategy followed to become smart is still very diffuse. This paper seeks to analyze the opinion of the ICT managers of local governments in their initial stage of cities to become smart. To achieve this aim, we have conducted empirical research in Costa Rican cities, which are initiating the SC process, but emphasizing the technological implementation strategy they are using. Concretely, this paper analyzes variables such as the number of ICT projects, dimensions, goals and expected impacts as well as their association. Findings provide technological strategies that can be used and thus facilitate the implementation process of cities to become smart as well as the achievement of results.

Keywords: Smart cities, smart dimensions, goals, Tau C Kendall

1. Introduction

Cities are at the center of the world's economic and human development, generating 60% of the world's GDP. However, rapid urban population growth due to continued migration flows from rural areas (Nations, 2020) has led to an unplanned increased demand for public services endangering the city sustainability (United Nations, 2016). Cities have undertaken some strategies, mainly based on Information and Communication Technologies (ICTs), to streamline processes and overcome this challenge, giving rise to the concept of sustainable cities (Roscia et al., 2013; United Nations, 2016), later transformed into digital cities, ubiquitous cities and other similar terms (Gil-Garcia, Pardo, & Nam, 2015; Meijer, Gil-Garcia, & Rodríguez Bolívar, 2016) and, finally, in the concept of smart cities (SC) (Duygan, Fischer, Pärli, & Ingold, 2022; Nam & Pardo, 2011a, 2011b; Roscia et al., 2013).

As the SC concept is so broad and complex, there is neither consensus on its definition as it is constantly evolving (Giffinger, et al., 2007; Giffinger et al., 2010; Gil-Garcia et al., 2015), nor a single methodology or strategy to make a city smart (Duygan et al., 2022; Giffinger et al., 2010).

It makes interesting to focus our attention on the path taken by cities to become smart. While it is important to analyze the development of SC in the world, the Latin American context is of great relevance as most of them are developing countries, with a growing population and high density (United Nations, 2019), which gives rise to problems of urbanization, pollution, and mobility among others (Worldometer, 2022).

Our research takes Costa Rican cities as the case study due to its appropriate characteristics to facilitate the SC implementation process. In fact, Costa Rican cities are in the initial stage of the SC process, are supported by policies issued by the central government (Mideplan, 2018) have a remarkable development on ICTs, (OECD, 2019), and a high human development index (Conceição & Assa, 2019). Also, Costa Rica shows high socio-economic progress which is at the level of Brazil, Mexico and Argentina (developed countries) (OECD, 2020). However, nowadays it is still debated whether Costa Rica should continue to be lassified as a third world country (Rosenberger, 2022). Thus, the case of Costa Rican cities could serve as an international reference for other cities located in countries with similar conditions at their early stages of their process of becoming smart (Lytras & Visvizi, 2018), broadening the vision on the implementation of SC in different places (Kitchin, 2016).

Moreover, there are still some unanswered questions on how to achieve this. According to previous research, at least six dimensions, economy, governance, mobility, environment, people, and life should be considered in this process (Giffinger et al., 2007; Vinod Kumar,

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2020), but there is still no consensus on the order in which these should be applied as it depends on the context (Duygan et al., 2022; Lytras & Visvizi, 2018). However, it is required to establish priorities in the strategic plan of cities due to the limited resources that exist (Sánchez-Albavera, 2003), so it is necessary to analyze case studies to answer the following question: RQ1. Which dimensions do local governments believe are the most relevant to become a smart city?

On the other hand, operational plans should clearly establish the guidelines on the objectives to be achieved (Deakin & Al Waer, 2011). Therefore, the following research question is derived: RQ2. What are the main objectives to be achieved to increase the interest in becoming smart?

Finally, public management must be oriented to generate public value (A. Meijer & Bolívar, 2016). So there must be an association between the projects developed, the dimensions and the objectives to reach. Thus, the following research question is derived: RQ3. Are the dimensions in which the projects are developed related to the objectives set to become a smart city?

This research aims to answer these questions by analyzing the opinion of the ICT managers of Costa Rican cantons (cities) in their initial stage of cities to become smart. This research identifies sample city planned, ongoing, and consolidated smart projects, and use some information collected from a wider e-survey to ICT managers with the aim at providing a basis for the implementation of public policies and guidelines for public managers and politicians on ICT policies, on their way to becoming a SC.

This paper is organized as follows. The second session analyzes the SC concept and related issues driven to the hypothesis formulation. The third section describes the empirical research, including the sample selection and methodology used. The fourth section is devoted to result analyses and, finally, "discussion and conclusion" section brings the paper to an end.

2. Strategy, technology, and smart cities. Hypothesis formulation

Due to the complexity of the topic and its constant evolution (Deakin, 2014), rather than dwelling on its definition, focusing on both the three fundamental axes - people, institutions and technology - (Nam & Pardo, 2011a) and the six generally accepted dimensions - smart governance, economy, mobility, environment, life and people- (Giffinger et al., 2007; Vinod Kumar, 2020) provides us with a better understanding and dimension of the concept, allowing us to have a comprehensive and general approach to the SC model.

Today, there is a large body of literature on SC, but as mentioned, there is still a lack of clarity about the smart dimensions to start with, the objectives to be achieved and the link between the smart projects developed and the smart dimensions.

Prior research indicates that the implementation of smart initiatives should be included in strategic city planning processes (Rodríguez Bolívar, Alcaide-Muñoz, & Alcaide-Muñoz, 2020) both for their expected long-term impact (Angelidou, 2015; Sánchez-Albavera, 2003) and to avoid individual, ineffective and uncoordinated efforts of local resources being contrary to the holistic development of the SC model (Komninos et al, 2019).

Furthermore, although there is a constant evolution towards more collaborative models (Rodriguez Bolivar, 2022), previous research has mainly linked the coordination role of this SC implementation process to the local government that seems to have the managerial capacity to execute and coordinate it (Angelidou, 2014). This strategic planning process should include strategies and operational plans developed both for the different axes of SC -people (stakeholders), institutions (local and national government) and technology (infrastructures and systems)- and for each of the smart dimensions, which implies the formulation of objectives with a timeline, as well as the use of indicators to measure them (Sánchez-Albavera, 2003).

Regarding smart dimensions, urban strategic planning processes should include actions in the smart governance dimension aimed at providing, through the use of ICTs, user-centered e-services that encourage citizen participation in decision-making, implementing open, transparent and collaborative governance models (Rodríguez Bolívar, 2017, 2018b, 2022), with the ultimate goal of creating public value (Rodríguez Bolívar, 2018a; Meijer & Rodríguez Bolívar, 2016).

Likewise, strategies should include actions aimed at the care, protection and sustainability of resources, pollution abatement and the creation of natural spaces in the urban area (Muvuna et al, 2019; Vinod Kumar, 2020). To achieve this goal, smart mobility actions are required (Queiroz et al, 2021), improving the sustainability of local and international transport modes, providing adequate infrastructure -pavements, trolleybuses, and others- strengthening parking systems and implementing ICTs to offer innovative mobility services (Gautama, 2018).

All these actions must take place in an environment that promotes creative citizens with a high level of education, lifelong learning, collective intelligence, social and ethnic plurality (Hosu & Hosu, 2019) and ICT skills -smart people dimension- as well as providing an urban space with tourist attractiveness, leisure, culture, housing quality, social cohesion, safety and security -smart living dimension- (Giffinger et al., 2007; Vinod Kumar, 2020), which can be facilitated and

accessed through technological means (Meijer & Rodríguez Bolívar, 2016), as well as the consolidation and flexibilization of the labor market, productivity and the development of innovative products and brands - smart economy dimension- (Purnomo et al, 2016).

In summary, the implementation of a SC is a broad, complex and technology-intensive process, which through policy implementation enables tangible economic, social and urban achievements, but from an implementation point of view, it remains rather diffuse and unknown (Angelidou, 2014). This is due to the prior research approach, mainly aimed at broadening the existing model in a general way (Kummitha & Crutzen, 2017; Meijer et al., 2016), so that new research should focus on mapping best practices and establishing international benchmarks (Lytras & Visvizi, 2018) and providing insights from different locations in the world (Kitchin, 2016). Therefore, our empirical research focusing on Costa Rican cities, which are at an embryonic stage of the SC process, could provide interesting data to find answers to this research gap.

Moreover, as noted in prior research, technology is the most used means to initiate the SC process (Meijer & Rodríguez Bolívar, 2016) and the one that most influences policies and priorities of cities (Angelidou, 2015). Therefore, in this research we collect the opinion of ICT managers to analyze the following hypothesis in terms of planned, ongoing and consolidated ICT projects, in the different dimensions.

H.1. All cities interested in becoming smart are significantly related to all dimensions of the SCs model.

On the other hand, strategic planning processes are materialized through operational plans that both show the goals to be achieved by city governments (Sánchez-Albavera, 2003) and serve as the means of monitoring all government actions, assessing whether the city management generates public value (Bromell, 2012) or social capital (Sánchez-Albavera, 2003). Therefore, it is expected to find that sample cities have any preference regarding some goals previously mentioned by prior research when a city becomes smart. This way, the following hypothesis is derived:

H.2. All cities interested in becoming smart are significantly related to specific goals.

Finally, it could be interesting to analyze whether city governments, on their city path to become smart, think that the performance of different actions in the smart dimensions seek to achieve some specific goals, understanding that smart dimensions and specific goals are linked in a unidirectional way (joint effects). This way, it could be interesting to know whether patterns are identified in cities at their initial stage to become smart, thus identifying in more detail the guidance used in the process, providing a broader view that allows identifying which goals and areas are relevant within the scope of the different smart dimensions. Therefore, the following hypothesis is derived:

H.3. All smart dimensions in which technological projects are developed are significantly associated with the goals posed by the cities to become smart.

In brief, this research addresses the hypotheses previously posed with the aim at getting some knowledge about the expected goals, smart dimensions, and impacts using the technological view on projects in cities on their path to become smart.

3. Empirical Research on Costa Rican cities. Sample selection, data, and method

As mentioned, this research focuses on the analysis of Costa Rican cities (cantons) on their way to becoming smart for several reasons. First, Costa Rica ranks 62nd (very high) in the 2021 Human Development Index issued by the United Nations (Conceição & Assa, 2019), which assesses long-term progress in three broad dimensions: a long and healthy life, access to knowledge, and a decent standard of living. Secondly, these cities are currently in the early stages of implementing SC models (only San José, their capital city, is ranked 114th in an international ranking).

They have also invested heavily in ICT implementation and e-services, showing high scores in all three UN e-government dimensions (United Nations, 2020). Finally, Costa Rica is organized into 82 cities (cantons) (National Institute of Statistics and Census, 2020), each with a local government in charge of city administration and public decision-making processes. Thus, these cities have the necessary capacities in the three main axes of SC (people, institutions, and technology) to become smart.

As for the method used in this research, we designed an e-survey to collect information on their interest in becoming smart, the smart dimensions in which they were developing or had planned smart projects, and the expected objectives - see Table 2. The smart projects were catalogued according to the responses of the sample ICT managers and checked by the research team following the Giffinger et al. (2007)'s scheme.

The e-survey was sent to all ICT managers of the 82 Costa Rican cities, to capture their perceptions concerning the variables mentioned previously. ICT managers were selected due to their responsibilities in the management and coordination of all technological initiatives aimed at solving the problems and challenges faced by their cities (O'Donovan & Smith, 2020). Moreover, they are directly involved in the process of their cities to become smart and their role in the

organization is broader than mere technology design and implementation, as they are enablers in processes and influence on the performance and goal achievement (Aral & Weill, 2007; Smith et al., 2021).

Forty-three responses (52.43%) were received, 41 of them indicating that their cities were very interested, moderately interested or interested in becoming smart. Therefore, 41 Costa Rican cities were finally selected for our research. The characteristics of these cities and the profile of respondents are shown in Table 1.

Table 1. Sample selection characteristics

Characteristics of Cities

CITY	Population	% Young people	% of high educated people	# of enterprises	# of universities	# of projects
San José	350,637	50%	13%	5,755	56	7
Alajuela	314,487	51%	10%	1,191	16	2
Cartago	186,957	52%	11%	1,601	6	6
Perez Zeledón	171,154	56%	7%	909	7	-
Heredia	148,524	50%	16%	3,062	10	13
Pococí	144,204	57%	5%	676	1	2
Puntarenas	133,039	53%	6%	1,007	9	2
Turrialba	86,952	51%	8%	623	6	2
Tibás	83,350	46%	15%	673	1	2
Vázquez de Coronado	82,175	49%	13%	387	-	-
Curridabat	75,196	48%	18%	762	2	3
Paraíso	72,101	54%	7%	222	1	3
Liberia	71,174	56%	10%	533	7	3
Aserrí	65,671	53%	7%	119	6	-
Santa Cruz	64,645	50%	10%	321	3	4
Nicoya	63,721	50%	9%	248	5	-
Montes de Oca	63,440	46%	24%	1,148	6	3
Santa Ana	56,339	49%	15%	630	1	3
Grecia	56,261	52%	9%	566	2	6
Oreamuno	55,613	53%	9%	211	-	10
San Rafael de Heredia	55,519	50%	13%	163	1	-
Santo Domingo	52,816	46%	16%	387	1	-
Guarco	51,900	53%	8%	203	-	1
Coto Brus	47,046	56%	5%	128	2	3
Upala	45,832	58%	4%	89	2	0
Palmares	44,054	50%	11%	239	1	4
Carrillo	38,636	54%	8%	181	-	-
Osa	35,292	54%	5%	158	2	-
Mora	33,612	49%	11%	122	-	3
Atenas	31,721	48%	11%	153	1	4
Cañas	30,007	55%	7%	146	6	6
Belén	28,777	46%	16%	392	2	6
Acosta	25,723	52%	5%	58	1	-
Bagaces	21,609	55%	6%	62	1	2
Garabito	19,501	58%	5%	331	-	-
Parrita	19,055	55%	4%	73	1	-
San Marcos de Tarrazú	18,557	56%	5%	113	1	3
Zarcero	13,785	54%	8%	130	-	1
Nadayure	12,960	51%	5%	64	3	1
Dota	8,489	54%	7%	53	1	-
San Mateo	7,218	48%	6%	21	4	1

Characteristics of respondents

Attribute	Value	%
Gender	Male	85%
	Female	15%
Age range (years)	From 20 to 30	7%
	From 31 to 40	34%
	From 41 to 50	49%
	From 51 to 60	7%
	From 61 to 70	2%
Years of experience	From 1 to 4	7%
	From 5 to 8	17%
	From 9 to 12	12%
	More than 12	63%
Professional Profile	ICTs Technician	5%
	Bachelor in ICTs	22%
	Degree in information technology, computer science or systems	49%
	Degree in administration technology	7%
	Degree in administration with emphasis on public accounting	5%
	Master in computer science	12%

Source: Survey and National Institute and Census of Costa Rica

With the information gathered, we first conducted a descriptive analysis of the sample Costa Rican cities that expressed their interest in becoming SC. Then, we conducted a bivariate analysis to determine the relevant dimensions and goals pursued by interested SC and to know whether smart dimensions are significantly linked to specific goals and impacts. Finally, we examined the statistical association between the expected impacts (economic and/or social) and the specific goals, if any.

As for the testing analysis, the Shapiro-Wilk statistical test for normality (less than 50 cities) shows that the data obtained do not follow a normal distribution (Finch, 2005; Lemeshko & Lemeshko, 2008; Mohd Razali & Bee Wah, 2011). Therefore, a non-parametric test should be used due to the sample size -less than 50- (Bonett & Wright, 2000) and to the values which are not tied. In this regard, Kendall's Tau-C correlation was selected to perform the bivariate analysis (Brossart et al., 2018). Finally, the statistical power test (1-β) was performed to determine whether the results obtained are generalizable to the population (1-β => 80%) (Borenstein et al., 1998).

4. Analysis of the Results

4.1. Characteristics of the sample cities and descriptive statistics

Costa Rica is a small country, organized in 82 cities, with populations lower than 356,000 inhabitants. The 46% of the population are young (under 21 years old), have a high level of literacy (98%) (Oviedo et al, 2015) and some of them completed university studies -between 5% and 24% of the population-. All cities (except 7) have at least one university in their municipality which is relevant for cities to become smart (Dameri et al., 2016; Duygan et al., 2022), and they have important entrepreneurial activities and a high number of enterprises (the city with the lowest number of enterprises has 20 -see Table 2-).

On the other hand, the results of the e-survey show that most Costa Rican cities with some degree of interest in becoming smart are carrying out ICT projects in the different smart dimensions. In total there are 106 projects, of which 30 are in execution, 27 in development and 49 in planning, a situation that demonstrates how these cities are in the initial process of implementing the model. The highest number of smart initiatives is in the dimensions of smart governance (25 cities) and smart environment (21 cities). In the other smart dimensions, smart initiatives range between 17 and 19 projects, showing a trend towards the knowledge economy (Angelidou, 2015; Ministry of Science and Technology -MICIT-, 2018). These data reflect the Central Government's policies, through the Digital Transformation Strategy, in search of a more technologically connected and productively innovative country (MICIT, 2018).

Table 2. Variables and descriptive statistics

Variable	Median	Mode	SD	Min.	Max.	Definition	Indicator
Interest in becoming a SCs	5	5	.76	3	5	Interest in becoming a SCs	Likert Scale: Not interested (1), Slightly interested (2), Moderately interested (3), Interested (4), Very interested (5)
Projects by dimension							
Smart economy-oriented projects are developed	2	2	1.04	1	4	Whether there are ICT projects, developed, ongoing or planned, that can be associated and useful in the future implementation of a smart city model.	Free points Likert scale: Yes (1), No (2), Doubtful (3), Does not know (4)
Smart people-oriented projects are being developed	2	2	1.08	1	4		
Smart governance-oriented projects are being developed	1	1	.99	1	4		
Smart mobility-oriented projects are being developed	2	2	1.02	1	4		
Smart environment-oriented projects are being developed	2	1	1.06	1	4		
Smart living-oriented projects are being developed	2	2	1.14	1	4		
Goals							
Increased citizen participation in ICT project requirements	2	2	.63	0	2	Benefits intended by the city from the point of view of technology use in becoming smart and identified in previous research and SCs indices, (R. Giffinger et al., 2007, 2010)	Likert Scale: Strongly Disagree (-2), Disagree (-1), Neutral (0), Agree (1), Strongly Agree (2)
Increased participation of the private sector in ICT project requirements	1	1	.62	0	2		
Increased participation of social organisations in ICTs project requirements	1	1	.72	-1	2		
Increased budget allocation for ICTs needs	2	2	.56	0	2		
Increased demand and development of applications for tourists	1	2	.67	0	2		
Increased satisfaction of citizens with the use of technologies	2	2	.46	1	2		
Increased generation of new ideas for uses of technology for citizens	2	2	.49	1	2		
Increased use of social media for information dissemination and accountability	2	2	.60	0	2		
Improvement in the lifestyle and quality of life of citizens, due to the facilities provided by technology	2	2	.64	0	2		
Improved technological infrastructure (Internet, bandwidth and others)	2	2	.48	1	2		
Improvement in mobility through public transport, with the use of applications (Apps)	2	2	.60	0	2		
Increase in the arrival of private investment	2	2	.77	-1	2		
Increase in tourism	2	2	.68	0	2		
New technological means for tax and fee collection	2	2	.50	0	2		

Source: Own elaboration (SPSS)

The e-survey results show that most of sample Costa Rican cities are undertaking ICT projects in different smart dimensions. In total there are 106 projects, 30 of them is under implementation, 27 are ongoing and 49 are planned. The highest number of smart initiatives is running in the smart governance (25 cities) and smart environment (21 cities) dimensions. The rest of smart dimensions range between 17 and 19 smart projects, which shows a trend towards the knowledge economy (Angelidou, 2015; MICIT, 2018).

Regarding the SC goals, results show a special interest in enhancing smart governance through participatory decision-making processes, improving public services, and government transparency. In addition, respondents indicate the establishment of strategies and policy perspectives concerning sustainability, resource management, environmental protection and cultural management (OECD, 2020; Oviedo et al., 2015). Finally, descriptive analysis shows that most of the median scores of all the goals is 2 which means that sample ICT managers usually strongly agree with most of the goals posed to the SC model, especially with those related to the participation in the requirements of ICT projects by the private sector and social organizations -see Table 2-.

4.2. Hypothesis testing

4.2.1. Relevance of smart dimensions for sample cities interested in becoming smart (H.1)

The SC model suggests implementing smart initiatives for improving in six main dimensions. Are cities in an initial stage of SC development to considering all of them on their path to become smart? According to our results –see Table 3- sample cities interested in becoming smart are conducting smart initiatives driven to develop specially some of these smart dimensions.

Table 3. Correlation between cities interested in becoming smart and the smart dimensions

Dimension	Nº CITIES	T (tau C)	SD	*p*	1-β	*f*
Smart Governance	25	- .360	.104	.001 ***	.836	600
Smart Mobility	18	- .225	.105	.033 **	.860	.474
Smart living	17	- .193	.119	.105 *	.907	.439
Smart people	17	- .195	.123	.114 *	.916	.441

Source: own elaboration (SPSS) Cases valid: 41
Legend: T: SD: Standard Deviation -.30 to -.10 or .10 to .30 low, -.60 to -.40 or .40 to .60 medium, -.90 to -.70 or .70 to .90 high. -1 or 1 perfect. P: *** 0.001 Very significant ** <= 0.05 medium significant * <= 0.12 low significant 1-β >0.80 *f* = .10 low, .30 medium, .50 high

Concretely, results show that there is a low and inverse correlation between the smart initiatives undertaken and four dimensions of the SCs model. Concerning the smart governance and smart mobility dimensions, data show a negative and significant statistical association, implying that an increase in the number of projects addressed to foster citizen participation and public services, as well as to improve accessibility and mobility through better transport systems, would not lead to an increase in the city interest in becoming smart.

There is also an inverse, but less statistically significant association with the promotion of a cosmopolitan and pluralistic lifestyle, smart people and increased quality of life and social cohesion (smart living), so that increasing the number of ICT projects in these areas does not seem to influence on the level of the city interest in becoming smart.

Finally, data do not show statistical association between the smart initiatives undertaken in the smart economy and smart environment dimensions and the interest of sample cities to become smart.

In summary, the results highlight three main aspects: (a) the undertaking of ICT-based initiatives in the different domains does not increase the interest of cities to become smart; (b) although ICT managers identify some links between smart projects and the dimensions

in which they should be implemented, these are not positively related to the dimensions i.e. the development of those projects does not impact on an increased interest in developing that specific dimension; and (c) no trend or focus towards one or some specific smart dimensions is evident which may indicate the absence of a technological strategy (Meijer & Rodríguez Bolívar, 2016). Therefore, in response to RQ1, from a technological point of view, the results show that there is no order or priority for the implementation of ICT projects in the dimensions to be implemented for Costa Rican cities to become smart.

4.2.2. Relevance of goals for sample cities interested in becoming smart (H.2)

Table 4 gathers information concerning the goals considered relevant by sample cities interested in becoming smart. Results show that four of the fourteen goals considered as relevant by prior research in SC are statistically significant and can influence in a higher or lower degree in the interest of cities in becoming smart.

Table 4. Correlation between the goals pursued by cities and the degree of their interest in becoming a SCs

Goals	T (tau C)	SD	*p*	1-β	*f*
2/ Increased participation of the private sector in ICT project requirements	.332	.119	.005**	.275	.344
11/ Improved mobility through public transport, with the use of applications (Apps)	.291	.121	.017**	.445	.347
12/ Increase in the arrival of private investment.	.244	.116	.036**	.544	.340
13/ Increase in tourism	.221	.119	.062*	.647	.344

Source: own elaboration (SPSS) Cases valid: 41
Legend: T: SD: Standard Deviation -.30 to -.10 or .10 to .30 low, -.60 to -.40 or .40 to .60 medium, -.90 to -.70 or .70 to .90 high. -1 or 1 perfect. P: *** 0.001 Very significant ** <= 0.05 medium significant * <= 0.12 low significant 1-β >0.80 *f* = .10 low, .30 medium, .50 high

Of particular importance in this regard are the promotion of private sector participation and investment in the city and the actions undertaken to improve mobility in the city using apps. It denotes that sample cities are moving from the traditional Weberian model of hierarchical and centralized government (Kettl, 2021), towards other more relational models of governance (Longo, 2008; Roscia et al., 2013), promoting the participation of public and/or private stakeholders in the co-production of ICT projects and higher quality services (Angelidou, 2015; Demirel & Mülazımoğlu, 2022).

Also, a strategy that considers the context (Muvuna et al., 2019) and favors the knowledge economy is envisioned (Dahlman et al., 2007) by supporting Costa Rica's main economic activities, such as services, specifically, the attraction of foreign direct investment -objective 12- (CINDE, 2021) and the promotion of tourism -objective 13-, being a country characterized by its green brand (Oviedo et al., 2015; Rodriguez Vives, 2022; Vindas, 2020). Responding to RQ2, objectives identified as the most relevant to becoming smart are those very focused on the country's strengths and linked to its context (Duygan et al., 2022; Lytras & Visvizi, 2018)) and government policies. (Rodriguez Bolívar, 2018b).

4.2.3. Relevance of goals according to the different smart dimensions for sample cities interested in becoming smart (H.3)

In this case, this research analyses the joint effect of smart dimensions and goals pursued over the interest of cities to become smart. Results in Table 5 indicate that all smart dimensions, except for smart people, are related to, at least, one of the pursued goals.

In this regard, three smart dimensions (smart economy, smart governance, and smart environment) show a low and negative correlation with some goals. The smart economy shows an inversely association with the goal of improving technological infrastructure (Internet, bandwidth, etc.), indicating that an increase of investment in these technological infrastructures does not lead to a strengthening of the smart economy dimension, which could be due to the limited resources of local governments for this kind of projects (Peteraf & Barney, 2003).

As for the smart governance, results show a negative significant association with two specific goals: increasing tourism and increasing private investment, which could be due to the focus of city management on both providing high-quality services and the presence of new private business in the urban area.

Finally, results indicate an inverse and moderately weak association between smart environment and four goals pursued. This way, whenever city management focuses its efforts on accountability through social media, improving technological infrastructure, increasing investment, and allocating more budgetary resources to ICT, it will not contribute to an improvement of the smart environment dimension.

On another hand, results show that there are two smart dimensions (smart mobility and smart living) with a statically positive significant correlation with four pursued goals by cities to become smart. It means that city governments fostering the achievement of these goals will contribute slightly to the improvement of these smart dimensions.

Concretely, if city governments promote the participation of citizens, private sector, and social organizations in the requirements of ICT projects, lifestyle is enhanced because the user needs would be included in public services such as in mobility issues. Also, the development of tourism-oriented applications

could have a positive impact on the improvement of smart living, particularly important in Costa Rica where tourism is one of the main economic activities (Vindas, 2020).

Table 5. Correlation between smart dimensions and the goals pursued by cities to become smart.

Benefits	T (tau C)	SD	*p*	1-β	*f*
Smart Economy					
10/ Improved technological infrastructure (internet, bandwidth, etc.)	- .255	.155	.100*	0,966	0,505
Smart Governance					
13/ Increase in tourism	- .271	.126	.032**	0,927	0,521
12/ Increase in the arrival of private investment.	- .200	.117	.088*	0,904	0,447
Smart Mobility					
3/ Increased participation of social organisations in ICT project requirements	.262	.122	.031**	0,914	0,512
1/ Greater citizen participation in the requirements of ICT projects	.271	.128	.034**	0,930	0,521
2/ Increased participation of the private sector in ICT project requirements	.262	.129	.042**	0,932	0,512
Smart Environment					
8/ Increased use of social networks for information dissemination and accountability	- .291	.133	.028**	0,941	0,539
10/ Improved technological infrastructure (internet, bandwidth, etc.)	- .340	.158	.031**	0,977	0,583
12/ Increase in the arrival of private investment.	- .241	.122	.048**	0,916	0,491
4/ Increased budget allocation for ICT requirements	- .145	.094	.123*	0,833	0,381
Smart Living					
1/ Greater citizen participation in the requirements of ICT projects	.237	.126	.059*	0,924	0,487
5/ Increased demand and development of tourist applications	.248	.132	.061*	0,938	0,498
3/ Increased participation of social organisations in ICT project requirements	.209	.124	.092*	0,919	0,457
2/ Increased participation of the private sector in ICT project requirements	.202	.131	.124*	0,932	0,449

Source: own elaboration (SPSS) Cases valid: 41
Legend: T: SD: Standard Deviation -.30 to -.10 or .10 to .30 low, -.60 to -.40 or .40 to .60 medium, -.90 to -.70 or .70 to .90 high. -1 or 1 perfect. p: *** 0.001 Very significant ** <= 0.05 medium significant * <= 0.12 low significant 1-β >0.80 *f* = .10 low, .30 medium, .50 high

In summary, whereas smart governance and smart economy dimensions are not favored by the increase of ICT investment, the arrival of private sector investment and the increase in tourism, the smart mobility and smart living dimensions, through the promotion of stakeholder participation (citizens, private and social sector) and the development of tourism applications, reinforce the implementation of these dimensions, which allows identifying a pattern of where actions can be directed in a strategic and operational planning for the cities on their path to become smart. In brief, concerning RQ3, results show a link between the goals and the dimensions in which ICT projects are being developed.

5. Discussions and conclusions

In the last decade, many cities around the world have undertaken ICT-intensive public reforms to become smart. However, the process so far is a black box, especially in smaller cities, in developing countries and in Latin America (Duygan et al., 2022). Also, although there are several approaches for cities to become smart (Kummitha & Crutzen, 2017), the technological axis is the most used to initiate the process (Meijer & Rodríguez Bolívar, 2016). Therefore, the identification of strategic patterns from the technological deterministic view could be an important contribution that helps to design operational actions and public policies that strengthen the SC implementation process.

Considering the holistic and complex nature of this process, all smart initiatives should be included in the strategic planning processes of cities, including the objectives pursued and designing operational plans with concrete actions to control and execute the process (Rodríguez Bolívar et al., 2020).

In this sense, this research has analyzed the opinion of ICT managers in Costa Rican cantons (cities) on the aforementioned issues on their path to becoming smart. To achieve this objective, this work has identified their planned, ongoing, and consolidated smart projects, and has conducted an e-survey to collect the opinion of ICT managers on the influence of smart initiatives on the development of the different smart dimensions and on the achievement of the goals pursued.

Findings of this research indicate that strategic policies and central government action plans are relevant to provide cities with the necessary capabilities in the three main axes of SC (people, institutions, and technology) to become smart. Indeed, the characteristics of sample cities in terms of their level of educated population, ICT infrastructure and social stability foster both the development of the knowledge economy (Dahlman et al., 2007) and the attraction of foreign investment (CINDE, 2021).

Technical and professional staff is required (targets 2 and 12), which has a direct impact on smart people (e.g. the development of virtual educational platforms in the city of Bethlehem) and the application of technological advances in tourism (targets 5, 11 and 13), contributing to the smart mobility dimension (e.g., the construction of cycle paths and bicycle rentals in the city of Cartago), to the smart economy by increasing economic activity through tourism (e.g., the installation of platforms for tax collection and ease of processing operating permits in El Guarco) and to the smart environment (e.g., applications to measure and control CO2 in the city of Curridabat).

Indeed, this is especially relevant in the Costa Rican context due to its ecological diversity (Oviedo et al., 2015; Vindas, 2020) and confirms the context-dependent nature of city development with respect to the objectives pursued by sample cities (Alcaide Muñoz et al., 2022; Rodríguez Bolívar, 2022). Future research could analyze the possible influence of different city patterns on their process of becoming smart, the level of different key drivers needed for cities to become smart, as well as the overall government policies needed to foster this process. To achieve this aim, future research should broaden the scope of this research to other cities

in different contexts with the aim at finding comparative insights concerning these issues.

Findings also reveal a shift from a traditional Weberian governance model (Kettl, 2021), towards a more relational and collaborative one (Longo, 2008), involving key stakeholders (goals 1, 2 and 3) in the design of ICT project requirements with the aim of better meeting citizens' needs and providing citizen-centric services (Angelidou, 2015; Demirel & Mülazımoğlu, 2022), thus, favoring the dimensions of smart governance, smart living, and smart mobility. A question for future research arises here, can we brand a non-participatory and non-collaborative city as "smart"?

Regarding the analysis of the interaction between the interest in becoming smart and the projects developed in the smart dimensions, findings suggest that smart initiatives undertaken do not influence the cities' interest in becoming smart. That is, according to the perception of ICT managers, cities do not show a preference for undertaking a greater number of smart initiatives in specific smart dimensions over others to become smart.

This finding could be due to the cities' interest in developing all aspects because ICT managers do not identify the objectives achieved by each of the smart dimensions or because of their lack of involvement in the strategic planning process, not understanding the overall strategy and plans of the municipality (Chourabi et al., 2012; Meijer & Rodríguez Bolívar, 2016).

Nonetheless, knowledge about the smart city process and its impact is very relevant to avoid technological investments that are not necessary or do not strengthen the SC implementation project. Therefore, future research should involve stakeholders in the SC strategic planning process to gather information on the influence of smart initiatives carried out in the development phase of the smart dimensions. The main question here is whether cities on their path to becoming smart follow some guidelines in terms of smart initiatives to face the challenges of their context, enabling them to achieve some specific goals and impacts on the urban space.

Also, another trend for future research could be to analyze whether it is possible to identify patterns of cities on their path to becoming smart that would help us to examine the preference for developing specific smart dimensions rather than developing all areas in parallel. Finally, other factors that may influence the degree of interest and the order of implementation of the dimensions can also be addressed in future research.

Another relevant finding is the focus on goals 10, 12 and 13, which could lead to a moderate or low decrease in the scope of smart governance and smart economy. Also, the findings indicate that if the smart environment dimension is to be strengthened in cities where environmental issues and ecotourism are relevant, such as in Costa Rica, the implementation of goals 4, 8, 10 and 12 could limit the achievement of these goals. Therefore, considering the scarce financial resources available to city governments to become smart (Peteraf and Barney, 2003), future research should analyze whether they are allocating the same amount of budget to all smart dimensions or, on the contrary, whether there are large differences, and, in the latter case, what is the main reason for these funding differences.

As far as smart mobility and smart people are concerned, the importance of the involvement of stakeholders, that is. citizens, social organizations and the private sector in ICT requirements is clearly visualized (objectives number 1, 2 and 3). Therefore, as noted previously, collaborative and participatory governance models are essential for cities on their path to becoming smart (Ramlaoui & Semma, 2014; Rodríguez Bolívar, 2018a, 2022).

Finally, findings seem to support actions promoted by international organizations such as the Organization for Economic Co-operation and Development (OECD, 2017, 2019), such as strengthening participatory governance in the design of ICT project requirements (goals number 1, 2 and 3), improving public services (goal number 11) and government transparency (goal number 8), establishing strategies and policy perspectives that encourage greater private sector participation and investment (goals number 2 and 12), promoting activities that foster economic development (goals number 5 and 13), and focusing on people and their quality of life (goals number 5, 11 and 13). Therefore, future research could analyze the different policies issued by international organizations such as the OECD, the United Nations -with the Sustainable Development Goals (SDGs)- (UN, 2015), to collect all their principles and analyze their impact on cities on their path to becoming smart.

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