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Strategic digital city: Concept, model, and research cases

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ABSTRACT

Cities, in addition to being physical, are also digital, requiring the use of information technology resources and strategies, information, and services to make appropriate decisions. The objective is to present the strategic digital city (SDC) concept and project model and its research considering the subprojects: city strategies; city information; public services to citizens; and information technology resources applied in cities. The research methodology comprises approaches mixing techniques in respective phases, including bibliometrics assignment, and model theory applied in SDC cases with more than 11 doctoral, 100 master's, undergraduate, scientific initiation, and postdoctoral program orientations obtained from more than 300 cities since 2003. The results showed that the SDC can be understood as a social project of public policy and is on the city managers' agenda, as demonstrated in the 8 cases researched and in the more than 86 publications in different scientific international journals in the recent decade. The conclusion reiterates the importance of the participatory and democratic SDC original project accepted to contribute to the proper city management and the citizens' quality of life expansion, including infrastructure, policy, and city development. Then, the SDC contemporary concept and model have been maintained regularly over the 10 years.

KEYWORDS

city strategies; city information; public services to citizens; information technology in cities; strategic digital city; urban management

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1. Introduction

Cities around the world, in addition to being physical, are also digital, that is, part of their operation requires the use of information technology resources. But not only information technology resources are relevant. Strategies, information, and public services are permanent challenges in cities that are concerned with the citizens' quality of life and with proper municipal management. Such a challenge requires the participation of all people in the city, including municipal employees, and citizens, whether workers, students, retirees, housewives, alderman, councilors, and businessmen, among others. In this way, the constant social, environmental, financial, mobility and political

challenges faced by cities have required their public managers to act more competently to provide adequate quality of life for their citizens. On the other hand, citizen participation in running the city is an inexorable necessity (He and Ma, 2021) including different city issues (Bukalova and Maland, 2023; Lee, 2023; K. Mouratidis, 2021; Witesman et al., 2023; Zhou, 2022). One of the ways to contribute to these challenges is through the collective, participatory, and formal elaboration of a strategic digital city (SDC) project. This SDC project must also take into account the respective planning of strategies, information, services, and city technologies, where specific assumptions and certain concepts, respective legislation, must be widely discussed, understood, and participative disseminated (Rezende, 2012).

Proper city management suggests reflections on urban plans, territorial dynamics, social projects, citizens' quality of life, and public management policies, including formal and informal, physical and digital spaces in which services, information, and knowledge are produced and reproduced (Bidandi and Williams, 2020; Kotus and Sowada, 2017; Lee, 2023; Navarro-Yáñez and Rodríguez-García, 2020; Wu, 2020). The discussion goes beyond the use of technology, urban solutions, and party politics, emphasizing the needs of society in a democratic, participatory, and inclusive relationship with public managers and citizens (He and Ma, 2021). The debate extends to the nomenclatures used to characterize cities, such as smart cities, intelligent cities, digital cities, and SDC projects. These are not synonyms, but different concepts that public managers choose for their city management (Wu et al., 2020). One of these strategies or public policy concerns the SDC. While smart cities, for example, normally are based on software in the appropriation of urban space (Almeida and Rezende, 2021), the SDC is based on the strategies listed for the city centered on the citizens' quality of life and on meeting the city's objectives and the metropolitan region (Rezende, 2018). These challenges have led many cities to propose improvements in their urban infrastructure, including digital vision and strategy as innovative alternatives (A. Mouratidis, 2021), facilitating interactions between different social actors that include city management and citizen participation (Chatterton, 2019), restoring the citizens' democratic participation (Masik et al., 2021) also promoting the governments' legitimacy (He and Ma, 2021) and in this case, all these initiatives can also be considered city strategy (Betancur and Brand, 2023; Leão et al., 2023).

Research problems reiterate the informality or lack of strategies planning and management, information, and public services to citizens through information technology resources. Without planning and executing strategies, information, services, and technologies, it is unlikely that cities, municipalities, city halls, and public organizations will be competently managed and will not offer a quality of life to their managers, municipal servants, citizens, or residents. And, it has not been usual to think about the city for a long time, much less in a collective, participatory way and with the citizens' involvement (Bukalova and Maland, 2023; A. Mouratidis, 2021; Rezende, 2018; Wu et al., 2020). Both physically and digitally, cities are growing in a planned way and harming the quality of life of those who live in them, including urban and rural spaces and respective metropolitan regions and their participatory and democratic visions, as well as economic, infrastructure, and development approaches (Cheng et al., 2022; Davidson, 2023; Kotus and Sowada, 2017; K. Mouratidis, 2021; Zhou, 2022). Cities often approach short-term actions, in contrast to classic thinking where strategy is built for the long term (Alizadeh, 2017). Without strategies, services, and information, cities are lacking in their urban indicators (Weiss, 2020), not offering perspectives for innovation and citizenship (Masik et al., 2021), undermining inclusion and sustainability in cities (Carr and Hesse,

2020; Tomor et al., 2019). The public services offered do not always satisfy citizens, profiling citizen complaints and increasing mistrust in city management (Tangi et al., 2021) and disfavoring accessibility to public benefits (Lee, 2023; Ryzin, 2015; Witesman et al., 2023).

Thus, the problem-question research emphasizes: city strategies, city information, public services to citizens, and information technology resources are applied in cities through strategic digital city projects?

The objective is to present the strategic digital city concept and project model and its research considering the subprojects: city strategies; city information; public services to citizens; and information technology resources applied in cities.

Research justifications stand out the elaboration and project execution and management of city strategies, city information, public services to citizens, and information technology resources are applied in cities, also considering collective strategic planning in cities, of short, medium, and long term, including citizens in a participatory manner (Bukalova and Maland, 2023; A. Mouratidi, 2021; Rezende, 2012; Witesman et al., 2023). Such projects in cities favor the city role and the space role in social production by citizens to meet their needs (Engin et al., 2020; Preiss and Schroeder, 2020), contemplating the cities' strategic reflections, the public application policies with citizen participation and the interaction between city management and citizens through timely information and adequate services (Cheema, 2020; Kotus and Sowada, 2017; Murphy et al., 2018; Navarro-Yáñez and Rodríguez-García, 2020). Citizens' knowledge can produce knowledge for the cities' development, for the social, environmental, and political movements, with human respect through the interdisciplinarity of public policies, aiming at effectiveness and appropriateness of society's participation with improved public management with different positive interests and respect for citizens' demands (Brazeau-Béliveau and Cloutier, 2021; Wu, 2020; Zhou, 2022).

When the city practices collaborative planning, lifestyle becomes more adequate, both in the urban and digital aspects (Bjørgen et al., 2021; Hatuka et al., 2021), where the city's performance indicators can also help in the quality of information analysis made available and public services offered to citizens through the technological resources of digital channels (Ryzin, 2015; Tangi et al., 2021) where all residents can be considered co-producers, fostering confidence in city management (Eijk and Steen, 2016; Farr, 2016; Fledderus et al., 2014) and facilitating the proper use of available digital technologies used to face the cities challenges, both in the urban and rural environment (Bauriedl and Strüver, 2020; Cheng et al., 2022; Chiappini, 2020; Leão et al., 2023; Shih et al., 2021). Proper city management also uses technological tools for urban and rural planning and control (Bennani et al., 2022), which favors strategic digital projects applied in cities, proposing a more inclusive, effective, participatory, democratic local management (Davidson, 2023; Masik et al., 2021; Wu et al., 2020). In this way, a city project based on city strategies and information can help city management in making timely decisions and implementing appropriate actions (Rezende, 2018).

2. Literature review

2.1. Strategic digital city

Unlike the concept of conventional digital city and smart city, the strategic digital city (SDC), a

concept coined by Rezende (2012), can be understood as the application of information technology resources in the management of cities and also in the information and services provided to citizens, based on the strategies of city management. It is a more extensive project than just offering the Internet to citizens through conventional telecommunication resources. It goes beyond digitally including citizens in the global computer network (Rezende, 2012). It is based on the city's strategies to meet the objectives of the different city public thematics or municipal functions. City public thematics or municipal functions are the macro activities present in all cities (or municipalities), they are not city areas and they are not municipal departments. For example, agriculture; science, technology, and innovation; dissemination or marketing or commerce; culture; education; sports; housing; industry; legal affairs; leisure; logistics or materials; environment; health; sanitation; security; social; transit or transport or mobility; tourism; urban; and rural; among others. Each one can be divided into modules or subsystems, which can also be called municipal affairs or subject, theme, or issue systematized and integrated (Rezende, 2018).

SDC is divided into four subprojects: city strategies (to achieve the city's objectives); city information (to assist in the decisions of citizens and city managers); public services (to increase the citizens' life quality); and information technology resources applied in cities. For the adequate implementation of the SDC model (Rezende, 2012) is necessary to elaborate on four projects: city strategic planning with objectives and strategies covering all city public thematics or municipal functions; city information planning; city public service planning; and city information technology planning, also considering the municipality, prefecture and municipal public organizations involved.

The SDC can also be understood as a public policy for city management and urban planning (Rezende et al., 2015) included in different city themes (Flores and Rezende, 2018; Fumagalli et al., 2021; Ribeiro et al., 2019), being a consolidated city model for a decade (Almeida and Rezende, 2021; Flores and Rezende, 2022; Fumagalli et al., 2022; Teixeira and Rezende, 2023).

2.2. City strategies

City strategies can be understood by means, pathways, or ways to achieve the city's objectives, and are also relevant in the development and execution of city strategic planning (Rezende, 2012). Strategies dynamics include a set of decisions to guide behavior in the city, addressing turbulence and changing conditions that surround and include municipalities, city halls, and public organizations (Alizadeh, 2017; Granda and Machin-Mastromatteo, 2017; Leão et al., 2023; K. Mouratidis, 2021; Weiss, 2020).

Effective decision-making is based on long-term city objectives, and refers to a critical analysis that directs the decision in the adoption of resources and available options to urban managers, considering city challenges and local problems that allows the decision with different alternatives (Bryson and George, 2020; Engin et al., 2020) also using non-conventional and non-classical strategies, that is, digital (Bañales-Mallo et al., 2019; Bloomberg et al., 2011; Bukalova and Maland, 2023; Ferretti and Grosso, 2019; Gallaugher, 2018; Marom, 2019; Navarro-Yáñez and Rodríguez-García, 2020).

2.3. City information

City information can be understood as an entity with a meaningful value attributed or added to it and have a natural and logical sense for different uses by citizens and city managers to assist their

respective decisions and further actions (Rezende, 2012).

The information must be qualified, effective, and timely to assist decision-makers effectively, including qualitative and quantitative indicators, becoming an operational, managerial, and strategic resource in cities (Leonteva et al., 2018; Rahim and Shirazi, 2018). Through adequate information, everyone can participate in the city, both in the elaboration and in the execution of innovative public policies (Gallaugher, 2018; Lee, 2023).

2.4. Public services in cities

Public service can be understood as any service provided by the government, including cities, or by delegates under state standards and controls to meet the essential needs of the community or secondary or simple convenience of the State (Rezende, 2012). Examples of public services: public education, security, health, transportation, and telecommunications and others (Meirelles, 2020) facilitating the well-being of all (Farr, 2016; Fledderus et al., 2014; Kohama, 2016; A. Mouratidis, 2021; Rahim and Shirazi, 2018).

Researchers, public managers, and government officials tend to agree with four essential public services issues: efficiency, effectiveness, equity, and responsiveness (England et al., 2016), trying to reduce bureaucracy, and many times, goods and services provisions are transferred from private to public e vice-versa (Eijk and Steen, 2016) trying to increase public transparency principally when information technology resources are used, they permit transactional interactions between citizens and city managers with participatory city planning and management (Cheng, 2020; He and Ma, 2021; Wu, 2020) promoting citizens' influences (Cheng et al., 2022; Li et al., 2019; Morel and Nuamah, 2020; Tangi et al., 2021; Witesman et al., 2023; Wu et al., 2020).

2.5. Information technology resources applied in cities

Information technology can be understood as computational and technological resources for data storage, generation, and use of information, based on four components: hardware and its devices and peripherals; software and its resources; telecommunications systems; data and information management (Laudon and Laudon, 2021; Rezende, 2012; Stair and Reynolds, 2017). When information technology is applied in cities and public administration (in the spheres of federal, state, or municipal) also can be called electronic government (e-gov) (Heeks, 2022; Turban et al., 2021; Wu and Manoharan, 2023).

Information technology is present in cities and is impossible to disregard by public management and urban and rural environments (Engin et al., 2020) requiring city planners to pay special attention to the technological resources available in the market that can be applied in cities to provide adequate results for citizens and public managers (Tomor et al., 2019) hating people technologically empowered by available technologies (Webster and Leleux, 2018).

3. Research methodology

The research methodology comprises an approach of applied work to a circumstantial reality, emphasizing the inductive method enhanced by experience achieved by the author-researcher, both in advising projects for cities and in academic projects for master and doctoral classes and guidelines (Nachmias and Nachmias, 2014).

The research method mixed different qualitative and quantitative research techniques in respective phases. The first research phase partially takes exploratory research concepts regarding documental and bibliographic raising, as a bibliometrics assignment (Morin et al., 2021).

The second research phase also considered model theory (Carlile and Christensen, 2005) when creating the strategic digital city model (Rezende, 2012) applied in the third research phase that contemplates SDC cases, including more than 11 doctoral thesis orientations and 100 master's, undergraduate, scientific initiation, and postdoctoral program orientations.

The research materials were alternated in action research obtained from more than 300 cities, municipalities, prefectures, and public organizations from different countries since 2003, integrating multiple approaches explained by eclecticism and integration of inseparable methods (Yin, 2017).

4. Strategic digital city cases research

4.1. Multidimensional information management framework for SDC

The research of Teixeira and Rezende (2023) is to perform an information analysis in two cities to develop a strategic multidimensional framework. The research methodology was based on the model theory. It took into consideration the digital services from two cities supported by non-participatory observations and a bibliographic review. The data were collected hierarchically and compared with five related international frameworks using the info mapping technique. The original framework comprised three constructs and ten multidimensional variables that related the conceptual theories to the developed and applied model. The research was conducted in Rio de Janeiro, Brazil, and Regina, Saskatchewan, Canada. The research findings indicated disconnections between one or more of the variables surveyed, limited customized services, and recurrent information use in a bidirectional form, it also, emphasized the multidimensional information character in terms of its dynamic nature and relations with distinct information management levels.

4.2. Crowdsourcing framework applied to SDC projects

The research of Flores and Rezende (2022) is to elaborate on an original crowdsourcing framework applied to SDC projects. The research methodology is exploratory and descriptive and was conducted in Curitiba, Brazil. On the one hand, the model supports empowerment degrees' systematic analysis of the e-participation actors to initiate a task and innovation-oriented spontaneous crowdsourcing activities for solving wicked problems. On the other hand, SDC projects play the role of passively monitoring spontaneous crowdsourcing activities and actively planning and implementing government initiatives. The research findings show that the framework can encourage local governments to identify talents, influencers, and partners among different stakeholders-to discover what motivates them to participate and the rewards they expect-thus evolving strategies to welcome innovative projects, processes, products, and ideas in a continuous learning cycle.

4.3. Data intelligence in public transportation and SDC subproject

The research of Fumagalli et al. (2022) is to determine these factors to monitor and use them for citizens' benefit by means of analytical tools and methods to gain a superior knowledge of reality with a focus on improving investments and services in an agile and efficient manner.

Methodologically, the number of passengers of main Curitiba's (Brazil) bus rapid transit (BRT) lines is operated in two linear regression models combined with the number of private vehicles, public transport fare, and fuel price for the period between January 2010 and December 2019. Research analysis indicates direct causal relationships between the studied factors and that the necessary data for decision-making is available in government information systems. The research findings consider urban management and SDC project can be more balanced and assertive in transport infrastructure investments and citizen services provision.

4.4. Public transportation and alternatives for the COVID-19 pandemic through SDC application

The research of Fumagalli et al. (2021) is to determine a demand control able to equalize the number of passengers in each car, respecting the COVID-19 social distancing protocols in Curitiba, Brazil. The passengers' number in each time-of-day range was combined in four different models that included independent variables related to passenger behavior indicating that almost 90% of all passengers are following a very strict and straight daily routine that can be coordinated and scheduled creating enough time space one from the other to avoid undesirable concentrations inside buses and bus stops. The research findings note that an accurate urban management tool can arise from the study and may be able to solve not only the pandemic issues but also to improve local public services efficiency, attract private investments, and improve citizens' quality of life.

4.5. Toward a model of the municipal evidence-based decision process in the SDC context

The research of Ribeiro et al. (2019) is to propose a municipal decision process model in the SDC context, in Guarapuava, Brazil. The research methodology employed was qualitative and applied to circumstantial theoretical reality, emphasizing exploratory and descriptive methods aided by bibliographic and documentary survey along with the non-participatory observation of the variables that make up the model. Similar models were identified and analyzed. The municipal decision process in the SDC context was built from three constructs: decision, evidence, and SDC. These constructs are interconnected by their thirteen variables, which are related to the conceptual base of the model developed. The research findings reinforce the importance of using evidence to support the decision process, making it one of the strategic elements for digital cities aiming at improving their citizens' quality of life.

4.6. Twitter information for contributing to the SDC and citizens as co-managers

The research of Flores and Rezende (2018) is to analyze Twitter information to contribute to the SDC. The research methodology used was a case study of a Brazilian city, Curitiba. Twitter was analyzed, and the information was assessed according to its characteristics, source, nature, quality, intelligence, and organizational level. The research findings reveal Twitter allows communication, rudiments of public services, and the Exchange and sharing of information on municipal themes inherent to strategic digital cities. Information has quality and intelligence to serve the government's strategic level, and confirms that Twitter enhances transparency and strengthens bonds between local government and citizens.

4.7. SDC projects: Information and public services offered to citizens

The research of Rezende (2016) is to describe and assess the digital city projects in Chicago (USA)

and Curitiba (Brazil), using information and public services offered to citizens by the website. The research methodology consisted of case studies covering the city hall, municipal departments, and other municipal entities. The research findings show advantages for the citizens who have free communal access to public services on the Internet. Chicago offers its citizens 281 public services distributed in 256 subjects or themes and Curitiba 508 public services distributed in 26 subjects or themes, highlighting the importance of the implemented projects. In both cities, it resulted in benefits for citizens through access to information and public services offered by the Internet.

4.8. Public policy and a SDC project based on citizen participation methodology

The research of Rezende et al. (2015) is to analyze and describe municipal information planning based on a project carried out, between 2009 and 2014, in the municipality of Vinhedo, São Paulo, Brazil. The study stresses the importance of adopting a project design methodology and implementing projects collectively at a municipal level to increase the efficiency of municipal management and implementing the SDC concept, thereby increasing public space and governability and, consequently, citizens' quality of life. The research findings show that municipal information planning projects constitute public policy, and demonstrated the participation of over a thousand citizens in the design, implementation, and provision of information and public services for the city.

5. Results and discussion

In the first strategic digital city (SDC) researched project, Rezende et al. (2015) focused on connecting city information with city strategies to improve public services in consonance with the SDC concept described in Section 2. The authors used cities interested in communication, education, and social development seeking to contribute to citizenship through planning, structuring, storage, and access to information and public services. The project was carried out for six years as action research, adopting the proposed SDC model and reiterating its strategic vision in practice. This project can be considered a reference in public policy by involving more than a thousand citizens in city information and public services design, implementation, and provision. This case discussed the practical feasibility of a city information planning project and the importance of a project methodology implemented collectively by city employees, city managers, and citizens to create an SDC project.

Sequentially, Rezende (2016) advances the SDC concept study by assuming that it is also necessary to offer comprehensive information and efficient public services for citizens as a permanent challenge for cities concerned with citizens' quality of life and effective city management. It is not just a matter of offering several public services but providing adequate services and timely information so citizens can effectively obtain well-being. Therefore, some criteria must be considered, for example, communicability, content, functionality, security and privacy, understanding, and citizen participation. For met these criteria, the research suggests that the city should carry out information and public services planning integrated with city strategic planning to make possible the breakthroughs in citizenship building within the public space, city democratic governability, and transparency of management and in the urban, rural and regional development of the cities. With this integration, it would be possible to realize enhanced communications between the citizens and government, expanding credibility, trust, and equality while promoting accountability, transparency, and democracy.

Regarding city information to contribute to SDC and to have citizens as co-managers in city management, Flores and Rezende (2018) described a process to have effective city management focused on the citizen. City management must find ways to provide citizens' participation in the decision-making process using social platforms to extract and classify useable strategic information. Twitter and its respective information were evaluated according to their characteristics, source, nature, quality, intelligence, and organizational level, allowing communication, rudiments of public services, and exchange and sharing of information on municipal issues inherent to the SDC project with transparency and strengthen bonds between local government and citizens. Due to its informality, Twitter makes citizens as users comfortable to discuss, make claims, and decide on municipal themes of their interest. On the other hand, the city managers, on the strategic level, might be the potential consumer of the information provided as information managers. This research points out that there is no reason to have technologies without people connecting, interacting, and communicating, and what flows in the deterritorialized and ubiquitous space and provides less hierarchical relationships is information, minimizing the impacts and possibilities of mass media to express citizenship and good practices that allow greater transparency in the relationship between governments and citizens.

Lately and more comprehensively, the fourth SDC researched case developed by Ribeiro et al. (2019) states that technological and connected modern cities demand effective decisions taken by managers aligned with citizens' demands, where the SDC and its subprojects can provide the necessary context to have proper decisions based on evidence at the city level of management. The original framework proposed includes three constructs (decision, evidence, and SDC) interconnected by thirteen variables. This case clarifies that various evidence-based policy decisions about city issues can be evaluated and weighted. And the framework assumes that, in city management, there is no perfect solution but the best possible one because the evidence construct is composed of essential variables that allow the decision process to use the evidence source properly.

Combining city information and IT resources applied in cities to define city strategies to improve public services, Fumagalli et al. (2021) found that public transport is one of the more complex issues for big cities where people are concentrated in the same space at the same time, especially during COVID-19 pandemic times where the consequences of social distancing are relevant. This research reiterates that a demand control can be able to equalize the number of passengers in each car, respecting the COVID-19 social distancing protocols, through four different models that include independent variables related to passenger behavior which variables can be easily obtained and controlled by the municipalities almost in real-time. The demand forecasting model developed in this research can define the number of cars needed on the line in each time range, with an optimized bus occupation in a profitable way for operators, efficient for the municipality, and with comfort and safety for users, reiterating connections with public transport management and SDC.

Later, in sequence with this previous research and by the SDC main concepts, Fumagalli et al. (2022) recommend that transport infrastructure investments must have strategic connections with the public transport demand since user behavior and decision-making process can originate different transportation options. The research shows that cities must manage these factors to promote equal and sustainable transport solutions through urban infrastructure, public transport competitiveness and attractiveness, and fossil fuels use and pricing policy. And suggested that are direct causal relationships between these variables since the necessary data for decision-making are

available in the government information systems, also proved that the SDC project can facilitate the management of city finances and passenger transportation. Public policy and properly managing other urban development investments can explore this research's results to be more democratic and sustainable.

In the seventh SDC research case, Flores and Rezende (2022) reiterate that when strategically implemented, crowdsourcing helps to capture the intelligence of a variety of e-participation actors, enabling them to share the leading role with the government in decision-making processes, considering the context of the SDC subprojects, through an original crowdsourcing framework applied to the SDC projects, with two constructs and their respective subconstructs establishing the relationships between them. The experience showed that the city does not typify the citizen, nor does it strategically plan the passive monitoring of spontaneous crowdsourcing initiatives; although it partially performs the active monitoring of the crowdsourcing initiatives initiated by him, without naming them that way. The research also reiterated the relevance of applying the framework for the city to align the implementation and monitoring of crowdsourcing initiatives with the strategic planning of the city, to identify talents and influencers, understand the appropriate language to reach each layer of society, discover the purpose that motivates citizens to participate and the forms of reward they expect. In this way, it becomes feasible to welcome innovative projects, products, and ideas resulting from crowdsourcing initiatives, including citizens in the co-creation and decision-making process in a continuous learning cycle in the context of the SDC subproject.

More recently, Teixeira and Rezende (2023) affirm that management and information systems are essential for SDC projects since they provide customized digital services that connect specific information and context to form a multidimensional construct. The original framework comprised three constructs and ten multidimensional variables related to the conceptual theories and the developed and applied model. The research noted the existence of research variables, the information dynamics, relationships with public services, and the SDC, indicating the connection between one or more variables, making the adequate constructs that make up two-dimensional city management systems, facilitating the possibility of customizing information and public services, for each query and each citizen. On the other hand, the relevance of the applied framework demonstrated interactions with citizens and SDC subprojects, where timely information is unquestionable for the decisions of citizens and city managers.

In addition to the reported research cases, in parallel, the analyzes of research published on the SDC from 2009 to 2019 (Almeida and Rezende, 2021) enabled the characterization of a less physical and more digital city profile, resulting in 86 publications in different scientific journals, because since Rezende (2012) created the SDC concept and model, several researchers have been investigating this research theme from different perspectives, emphasizing that the results even pointed out that the SDC based on the city strategies, impacting city management, the social production of urban space and the citizens quality of life, and can also be considered a public management policy.

The impact on the surveyed cities is strongly oriented towards the realization of more intelligent governance, where it can be seen that timely information can be effective, and where adequate public services using information technology constitute innovative resources in cities. These tendencies may be essential for the contemporary city that allows the participation of citizens and

city managers to expand urban, rural, and regional development, including infrastructure, policy, and city development.

6. Conclusion

The concept, model, and research on SDC can corroborate the integrated vision of cities concerning their physical and digital environments combined through strategies, information, and the respective services offered to those citizens. In this sense, the participation of citizens in cities provides more appropriate, innovative, and participatory management. However, it is also relevant to prepare and execute plans considering the urban and rural environment of the cities, integrating the metropolitan region and its respective policies in the context of all city public thematics or municipal functions. Such plans and the SDC project require the citizens' participation and the involvement of city managers to increase the transparency of management and the economic, educational, social, cultural, environmental, technological, and innovative city development. It is undeniable that cities worldwide are becoming more digital, demanding the participatory formalization of strategies, information, and services through information technology resources. The cities' management and digitization constitute permanent challenges in cities concerned with their citizens' quality of life and with the new adequate public administration precepts.

The SDC project and its respective four subprojects can favor the city's management and encourage the exercise of citizenship to the extent that citizens participate in city planning, feeling equally inclusive. On the other hand, these addressed issues also suggest reflections on urban and rural dynamics, social projects, environmental programs, and public policies, including formal and informal spaces in which information and knowledge are produced and reproduced. Citizens' information and knowledge are unquestionable requirements to develop appropriate strategies and innovative services that effectively satisfy citizens in their daily lives and that generate positive changes in cities.

The proposed objective was achieved, as it described the SDC concept and project model and its research considering the subprojects: city strategies; city information; public services to citizens; and information technology resources applied in cities, described in the Literature Review, and in particular, the eight SDC research case, proving the particularities of the concept, model, and project applications. Not to mention more than 100 student orientations and executed projects in more than 300 cities in different countries.

The findings result can evidence that the concept, model, project, and research in the SDC suggest a collective and participatory way of thinking about the city for the long term, including the innovative planning of city strategies, city information, public services with information technology resources, for city managers and citizens, considering the urban and rural environment, physically and digitally. It stands out, then, that the SDC can be understood as a social project of public policy and is on the agenda of city managers, as demonstrated in the 8 city cases researched and more than 86 scientific academic articles published in different international journals in the recent decade. However, the SDC concept is still confused with smart cities, intelligent cities, and digital cities.

The research contributions report on the practical viability of the SDC concept and project model proven by research cases and student orientations, which can be different ways of sharing

the knowledge acquired through these experiences and cases. Thus, other cities, municipalities, city halls, and public organizations can absorb and use this knowledge. Contributions can be directed to city managers who can dialogue and implement the respective SDC concept and project model and research cases. And can also be extended to the academy or relevant studies or science related to the theme SDC which is still original with its four subprojects. In this way, researchers on related topics, including smart cities, intelligent cities, and digital cities, can expand their respective studies. As for citizens, society and city managers, urban managers, or public managers, the constructions emphasize the possibility of elaborating and executing projects in cities in a participatory, democratic, and innovative way, corroborating with the local and regional development proper way. The city management that involves its citizens, municipal servants, public managers, and other actors interested in these subjects increases transparency and active citizenship. Finally, government best practices can possibly be shared with other cities, stimulating conceptual reflections on their practical realities.

Research limitations report that the SDC concept and project model cannot be generalized and applied in all cities, requiring specific projects and mainly action research to monitor the progress of the proposed projects. From a scientific point of view, there were no limitations on the SDC concept and project model, however, the challenge of the cities is related to the acceptance and application of this innovative concept and with an original model for cities that want to contemplate the strategic vision of the digital city, not expressing the reality of world cities, world cities, because they have economic, environmental, cultural, social, among others differences.

The conclusion reiterates the importance of an innovative concept and an original SDC project model that can be adopted collectively by municipal servants, public managers, and citizens. Then, the SDC concept has been maintained regularly over the years, so it is one contemporary concept. The original SDC project model can be accepted as an instrument to effectively contribute to the cities' management and implementation projects through the planning and execution of short, medium, and long-term strategies and actions in cities. With the effective implementation of this original SDC project model, the participatory and democratic public space, the transparency, effectiveness, and governance of public services, and the social, municipal, and regional development, can be expanded and, as a consequence, the citizen' quality of life may also be more suitable, including infrastructure, policy, and city development.

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Conflict of interest

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References

Alizadeh T (2017). Urban digital strategies: Planning in the face of information technology. *Journal of Urban Technology* 24(2): 35–49. doi: 10.1080/10630732.2017.1285125

Almeida GGF, Rezende DA (2021). Strategic digital city: A decade of research under debate (Portuguese). *Revista Espaço Acadêmico* 21(230): 1–12.

Bañales-Mallo A, Aguirre-García MS, Santos-Vijande ML (2019). Urban strategic management, city marketing, total quality management and local economic development. *urbe. Revista Brasileira de Gestão Urbana* 11. doi: 10.1590/2175-3369.011.e20180205

Bauriedl S, Strüver A (2020). Platform urbanism: Technocapitalist production of private and public spaces. *Urban Planning* 5(4): 267–276. doi: 10.17645/up.v5i4.3414

Bennani KS, Hassine AB, Mazouz B. (2022). Public governance tensions: A managerial artefacts-based view. *International Review of Administrative Sciences* 88(4): 1050–1067. doi: 10.1177/0020852320988155

Betancur JJ, Brand P (2023). Revisiting Medellin's governance arrangement after the dust settled. *Urban Affairs Review* 59(1): 73–98. doi: 10.1177/10780874211047938

Bidandi F, Williams JJ (2020). Understanding urban land, politics, and planning: A critical appraisal of Kampala's urban sprawl. *Cities* 106: 102858. doi: 10.1016/j.cities.2020.102858

Bjørgen A, Fossheim K, Macharis C (2021). How to build stakeholder participation in collaborative urban freight planning. *Cities* 112: 103149. doi: 10.1016/j.cities.2021.103149

Bloomberg MR, Oliver K, Asher T, et al. (2011). Road map for the digital city: Achieving New York city's digital future. Available online: https://www.nyc.gov/html/media/media/PDF/90dayreport.pdf (accessed on 2 February 2023).

Brazeau-Béliveau N, Cloutier G (2021). Citizen participation at the micro-community level: The case of the green alley projects in Quebec City. *Cities* 112: 103065. doi: 10.1016/j.cities.2020.103065

Bryson J, George B (2020). Strategic management in public administration. In: *Oxford Research Encyclopedia of Politics*. Oxford University Press.

Bukalova D, Maland E (2023). Mind the gap: Strategies from California on navigating access to public hearings. *Public Administration Review* 83(2): 435–441. doi: 10.1111/puar.13581

Carlile PR, Christensen CM (2005). The cycles of theory building in management research. Available online: https://www.hbs.edu/ris/Publication%20Files/05-057.pdf (accessed on: 2 February 2023).

Carr C, Hesse M (2020). When Alphabet Inc. plans Toronto's waterfront: New post-political modes of urban governance. *Urban Planning* 5(1): 69–83. doi: 10.17645/up.v5i1.2519

Chatterton P (2019). *Unlocking Sustainable Cities: A Manifesto for Real Change*. Pluto Press.

Cheema S (2020). Governance for urban services: Towards political and social inclusion in cities. In: Cheema S (editor). *Advances in 21st Century Human Settlements*. Springer. pp. 1–30. doi: 10.1007/978-981-15-2973-3_1

Cheng YD (2020). Bridging the great divide: Toward a comparative understanding ofcoproduction. *Journal of Chinese Governance* 5(1): 1–7. doi: 10.1080/23812346.2019.1709325

Cheng YD, Yang LK, Deng S (2022). Nonprofit density and distributional equity in public service provision: Exploring racial/ethnic disparities in public park access across U.S. cities. *Public Administration Review* 82(3): 473–486. doi: 10.1111/puar.13465

Chiappini L (2020). The urban digital platform: Instances from Milan and Amsterdam. *Urban Planning* 5(4): 277–288. doi: 10.17645/up.v5i4.3417

Davidson M (2023). Participatory budgeting as democratization? The post-bankruptcy democratization of Vallejo California. *City*. doi: 10.1080/13604813.2023.2209450

Eijk CV, Steen T (2016). Why engage in co-production of public services? Mixing theory and empirical evidence. *International Review of Administrative Sciences* 82(1): 28–46. doi: 10.1177/0020852314566007

Engin Z, van Dijk J, Lan T, et al. (2020). Data-driven urban management: Mapping the landscape. *Journal of Urban Management* 9(2): 140–150. doi: 10.1016/j.jum.2019.12.001

England RE, Pelissero JP, Morgan DR (2016). *Managing Urban America*, 8th ed. CQ Press.

Farr M (2016). Co-production and value co-creation in outcome-based contracting in public services. *Public Management Review* 18(5): 654–672. doi: 10.1080/14719037.2015.1111661

Ferretti V, Grosso R (2019). Designing successful urban regeneration strategies through a behavioral decision aiding approach. *Cities* 95: 102386. doi: 10.1016/j.cities.2019.06.017

Fledderus J, Brandsen T, Honingh M (2014). Restoring trust through the co-production of public services: A theoretical elaboration. *Public Management Review* 16(3): 424–443. doi: 10.1080/14719037.2013.848920

Flores CC, Rezende DA (2018). Twitter information for contributing to the strategic digital city: Towards citizens as co-managers. *Telematics and Informatics* 35(5): 1082–1096. doi: 10.1016/j.tele.2018.01.005

Flores CC, Rezende DA (2022). Crowdsourcing framework applied to strategic digital city projects. *Journal of Urban Management* 11(4): 467–478. doi: 10.1016/j.jum.2022.08.004

Fumagalli LAW, Rezende DA, Guimarães TA (2021). Challenges for public transportation: Consequences and possible alternatives for the Covid-19 pandemic through strategic digital city application. *Journal of Urban Management* 10(2): 97–109. doi: 10.1016/j.jum.2021.04.002

Fumagalli LAW, Rezende DA, Guimarães TA (2022). Data intelligence in public transportation: Sustainable and equitable solutions to urban modals in strategic digital city subproject. *Sustainability* 14(8): 4683–4699. doi: 10.3390/su14084683

Gallaugher J (2018). *Information Systems: A Manager's Guide to Harnessing Technology*, 6th ed. Flat World Knowledge.

Granda R, Machin-Mastromatteo JD (2017). Recovering troubled cities through public spaces and libraries. *Information Development* 34(1): 103–107. doi: 10.1177/0266666917741069

Hatuka T, Zur H, Mendoza JA (2021). The urban digital lifestyle: An analytical framework for placing digital practices in a spatial context and for developing applicable policy. *Cities* 111: 102978. doi: 10.1016/j.cities.2020.102978

He AJ, Ma L (2021). Citizen participation, perceived public service performance, and trust in government: Evidence from health policy reforms in Hong Kong. *Public Performance & Management Review* 44(3): 471–493. doi: 10.1080/15309576.2020.1780138

Heeks R (2022). Digital inequality beyond the digital divide: Conceptualizing adverse digital incorporation in the global South. *Information Technology for Development* 28(4): 688–704. doi: 10.1080/02681102.2022.2068492

Kohama H (2016). *Public Accounting: Theory and Practice* (Portuguese), 15th ed. Atlas.

Kotus J, Sowada T (2017). Behavioural model of collaborative urban management: Extending the concept of Arnstein's ladder. *Cities* 65(1): 78–86. doi: 10.1016/j.cities.2017.02.009

Laudon KC, Laudon JP (2022). *Management Information Systems*, 17th ed. Generic.

Leão P, Santos GGFO, Rocha TN, et al. (2023). The digitalization phenomenon and digital strategies in emerging countries: A semi-systematic review. *Revista de Administração Mackenzie* 24(3). doi: 10.1590/1678-6971/eRAMR 230059.en

Lee H (2023). Strategic types, implementation, and capabilities: Sustainability policies of local governments. *Public Administration*. doi: 10.1111/padm.12917

Leonteva LS, Maximov DA, Kurbanov SA, et al. (2018). Information services and development of effective urban management. *International Journal of Civil Engineering and Technology* 9(11): 2518–2525.

Li H, Wang Q, Deng Z, et al. (2019). Local public expenditure, public service accessibility, and housing price in Shanghai, China. *Urban Affairs Review* 55(1): 148–184. doi: 10.1177/1078087417702504

Marom N (2019). Urban visions and divisions in the global south: Comparing strategies for Mumbai and Cape Town. *Transactions of the Institute of British Geographers* 44(4): 778–793. doi: 10.1111/tran.12309

Masik G, Sagan I, Scott JW (2021). Smart City strategies and new urban development policies in the Polish context. *Cities* 108: 102970. doi: 10.1016/j.cities.2020.102970

Meirelles HL (2020). *Brazilian Administrative Law* (Portuguese), 44th ed. Juspodivm.

Morel D, Nuamah SA (2020). Who governs? How shifts in political power shape perceptions of local government services. *Urban Affairs Review* 56(5): 1503–1528. doi: 10.1177/1078087419855675

Morin JF, Olsson C, Atikcan EO (2021) *Research Methods in the Social Sciences: An A-Z of Key Concepts*.

Oxford University Press.

Mouratidis A (2021). Smooth integration of transport infrastructure into urban space. *Journal of Infrastructure, Policy and Development* 5(2): 1379. doi: 10.24294/jipd.v5i2.1379

Mouratidis K (2021). Urban planning and quality of life: A review of pathways linking the built environment to subjective well-being. *Cities* 115(1): 103229. doi: 10.1016/j.cities.2021.103229

Murphy J, McDowell S, Braniff M, Denyer D (2018). Managing contested spaces: Public managers, obscured mechanisms and the legacy of the past in Northern Ireland. *Environment and Planning C: Politics and Space* 36(3): 443–459. doi: 10.1177/2399654417714800

Nachmias D, Nachmias CF (2014). *Research Methods in the Social Sciences*, 8th ed. Worth Publishers.

Navarro-Yáñez CJ, Rodríguez-García MJ (2020). Urban policies as multi-level policy mixes. The comparative urban portfolio analysis to study the strategies of integral urban development initiatives. *Cities* 102: 102716. doi: 10.1016/j.cities.2020.102716

Preiss O, Schroeder RV (2020). The city and the region: Images and realities revisited (Portuguese). *Redes* 25(2): 635–651. doi: 10.17058/redes.v25i2.14033

Rahim FU, Shirazi NS (2018). Fiscal decentralization and citizen's satisfaction from local public service delivery in Pakistan. *International Journal of Ethics and Systems* 34(1): 122–142. doi: 10.1108/IJOES-04-2017-0066

Rezende DA (2012). *Planning Strategies and Municipal Information for Digital City. Guide for Projects in City Halls and Public Organizations* (Portuguese). Atlas.

Rezende DA (2016). Digital city projects: Information and public services offered by Chicago (USA) and Curitiba (Brazil). *International Journal of Knowledge Society Research* 7(3): 16–30. doi: 10.4018/IJKSR.2016070102

Rezende DA (2018). Strategic digital city: Concept and model. In: Proceedings of 15th CONTECSI—International Conference on Information Systems and Technology Management; 23–25 May 2018. doi: 10.5748/9788599693148-15CONTECSI/OS-5217

Rezende DA, Procopiuck M, Figueiredo FC (2015). Public policy and a strategic digital city project: A case study of the Brazilian Municipality of Vinhedo. *Journal of Urban Technology* 22(2): 63–83. doi: 10.1080/10630732.2014.971536

Ribeiro SS, Rezende DA, Yao J (2019). Toward a model of the municipal evidence-based decision process in the strategic digital city context. *Information Polity* 24(3): 305–324. doi: 10.3233/IP-190129

Ryzin GGV (2015). Service quality, administrative process, and citizens' evaluation of local. *Public Management Review* 17(3): 425–442. doi: 10.1080/14719037.2013.841456

Shih C, Treija S, Zaleckis K, et al. (2021). Digital placemaking for urban regeneration: Identification of historic heritage values in Taiwan and the Baltic States. *Urban Planning* 6(4): 257–272. doi: 10.17645/up.v6i4.4406

Stair RM, Reynolds G (2017). *Principles of Information System*, 13th ed. Cengage Learning.

Tangi L, Benedetti M, Gastaldi L, et al. (2021). Mandatory provisioning of digital public services as a feasible service delivery strategy: Evidence from Italian local governments. *Government Information Quarterly* 38: 101543. doi: 10.1016/j.giq.2020.101543

Teixeira AV, Rezende DA (2023). A multidimensional information management framework for strategic digital cities: A comparative analysis of Canada and Brazil. *Global Journal of Flexible Systems Management* 24(1): 107–121. doi: 10.1007/s40171-022-00325-w

Tomor Z, Meijer A, Michels A, Geertman S (2019). Smart governance for sustainable cities: Findings from a systematic literature review. *Journal of Urban Technology* 26(4): 3–27. doi: 10.1080/10630732.2019.1651178

Turban E, Pollard C, Wood G. (2021). *Information Technology for Management: Driving Digital Transformation to Increase Local and Global Performance, Growth and Sustainability*, 12th ed. Wiley.

Webster CWR, Leleux C (2018) Smart governance: Opportunities for technologically-mediated citizen co-production. *Information Polity* 23(1): 95–110. doi: 10.3233/IP-170065

Weiss J (2020). Managing performance and strategy: Managerial practices in German local governments. *Public*

Performance & Management Review 43(5): 1129–1149. doi: 10.1080/15309576.2019.1702064

Witesman EM, Walters L, Christensen RK (2023). Creating a public service topology: Mapping public service motivation, public service ethos, and public service values. *Public Administration*. doi: 10.1111/padm.12939

Wu H, Manoharan AP (2023). Three cities on YouTube: E-government's evolution through content creation. *International Journal of Public Administration in the Digital Age* 10(1): 1–22. doi: 10.4018/IJPADA.318126

Wu WN (2020). Does citizens' 311 system use improve satisfaction with public service encounters? *International Journal of Public Administration* 44(8): 665–673. doi: 10.1080/01900692.2020.1744644

Wu Y, Sun X, Sun L, Choguill CL (2020). Optimizing the governance model of urban villages based on integration of inclusiveness and urban service boundary (USB): A Chinese case study. *Cities* 96: 102427. doi: 10.1016/j.cities.2019.102427

Yin RK (2017). *Case Study Research and Applications: Design and Methods*, 6th ed. Sage Publications.

Zhou A (2022). Digital infrastructure and economic growth—Evidence for China. *Journal of Infrastructure, Policy and Development* 6(1): 1397. doi: 10.24294/jipd.v6i1.1397