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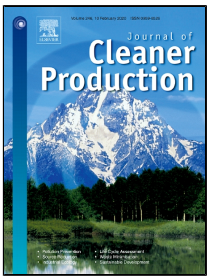

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Julio Cesar Ferro de Guimarães, Eliana Andréa Severo, Luiz Antonio Felix Júnior, Wênyka Preston Leite Batista da Costa, Fernanda Tasso Salmoria

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Governance and quality of life in smart cities: towards sustainable development goals

Julio Cesar Ferro de Guimarães *
Federal University of Pernambuco (UFPE), Departament of Business Administration. Av. Professor Moraes Rego, 1235, Cidade Universitária, 50670-901, Recife-PE, Brazil. Phone: +55 81 2126-8360, E-mail: juliocfguimaraes@yahoo.com.br
*Corresponding Author

Eliana Andréa Severo
University Potiguar (UnP), Departament of Doctorate and Master in Business Administration (PPGA-UnP). Roberto Freire, 2184, 59082-902, Natal-RN, Brazil. E-mail: elianasevero2@hotmail.com

Luiz Antonio Felix Júnior
University Potiguar (UnP), Departament of Doctorate and Master in Business Administration (PPGA-UnP). Roberto Freire, 2184, 59082-902, Natal-RN, Brazil. Email: juniorfelixx@hotmail.com

Wênyka Preston Leite Batista da Costa
University Potiguar (UnP), Departament of Doctorate and Master in Business Administration (PPGA-UnP). Roberto Freire, 2184, 59082-902, Natal-RN, Brazil. Email: wenykapreston@hotmail.com

Fernanda Tasso Salmoria
University Potiguar (UnP), Departament of Doctorate and Master in Business Administration (PPGA-UnP). Roberto Freire, 2184, 59082-902, Natal-RN, Brazil. Email: nandaska@hotmail.com

Biographical notes:

Dr. Julio Cesar Ferro Guimarães holds a Post-doctoral degree from the University of Caxias do Sul (UCS), Doctor in Business Administration at the Pontificia University Católica of Rio Grande do Sul (PUC-RS) and University of Caxias do Sul (UCS), Brazil. He has experience in the area of Business Administration, emphasis in management of innovation, business competitiveness and Cleaner Production. Professor at the Professor of Federal University of Pernambuco (UFPE), Departament of Business Administration, Center for Applied Social Sciences (CCSA/UFPE).

Dr. Eliana Andréa Severo holds a Post-doctoral in Business Administration from the University of Caxias do Sul (UCS), Doctor degree in Business Administration at the Pontifícia University Católica (PUC-RS) and University of Caxias do Sul (UCS), Brazil. She has experience in the area of Business Administration, with emphasis in environmental management, innovation and entrepreneurship. Professor at the University Potiguar (UnP), Post-Graduate Program in Administration.

Msc. Luiz Antonio Felix Júnior is a Master Degree in Accounting at the Federal University of Pernambuco (UFPE). Doctoral student in Business administration at the University Potiguar (UnP). He has experience in the accounting and studies of smart cities. Professor at the Federal Institute of Alagoas (IFAL)

Msc. Wênyka Preston Leite Batista da Costa is a Master Degree and Doctoral student in Bussiness Administration at the University Potiguar (UNP), Specialist in Accounting Auditing and Graduate in Accounting Sciences from the State University of Rio Grande do Norte (UERN). Experience in the accounting area with emphasis on Audit and Accounting Skills. Professor at the Department of Accounting Sciences at UERN.

Esp. Fernanda Tasso Salmoria, Post graduate in Business Management and Financial Management and Controlling, Bussiness Administration at the Potiguar University (UNP). Experience in corporate administration and study smart cities.

Governance and quality of life in smart cities: towards sustainable development goals

Abstract

The concentration of housing in the urban area and the strong population growth, implies adapting the cities to meet the people's Quality of Life minimum. In this sense, smart cities present themselves as a viable solution to aggregate public resources, human capital, social capital and information, and communication technologies, to promote sustainable development. In this context, this research aims at analyzing the influence of the factors of Smart Governance on the Quality of Life in the context of the smart cities. This study is characterized as quantitative research, of a descriptive nature, made possible by means of a survey applied to 829 inhabitants of a city in the Northeast of Brazil. For the analysis of the data, we used multivariate data techniques, with the application of Structural Equation Modeling methodology. This study aims to analyze the influence of Smart Governance factors on Quality of Life in the context of smart cities, in the Northeastern region of Brazil. To that end, Transparency, Collaboration, Participation and partnership, Communication and Accountability on Quality of Life relationships were measured. The results of the research indicate intense and important relations among the constructs. Among the research findings, we highlight the identification of strategic drivers that can help the smart city rulers in the development of public policies and actions of the municipal executive that involves the population to achieve sustainable development goals. It is noteworthy that the research findings contribute to improving the governance of smart cities, in order to improve citizens' quality of life.

Keywords: Smart governance, Quality of life, Smart city, Sustainable development, Structural Equation Modeling, Brazil.

1 Introduction

The population growth, aggravated by the high concentration in the urban area, implies adapting the cities to meet the minimum Quality of Life (QoL) of the people. The United Nations (2018) report states that in the year 2018, around 55% of people in the world inhabit urban centers, and there is a tendency to increase in the coming decades, leading to a continuous and gradual increase of the world population that resides in urban centers.

In this context, the new paradigms of life in society require the processes of governance of urban centers to use innovations, creativity and planning to meet the challenges encountered in social life (Pratt, 2008; Schwab, 2017). For Capdevila and Zarlenga (2015) and Camboim, Zawislak and Pufal (2019), urban centers, called cities, are complex ecosystems, inhabited by individuals of diverse interests, who can be encouraged to collaborate with each other, seeking to achieve a sustainable environment and an adequate QoL. In the context of smart cities, QoL refers to positive situations that result in citizens' cognitive, subjective and affective well-being (Carvalho et al., 2018, Florida et al., 2013). These positive situations arise through attitudes, behaviors and emotions, which can increase socialization, enabling less violence, more friendships, support, generosity, making people happier, healthier, friendlier and more loving (Bertram and Rehdanz, 2015; Montgomery, 2013; Corrado et al., 2013; Gehl, 2010; Kuo and Sullivan, 2001; Sirgy and Cornwell, 2002).

To address issues such as unemployment, homelessness, social inequality, traffic jams, pollution, disease and violence (Dodgson and Gann, 2011; Neirotti et al., 2014) caused by rapid global housing growth, cities are looking for tools to improve living conditions for their citizens, and among them, Information Technology (IT) stands out. Accordingly, cities can use IT in the governance process to understand and create smart ways to address the demands of the public and private sectors. This phenomenon marks the meeting of two trends, the digital revolution and the process of urbanization in the quest to become a smart city (Chourabi et al., 2012).

In this sense, Gil-Garcia et al. (2014) argue that technologies can influence and be useful in how government manages its health services, work relationships, work, and education. For the reality of the cities changes daily, passing through numerous transformations in short spaces of time, being able to find in IT an ally to accompany it. According to Machado Jr. et al. (2018), cities with a set of superior economic, social and environmental indicators have the potential to present better living conditions for their inhabitants.

The idea of a smart city is a motivator for the development of policies that contribute to a better society, and consequently to improvements in citizens' quality of life (Meijer and Bolívar, 2016; Meijer et al., 2016; Van Winden et al., 2016). Corroborating, Capdevila and Zarlenga (2015) and Dumay (2016), emphasize that the basis of smart cities is the combination of human capital, social capital and information, with the use of communication technology infrastructure, in order to generate economic development, improve well-being and the quality of life of the people.

Therefore, quality of life is a key element for the development of smart cities (Hall, 2000; Giffinger et al., 2007, Nam and Pardo, 2011, Thuzar, 2011). However, the theme of smart cities is recent, so there are several research gaps related to the factors that influence the quality of life. According to Nilssen (2019), the concept of smart cities is still considered somewhat elusive, for the multifaceted character, arousing both excitement and skepticism. According to Shen et al. (2018), there are few studies examining what results have been achieved in the practice of applying policy measures in smart cities. Regarding the concept of smart cities associated to QoL, we highlight the studies of Ismagilova et al. (2019), Camboim et al. (2019), Cerutti et al. (2019), Appio et al. (2019), Carvalho et al. (2018), Paaso et al. (2018), who emphasized that QoL is a fundamental aspect of the development of smarts cities. In the Brazilian scenario, we have the investigation of Macke et al. (2018), which sought to analyze the main elements of citizens' satisfaction in the city in which they were born and reside. According to De Jong et al. (2015) and Wolfram (2018), the impact of the application of the

concept of smart cities on the QoL of citizens is still insufficiently investigated, which is why the authors suggest further research in this area.

According to Ruhlandt (2018), research on smart cities lacks a systematic understanding of the different components of smart city governance, the metrics to measure these components. According to Meijer and Bolívar (2016) and Meijer et al. (2016), there is a need for the advancement of empirical research that provides answers and an academic understanding between technology and governance, the role of government leadership, participatory governance structures and collaborative media that promote development in a smart city.

In view of the above, this study aims to analyze the influence of Smart Governance factors on QoL in the context of smart cities, in the northeastern region of Brazil. In this sense, we defined five research hypotheses that measure the influence of Transparency (TRANS), Collaboration (CO), Participation and Partnership (PP), Communication (COM) and Accountability (ACC) on QoL in smart cities.

In addition to this introduction, this research divided into the sections of Theoretical Framework and Research Hypotheses, Method adopted for the development of the study, Results, Discussions developed and Conclusion of the research, as well as closes the contributions of this study to the public management and for academic studies.

2 Theoretical framework and research hypotheses

Before presenting the research hypotheses, it is essential to understand some vectors that have a direct influence on the development of Smart Cities, among which we highlight the evolution from the concept of "governance" to the concept of "Smart Governance".

Public governance, in its traditional way, can be conceptualized as the junction of laws, administrative rules, judicial positions, and rules that restrict, determine, and permit government activities (Lynn et al., 2000). Odendaal (2003) adds that the term governance in cities refers to how the local government will conduct its spaces to achieve the growth, distribution, and effective administration of public affairs. The role of governance dealt with the intention to comply with rules, which manage the proper functioning of public institutions.

However, traditional governance devalues the participation of society and the use of technologies. It is in these two large groups that the term "intelligent" collaborates, with the participation of society and the use of technology in its favor, a better quality of life is possible since the demands become social and not merely institutional. For this reason, Razagui and Finger (2018) emphasize that there is a need for the implementation of smarter governance systems that make increasing use of information and communication technologies (ICT),

seeking changes in sociopolitical culture of societies, improving the ways of taking decision making and implementation improvements in the daily lives of cities.

Not recently, in the mid-1990s, it was already stated that traditional modes of bureaucratic government would be replaced by new mechanisms, such as collaborative governance (Blanco, 2015). The barriers faced by smart cities go beyond the capacities of their entities' so-called traditionalism, requiring innovative forms of governance (Meijer et al., 2016; Bolívar, 2018).

In this sense, Wijs et al. (2016) argue that smart governance enables, with the help of ICT, the participation and collaboration of various actors in decision-making. For Meijer et al. (2016) This smart city governance makes use of new technologies and develops innovative governance combinations. Electronic platforms represent the use of information and communication technologies to encourage citizen participation in decision-making, improving the provision of information and services, enhancing transparency, accountability and credibility (Gil et al., 2019). It is thus showing the possibility of a collaborative link between Government and Society, with ICT as an ally. After all, the main goal of smart city governance is not just the use of new technologies, but the contribution of the urban environment that should focus on the community, network and participants (Meijer, 2016).

It is noteworthy that the success and the approach given to city governance will depend on the goals set by the political representatives, the party action, the exchange of experiences between government, social representations and citizens (Nesti, 2018)

In short, governance has been improved over time by receiving new features by coming up with smart governance that is the way government works with the participation of various stakeholders and the use of technology, bringing better citizen participation, public and private partnerships. Accountability, cost reduction, linkages between the spheres of power, government-directed efforts, and innovation in public service providing higher quality public service delivery and consequent quality of life. In this context comes Smart Cities, with the use of ICT to generate solutions for the improvement of urban life.

The term smart cities were initially used in the 1990s to refer to cities that used the new Information and Communication Technologies (ICT), which made their infrastructures more efficient (Albino et al., 2015). However, the concept of the smart city is not limited only to the diffusion of ICT, as well as to meeting the needs of people and the community (Kummitha and Crutzen, 2017). Therefore, according to Eger (2009), smart cities is a means to reinvent cities for a new economy and a society with clear and convincing community benefits. For Nam and

Pardo (2011), the smart city titration comprises a set of synergy factors, including technological solutions, with social, technical and environmental factors of the city.

In this perspective, smart cities are considered complex ecosystems, surrounded by innovation and creativity, aiming at the development of a sustainable environment and with better Quality of Life (QoL) for citizens (Capdevila and Zarlenga, 2015). For this reason, governments and public agencies are adopting policies and programs to achieve sustainable development, economic growth, better QoL for their citizens (Shen et al., 2018) and the creation of happiness (Ballas, 2013).

In 2013, the IEEE Smart City Initiative was created to develop a global network of cities, sharing experiences, and organizing the dissemination of knowledge of their respective ecosystems (IEEE, 2018b). An example of a city that integrates the vision of an intelligent city with QoL is Trento, in Italy, which presents characteristics of smart cities. Two key distinguishing features of the intelligent city are: (i) a tightly knit ecosystem made up of its university, research centers and local businesses that leverage a shared knowledge-based view; and, ii) a strong commitment by public bodies and strong, cohesive relationships that promote strong citizen engagement.

The QoL becomes a key element in the context of smart cities (Hall, 2000; Giffinger et al., 2007; Nam and Pardo, 2011; Thuzar, 2011). In this context, Hall (2000), Nam and Pardo (2011) and Thuzar (2011) emphasize that the efforts made for the sustainable development and economic growth of the city aim to offer improvements in the QoL for its citizens. Therefore, the concept of smart cities goes beyond technological issues, including the concern for the well-being of citizens, such as infrastructure for education and innovation, business-government partnerships, innovation and quality of services driven by citizens (Bibri and Krogstie, 2017).

In relation to the research hypotheses, the elements that represented smart governance (Transparency, Collaboration, Participation and Partnership, Communication, Accountability) and its influence on QoL were observed from the concepts described in Table 1.

Table 1
Sources and definitions of the constructs

Construct	Definitions
Transparency (TRANS)	Transparency appears as an instrument of citizen empowerment, helps in the fight against corruption and represents the commitment of public management with the dissemination of accountability and decision-making (Odendaal, 2003; Mooij, 2003; Nfuka and Rusu, 2010; Schware and Deane, 2003; Chourabi et al., 2012; Harisson et al., 2012).
Collaboration (CO)	It represents the collaboration of citizens in the search for solutions to the problems of the city, constant action and active participation with the government. Debating with the citizen, the problems of cities, the government

	tends to have more successful actions (Lam, 2005; Luna-Reyes et al. 2009; Chourabiet al., 2012; Harisson et al., 2012).
Participation and Partnership (PP)	The government can establish partnerships and partnerships with the private sector, educational institutions, communities and all public administration stakeholders. The partnerships with educational institutions, investing in technologies, generate skills for their use in the management of smart cities. Together with the private sector, partnership for the deployment of new technologies can improve the economy. Non-profit and socially-funded institutions benefit from the Participation and Partnership, which can promote social and technological advances (Odendaal, 2003; Giffinger et al., 2010; Chourabi et al., 2012; Harisson et al., 2012).
Communication (COM)	Communication between government and citizens tends to generate more transparency in decision-making. It is important to emphasize the importance of technologies that interconnect government and citizen so that communication is efficient (Odendaal; 2003; Chourabi et al., 2012).
Accountability (ACC)	Accountability relates directly to the commitment of the rulers to the management of money and public assets. In this sense, the government does not use political bureaucracies to evade its responsibilities and obtain its benefit. Therefore, it is up to the government to promote anti-corruption actions and ensure a smooth transition at the end of the elective mandates so that continuity can occur in projects in progress (Mooij, 2003; Johnston and Hansen, 2011; Chourabi et al., 2012).
Quality of Life (QoL)	Quality of Life in the context of smart cities is directly related to government actions to encourage interaction between public and private entities, with the goal of promoting sustainable development. Governors use technological innovations to offer services and products to citizens, which influence QoL. Government management can provide health, education and security services more transparently, more efficiently, through the joint work of government and citizens (Chourabi et al., 2012; Harisson et al., 2012).

The following is the theoretical basis that supports the research hypotheses for evaluating the relationships of the Transparency (TRANS), Collaboration (CO), Participation and Partnership (PP), Accountability (ACC), and Quality of Life (QoL) constructs.

2.1 Transparency and quality of life

Albino et al. (2015) emphasize that the design of a smart city has an impact on the QoL of citizens, promoting informed, educated and participative citizens. However, Schware and Deane (2003) emphasize that the citizen plays a fundamental role in the management of smart cities. In addition to exercising citizenship, the task of conducting data monitoring and management is made transparent by Transparency (TRANS). reductions for corruption. According to Odendaal (2003), TRANS in decision making allows for greater communication between government and citizens.

TRANS, participation and Collaboration (CO) are considered as relevant practices to produce a democratic environment, seeking the construction of policies aimed at an open

government (Harisson et al., 2012). For the author, TRANS with information and democracy are fundamental for citizen participation and action in decision making, because without information the citizen is unable to make the government comply with the collective will. Mooij (2003) states that TRANS contributes to the reduction of corruption, favoring the provision of satisfactory services to the population. Still, Khademian (1998) and Chourabi et al. (2012) emphasize that TRANS makes efficiency and effectiveness in city governance possible, resulting in satisfactory service delivery, ensuring the best social welfare, positively impacting citizens' QoL. Based on the assumptions found in the literature, the H1 hypothesis was developed.

H1: Transparency is positively related to Quality of Life in the context of smart cities.

2.2 Collaboration and quality of life

Thus, in addition to TRANS, the citizen's collaborative participation in decision-making processes is highlighted as being relevant to the governance of smart cities (Schware and Deane, 2003), strengthening the citizen's collaborative factor. According to Giffinger et al. (2010), citizen participation in decision making is one of the criteria to be considered for classifying a smart city, as well as public services, social services, transparent governance and political strategies. Engelbert et al. (2019) highlight the relevance of the role of citizens for the development of smarts cities, emphasizing their active participation in the governance process. For Dawes (2010), participation in decision-making occurs through the control and follow-up of the citizen, the measures employed by the government, ie, observations of actions, actions and decisions taken by the government in terms of Accountability (ACC).

Coadunando et al. (2011) extend the discussion by stating that smart cities emphasize investments in human and social capital, as well as the development of conventional and modern communication infrastructures. These actions aim at sustainable economic growth and improvement in QoL, through resource management and through participatory governance, which involves the CO of the people in the decision-making process. According to Scholl et al. (2009) and Chourabi et al. (2012) the capacity for cooperation among stakeholders is an indispensable factor for public management.

Therefore, the approach proposed by this new conception of city, is concerned with promoting the empowerment of citizens, through the collaborative context and the interconnection and systematization of the data used to improve society, transforming it into a healthy and happy environment (De Jong et al., 2015), in which people can learn and develop with better QoL (Machado Jr. et al., 2018).

Due to the participatory context, inserted in the governance of smart cities, the CO factor developed by citizens is highlighted, since city dwellers work collaboratively to follow up, formulate and implement the policies developed (Colldahl et al., 2013). For Capdevila and Zarlenga (2015), in the smart cities the different stakeholders, inhabitants of the ecosystem, are encouraged to collaborate in order to have a sustainable environment and an adequate QoL. However, Harisson et al. (2012) emphasize that for CO to effectively involve greater involvement, greater experience with the government, so that CO is efficient in government decisions and can contribute to improvements in social welfare. Based on the above, H2 hypothesis was established.

H2: Collaboration is positively related to Quality of Life in the context of smart cities.

2.3 Participation and partnership and quality of life

Smart city governance is considered capable of solving different urban problems, aiming at sustainable development and quality of life in the urban environment (Lee et al., 2013). To characterize a smart city, Participation and Partnership (PP) is considered a relevant attribute because it aims to improve the active participation of human and social capital (Caragliu et al., 2009; Dameri, 2013) emphasizing the empowerment of citizens, as a way to to support the decision-making process and to ensure the development of more participatory processes capable of responding to society's longings (Papa et al., 2015). Harisson et al. (2012), emphasize that the Participation and Partnership (PP) purposes are much larger than those already described, although not so evident. In this sense, Caragliu et al. (2009) emphasize that a city is considered smart when economic and sustainable growth is made possible by investments in human and social capital and ICT infrastructure, through participatory governance that results in a higher quality of life.

Public management becomes more efficient with the involvement of the population, through participation and partnership with other entities. According to Odendaal (2003), Participation and Partnership (PP) are indispensable for a Smart Governance, in which CO takes place between different spheres of government and the construction of public-private partnerships. According to Scholl et al. (2009), a key point for a good partnership in public management, is the good relationship between the stakeholders, through capacity for cooperation, leadership support, alliances structure and the possibility of acting in different jurisdictions, which refers the partnership between the spheres of municipal, state and federal government.

Awoleye et al. (2014) also defends PP as guidelines for the proper functioning of a safe and intelligent government, more specifically in the construction of a computerized government using ICT, and which recognizes that citizens, organizations and the government in their diverse spheres are interested in the proper functioning of this governance process, as well as this relationship between stakeholders is responsible for contributing to the maintenance of governability, following the requirement of equity, that is, independent of their own interests, treating the elements that compose it as property public and non-exclusive. Corroborating the discussion, Koppenjan and Enserink (2009) point out that this process of cooperation between public and private sectors is an important source for the achievement of the goals and objectives for the provision of public services, with higher quality.

The management of natural resources through participatory politics and the pursuit of sustainable economic development, aid in the development of QoL (Thuzar, 2011). The relationship between QoL and participation is reinforced through the affirmation of Caragliu et al. (2011), which emphasizes that a city is smart when investments in human and social capital, as well as the traditional (transportation) and modern (ICT) communication infrastructure, together drive sustainable economic growth and high QoL, with a management of natural resources, through participatory governance. As Meer and Wilden (2003) emphasize, when they emphasize the participation of the citizen as central points of the smart cities. Accordingly, Giffinger et al. (2010) listed participation in decision making as one of the requirements for good governance. However, CO, according to the study by Harisson et al. (2012) is more responsive and requires a greater degree of experience for their participation in the decision-making process of government entities.

In this way, PP relates to the QoL of the citizens, considering that it offers several benefits, such as economic development, social services, infrastructure and others (Bonu, 2004; Evdorides and Shoji, 2013). In view of the above, the hypothesis H3 was elaborated.

H3: Participation and Partnership is positively related to Quality of Life in the context of smart cities.

2.4 Communication *and quality of life*

Communication is considered a relevant factor for the governance of smart cities, emphasizing that communication is relevant because of its emphasis on community participation (Chourabi et al., 2012). According to Odendaal (2003), it is through

communication that a continuous dialogue takes place between governments and their constituents, also reinforcing the element of partnership between government and citizens.

According to Maheshwari and Janssen (2014) it is through channels created by communication that it becomes possible to connect citizens with public organizations that collaborate, cooperate and coordinate among themselves and make use of private companies to solve social problems.

Communication is used by technology to be associated with the citizen, for this reason Scholl et al. (2009) warn that from the users '/ citizens' point of view, skills or awareness of how to access and treat information may be lacking in some moments, as well as, the use of ICT should be facilitated effectively and efficiently. Odendaal (2003) points out that it is interesting that ICTs are seen as more than a simple CO tool, but also as socio-cultural benefits, as this will be incorporated correctly in society. For, the use of ICTs in government is characterized as a powerful strategy of administrative reform (Luna-Reyeset al., 2007).

In this context, Capdevila and Zarlenga (2015) point out that the CO provides a means of democratizing citizens' capacity for insertion, considering that citizens have the capacity to participate in the innovative process developed in the city in which they live, seeking to guarantee a service delivery to society effective and consequently enabling better QoL.

Considering that the communication process is an indispensable element within the formation of smart cities and that this new way of thinking the structures of a city seeks to collaborate with the Qol of its citizens, the H4 hypothesis emerges.

H4: Communication is positively related to Quality of Life in the context of smart cities.

2.4 Accountability and quality of life

Among the elements involved in achieving satisfactory governance is the accountability of the governor, defended by Mooij (2003) as one of the goals of governance in smart cities to use ICT, to boost the accountability of managers, thereby reducing corruption. Chourabi et al. (2012) emphasize that Smart Governance depends on the implementation of an infrastructure strategy that must be responsible. According to Sayer (2000), the state is responsible for its management, for securing the future of later generations. According to Shen et al. (2018), investment in smart infrastructure, training programs, and evaluation mechanisms should be increased.

Thus, through managerial ACC, efficient governance becomes possible, enabling economic development, improved well-being and QoL (Coleman, 1990). Healey (2006) adds

that the manager responsible for improving the QoL of cities reduces the inequalities in access to the various urban services. Based on the above, the hypothesis H5 was developed.

H5: Accountability is positively related to Quality of Life in the context of smart cities.

Fig. 1 represents the theoretical model proposed, with the constructs, observable variables and hypotheses of the research with the relations of influence between the constructs. The Measurement Model, formed by the observable variables of each construct, is composed of affirmations based on the literature consulted (Table 2), as well as the constructs conceptualized in Table 1. The Structural Model, which measures the relations between the constructs, expressed in hypotheses of research, was developed based on the literature, in which the theoretical model proposes a causal relationship and influence among the constructs.

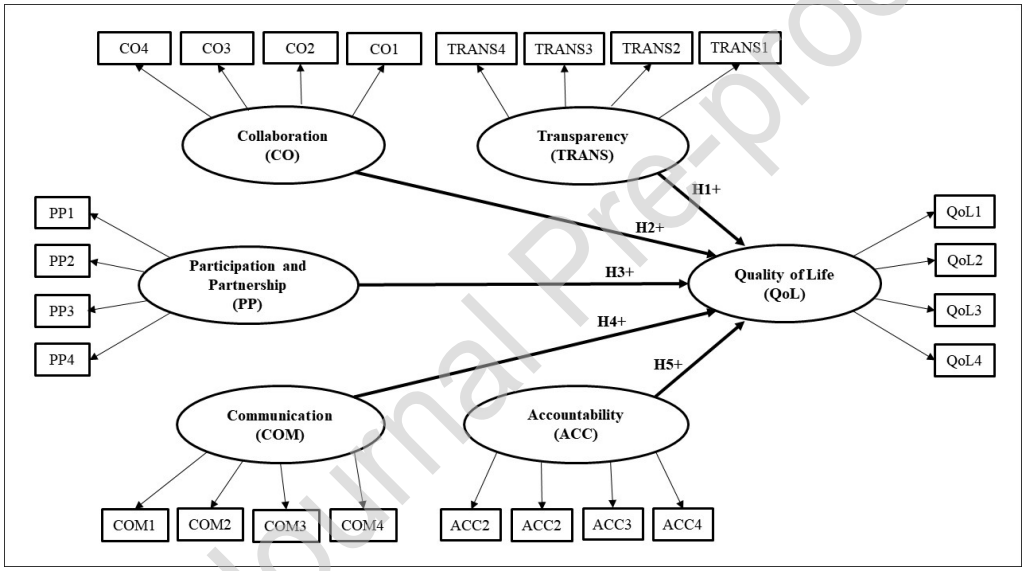

Fig. 1. Theoretical model proposed - Framework

Based on the research findings and based on the theoretical assumptions that support this study, the measurement model and structural model were validated and tested using Multivariate Data Analysis techniques, which described in the Method section.

3 Method

This study can be characterized as a descriptive, quantitative survey, which proposes to analyze the influence between public governance and quality of life in the context of smart cities. For this, we used the technique of structural equation modeling (SEM), as advocated by

Hair Jr. et al. (2010) this is a methodology able to observe relations of dependence between observable variables and latents, as well as the relationships between latent variables (constructs). The observable variables form the latents variables, through Confirmatory Factorial Analysis (CFA), so the SEM technique is able to form paths of relation and influence between the formed constructs (Hair Jr. et al., 2010; De Guimarães et al., 2018).

The survey sample was obtained in a random and non-probabilistic manner (Hair Jr. et al., 2010). Respondents were approached in person, through e-mail and through social media using an electronic form. For the online data collection, the Snowball method was used, in which the electronic form was initially sent to the researchers' contacts, which later sent them to other respondents. The Snowball method used as a way to obtain a larger and more homogeneous sample, in which the researcher sends the invitation to some respondents to participate in the research and this pass the invitation to other respondents (Hair Jr. et al., 2010; Severo et al., 2018).

For each observable variable of the study, 34.5 respondents were obtained, demonstrating that the sample size is representative for the study, since according to Hair Jr. et al. (2010) for each observable variable of the study is necessary 10 respondents, as well as exceeds the minimum suggested by Hair Jr. et al. (2010) and Kline (2011) from 200 to 400 respondents for the application of SEM.

The focus of research were the citizens of the city of Natal, located in the state of Rio Grande do Norte (RN), Brazil. This city was selected for the application of the survey because it is the only city in Brazil to be affiliated with the IEEE Smart Cities Initiative (IEEE, 2018a). Noting the growing demand from cities for smart and sustainable environments that offer citizens a high quality of life, the IEEE argues that an Intelligent City brings together technology, government and society, and includes but is not limited to the following: smart energy, intelligent mobility, intelligent environment, intelligent life and intelligent governance (IEEE, 2018a;2018b).

IEEE Smart Cities Initiative's mission is to be recognized as the official voice and the main source of credible technical information and educational content within the scope of smart cities, facilitating and promoting the collaborative and individual work of its Member Societies in relation to smart city technology, elaborating standards of use of these technologies (IEEE, 2018a; 2018b). The city, as a member of the IEEE Smart Cities Initiative, demonstrates its interest in using best technical practices in the innovation process of its public services.

Based on the precepts of the IEEE Smart Cities Initiative (IEEE, 2018a; 2018b) the city of Natal aims to become a smart city through the development of systems and applications to

reinforce the use of ICT as a way to contribute to improving citizens' quality of life (Cacho et al., 2016). The Natal initiative as a smart city is represented locally by the Natal Smart City and Human Program.

Also, in the metropolitan region of Natal, the municipality of São Gonçalo do Amarante, develop the Smart City Natal project, which is considered the second smart and social city in Brazil. Seeking to provide a better quality of life for people, the project enhances the use of connectivity and sustainability in a collaborative way, creating spaces and opportunities for citizens to interact with the city. Private sector investment in the region reinforces its potential to become a smart city model.

Other projects have been developed in the city of Natal, in partnership with the Metropolis Institute of Development, an example is the unique registration "Multifinality", which will allow the integration of data of all citizens. Together with the Security Secretariat, the Smart Hotspot has been developed, which, through the provision of data, allows prediction of crimes.

Social media has also been used as a way of interacting and seeking, with the citizen, better services and solutions to the city's problems, according to Paletti (2016) behind the co-production of services. Of public service production that matches your aspirations and current collective ideas. Based on the strategic importance of the city of Natal, in the context of northeastern Brazil, it was defined as the primary source for conducting research data collection.

To collect information from the survey, the data collection instrument used was a questionnaire containing the profile of the respondents and a survey of closed questions (affirmative), evaluated using the Likert scale of five points (1 strongly disagree; 2 disagree; 3 neither disagree nor agree; 4 agree; 5 strongly agree). The questionnaire used to collect the research information was previously validated by three experts from the smart city area and in the application of the SEM methodology. We highlight the experts for the validation of the instrument of data collection, which were chosen using the criteria of being a researcher, with publications in relevant journals in the area of smart city and that dominated statistical techniques of multivariate data analysis, among them the SEM. After the adjustments suggested by the experts, the questionnaire was elaborated. For the formulation of the questions, the elements responsible for the existence of good public governance (Smart Governance) were identified, as shown in Table 2.

Table 2
Constructs and observable variables

Transparency (TRANS)	
TRANS1) The constant sharing of information with citizens generates greater transparency in government decision-making. TRANS2) The use of technology assists in the transparency of government actions. TRANS3) The transparency of government information and actions is a tool that helps reduce corruption. TRANS4) The transparency of government information and actions is an instrument for the empowerment of citizens.	Khademian (1998), Odendaal (2003), Mooij (2003), Schware and Deane (2003), Chourabi et al. (2012), Harisson et al. (2012), Albino et al. (2015).
Collaboration (CO)	
CO1) The collaboration of the citizen with the government is an important tool to implement actions that generate quality of life. CO2) Government that debates with citizens about solutions to the city tend to have more successful actions. CO3) Citizen participation in the definition of the government budget is an instrument of collaboration with the government. CO4) Active community leadership is a tool for representing citizens for effective direct collaboration with the government.	Schware and Deane (2003), Scholl et al. (2009), Haindlwair and Kramar (2010), Dawes (2010), Del Bo and Nijkamp (2011), Chourabi et al. (2012), Colldahl et al. (2013), Harisson et al. (2012), Capdevila and Zarlenga (2015), Jong et al. (2015).
Participation and Partnership (PP)	
PP1) Partnerships with educational institutions, investing in technology, generate skills for their use. PP2) Partnerships with the private sector to implement new technologies can improve the economy. PP3) The participation of third sector entities (Non-Governmental Organizations - NGO, association, cooperative, religious institutions and etc.) are important for the implantation of solutions in the cities, from social advances to technological advances. PP4) The partnership between the spheres of municipal, state and federal government, exempt from partisanship, is important for the implementation of integrated and technological solutions for the advancement of cities.	Meer e Wilden (2003), Odendaal (2003), Bonu (2004), Scholl et al. (2009), Koppenjan and Enserink (2009), Giffinger et al. (2010), Thuzar (2011), Chourabi et al. (2012), Harisson et al. (2012), Evdorides and Shoji (2013), Awoleye et al. (2014).
Communication (COM)	
COM1) Communication between government and citizen creates transparency in decision-making. COM2) The use of technology generates more efficient communication between government and citizen. COM3) Tools that carry out communication between government and citizen should be prioritized. COM4) Social networks are practical, accessible and useful tools in the solution for communication between government and citizen.	Odendaal (2003), Scholl et al. (2009), Luna-Reyes et al. (2007), Chourabi et al. (2012), Maheshwari and Janssen (2014), Capdevila and Zarlenga (2015).
Accountability (ACC)	
ACC1) Greater transparency in government actions prevents it from relinquishing its responsibilities ACC2) The responsible commitment of the government reflects in the improvement of the public administration. ACC3) It is government accountability to reduce corruption in its managements. ACC4) It is the accountability of the government to make a good transition between governments at the end of the elective mandates, in order to continue the ongoing projects.	Coleman (1990), Sayer (2000), Mooij (2003), Healey (2006) e Chourabi et al. (2012).
Quality of Life (QoL)	
QoL1) Strengthening the link between public power and private initiative makes barriers break, brings an innovation that is important for everyone's life, evolving throughout society. QoL2) The technology, with security solutions, cloud services, and big data, is the instrument that will enable to offer better products and services to the citizen and the management. QoL3) Transparency and efficiency improve tax return on basic services such as health, education, and security for citizens.	Chourabi et al. (2012), Harisson et al. (2012)

QoL4) The valorization of joint work between government and citizen, with the aid of technology, allows prioritizing actions that directly impact the quality of life of citizens.

Data collection occurred from July/2018 to January/2019. Initially, a pre-test was performed with 30 respondents to evaluate the comprehension of the questionnaire's statements. Subsequently, the pre-test responses were incorporated into the final sample because no difficulties were identified and no answers were given to the questionnaire. In the data purification process, 42 cases were eliminated by responses focusing on a single alternative on the five-point Likert scale, where they were considered univariate outliers. In the cleaning process, 51 cases were considered, considering multivariate outliers, since they presented farthest observations from the centroid based on Mahalanobis Distance parameters (Maesschalck et al., 2000). The final sample consists of 829 valid cases, which exceeds the recommendation of Hair Jr. et al. (2010) and Kline (2011), as an adequate quantity for the application of the data analysis through SEM. Multivariate data analysis was developed using SPSS® software (v21) for Windows® and AMOS® software (v21).

Initially the combination of observable variables was constructed in their respective constructs, this step was developed through the theoretical background and Confirmatory Factorial Analysis (CFA), for which the following validation parameters were followed (Hair Jr. et al., 2010; Marôco, 2010): i) Cronbach's Alpha (> 0.6); ii) Kaiser-Meyer-Olkin (KMO) (> 0.5); iii) Bartlett's test of sphericity (p <0.05); iv) Factorial load (= or> 0.5); v) Communality (= or> 0.5).

Based on the precepts of Fornell and Larcker (1981), Byrne (2010), Severo et al. (2017) and De Guimarães et al. (2016), in the SEM process, the scale evaluation was initially assessed using the Composite Reliability tests (values greater than 0.7 is considered the appropriate scale) and the hypotheses of the study were evaluated through Unstandardized Estimates (UE) and Standardized Estimates (SE), where the UE test is checked at the level of significance (p<0.05) and in the SE test it is considered as parameter values from 0.0 to 0.299 low intensity, 0.3 to 0.499 moderate intensity and values higher than 0.5 high ratio intensity.

To evaluate the structural model, considering the simultaneous relations made possible by the SEM, the values of the adjustment indices of the model indicated by Tanaka and Huba (1985), Bollen (1989), Bentler (1990), McDonald and Marsh (1990), Browne and Cudeck (1993), Hair Jr. et al. (2010) and Severo et al. (2018): i) Chi-square value divided by the degree of freedom (equal to or less than 5); ii) Comparative Fit Index (IFC): interval from 0 to 1, and values close to 1 indicates a very good fit); (iii) Normed Fit index (NFI): models with global fit

indices below 0.9 can usually be improved substantially; iv) Goodness of Fit Index (GFI): interval from 0 to 1, and values close to 1 indicates a very good fit; v) Adjusted Goodness of Fit Index (AGFI): the minimum value is not limited to 0 and 1; vi) Root Mean Squared Error of Approximation (RMSEA) (between 0.05 and 0.08). It should be noted that the adjustment indices of the model evaluate the quality of the structural model and indicate possibilities for improvement, but can not be used as a parameter for the evaluation of the hypotheses.

4 Results

Based on the questions on the characterization of the respondents of the research (Table 3), it is observed that the female gender represents the majority of the respondents in 57.5%. Regarding the level of education, it should be noted that most respondents have higher education (64.3%) and postgraduate (23.6%), indicating that the higher education level of the respondents, with higher formal education, academic skills to infer judgment on the elements that makeup Smart Governance and influence on Quality of Life (QoL).

Concerning the age of respondents, the majority of respondents are between 19 and 33 years old (68.8%) and between 34 and 53 (26.3%), showing that the majority are adults, with at least leads us to infer that this public possesses a maturity and capacity to understand the changes necessary to build a smarter city, since being this age group experienced one of the key elements of the smart city proposal that is the intense use of ICT, as well as other technological and socioenvironmental innovations.

Table 3
Descriptive statistics

Gender	**Frequency**	**Percentage (%)**
Female	447	57.5
Male	352	42.5
Total	829	100
Academic education	**Frequency**	**Percentage (%)**
Elementary School	1	0,1
High school	56	6.8
Higher Education	533	64.3
Specialization (Postgraduate)	196	23.6
Postgraduate (Master's)	35	4.2
Postgraduate (Doctorate degree)	8	1.0
Total	829	100
Age of respondents	**Frequency**	**Percentage (%)**

Up to 18 years	15	1.8
Between 19 and 33 years	570	68.8
Between 34 and 53 years	218	26.3
Between 54 and 73 years	26	3.1
Total	829	100

In the analysis of the data, based on the literature, it was verified the formation of observables latents (constructs) with the interaction of observable variables. The proposed model (Fig. 1) presents five constructs that makeup the elements of Smart Governance: i) Transparency (TRANS); ii) Collaboration (CO); iii) Participation and partnership (PP); (iv) Communication (COM); v) Accountability (ACC). Also, the proposed model measures the relations of the elements of Smart Governance over QoL.

For the formation of the constructs, the theoretical basis of the studies indicated in Table 2 and in the description of the research hypotheses was used. To verify the feasibility of the data set and the validation of the scale, the Confirmatory Factorial Analysis (CFA) was applied.

It is observed in Table 4 that the results indicate a high agreement of the respondents on the affirmative (observables variables) of each construct, noting that only in the variable ACC1 the answers obtained an mean of 3.854 and standard deviation 1.2775, since all in all other variables the mean response is greater than 4.0 and the standard deviation is less than 1.0. These results indicate that among the respondents there is a high agreement and low variability. The evaluation of means and standard deviation indicates that great importance is perceived in the elements that makeup Smart Governance (TRANS; CO; PP; COM; ACC) and QoL.

The scale (Table 4) composed of the observable variables that formed the constructs was measured by means of the general data consistency, normality, simple reliability and composite reliability of the constructs and the totality of observable variables. For this, the following parameters were evaluated:

a) The overall consistency of data: The KMO of all observable variables resulted in 0.943. The KMO results in intrablocks analysis, in the constructs, presented values higher than 0.6. These results are above that recommended by Hair Jr. et al. (2010) and Marôco (2010).

b) Simple reliability: The result of Cronbach's Alpha presents the value of 0.907 in the analysis of all observable variables. The Cronbach's Alpha of the observable variables of the constructs TRANS, CO, PP, COM, and QoL resulted in values greater than 0.6, which meets the recommendation of Hair Jr. et al. (2010) and Marôco, (2010), but the ACC variables obtained Cronbach's Alpha value of 0.493, which indicates the need for scale improvement. It is worth noting that the scale can

be improved by adjusting the affirmative or exclusion text of the variable ACC1, which presents the lowest Factorial load (0.419) and Communality (0.175), however, for this study, it was decided to maintain the variable, since this contributes to the theoretical understanding of the construct.

c) Normality of data: Bartlett Sphericity Test, which evaluates the overall significance of all correlations in a data matrix (Hair Jr. et al., 2010). The test results presented significant values ($p>0.001$), which refutes the hypothesis that the data are not normal.

d) Composite Reliability: to measure composite reliability, the calculation proposed by Fornell and Larcker (1981), with the precepts of Byrne (2010), Severo et al. (2017) and De Guimarães et al. (2016). The results of the composite reliability of all variables show the value of 0.944 and of the variables of the constructs TRANS, CO, PP, COM, and QoL with values higher than 0.7. It is noteworthy that only the ACC variables resulted in the value of 0.685, which was influenced by the ACC1 variable.

Table 4
Confirmatory Factorial Analysis

Observable Variables	Factorial Loads [a]	Communality	Mean	Standard Deviation	Cronbach's Alpha	KMO	Composite Reliability
Transparency (TRANS)							
TRANS1	0.673	0.453	4.304	0.7935	0.707	0.748	0.798
TRANS2	0.752	0.566	4.312	0.7422			
TRANS3	0.734	0.583	4.467	0.7159			
TRANS4	0.762	0.581	4.311	0.7737			
Collaboration (CO)							
CO1	0.691	0.477	4.413	0.7197	0.605	0.676	0.709
CO2	0.760	0.578	4.505	0.6678			
CO3	0.675	0.455	4.174	0.7825			
CO4	0.589	0.347	4.318	0.8030			

Participation and partnership (PP)							
PP1	0.766	0.586	4.622	0.6620	0.698	0.732	0.794
PP2	0.797	0.636	4.356	0.7971			
PP3	0.677	0.459	4.218	0.8523			
PP4	0.666	0.443	4.509	0.7183			
Communication (COM)							
COM1	0.706	0.498	4.627	0.6273	0.604	0.685	0.711
COM2	0.754	0.569	4.458	07338			
COM3	0.674	0.454	4.396	0.7390			
COM4	0.584	0.341	4.090	0.8500			
Accountability (ACC)							
ACC1	0.419	0.175	3.854	1.2775	0.493	0.631	0.685
ACC2	0.749	0.561	4.626	0.6521			
ACC3	0.684	0.468	4.491	0.7431			
ACC4	0.779	0.607	4.601	0.6321			
Quality of life (QoL)							
QoL1	0.632	0.399	4.110	0.9562	0.607	0.697	0.723
QoL2	0.674	0.454	4.014	0.8666			
QoL3	0.694	0.482	4.524	0.7179			
QoL4	0.746	0.556	4.606	0.6178			

[a] intrablocks analysis

In the Confirmatory Factorial Analysis (CFA) intrablocks analysis, using the principal components method, it measured the Factorial load and Communality expressed in Table 4. The CFA calculation of all variables resulted in 48.9% explanation of variability of the data, as well as (46.4%), COM (46.6%), ACC (45.3%) and QoL (46.3%) presented the significant and important values for the validation of the scale and constructs.

The results of the Factorial load show in Table 4 that only the ACC1 variable has a value lower than 0.5 recommended by Hair et al. (2010). The Communality calculation identified variables (TRANS1, CO1, PP3, PP4, COM1, COM3, COM4, ACC1, ACC3, QoL1, QoL2, QoL3) with values less than 0.5. These results indicate that these variables are poorly correlated with the other variables, which according to Hair et al. (2010) may be a statistical criterion of exclusion of the variable, however, the variables were maintained by the importance in the theoretical explanation of the constructs.

The evaluation of the general consistency of the data, normality, simple reliability, composite reliability and the results of the CFA, evidenced data viability for structural equation modeling (SEM). Figure 2 shows the SEM results of the proposed model, considering the measurement model and the structural model, with the construction of the constructs by the

observable variables and the relations of influence between the constructs (path analysis) that graphically express the hypotheses of the search.

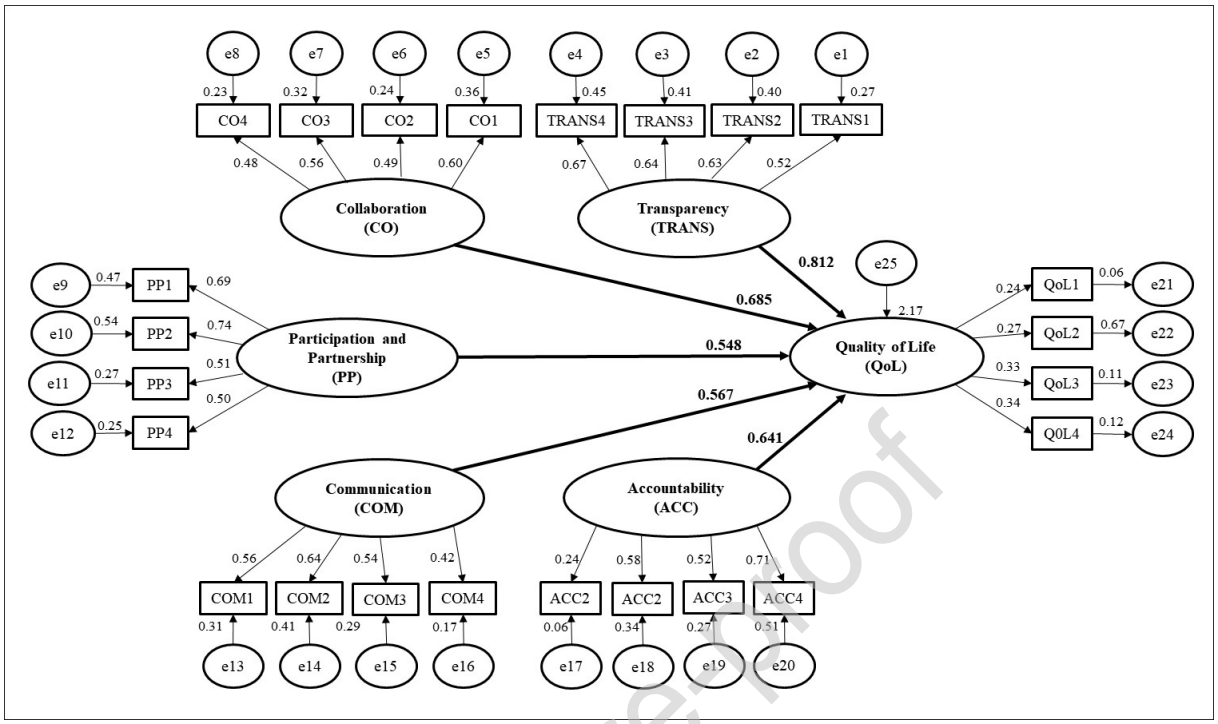

Fig. 2. Integrated model - Framework

Table 5 presents the results of the Unstandardized Estimates (UE) and Standardized Estimates (SE) hypothesis tests, which assess the influence relationships of the elements of Smart Governance on QoL. It is observed that the SE and UE values are positive and statistically significant. The relationship between the constructs TRANS→QoL (H1), CO→QoL (H2), PP→QoL (H3), COM→QoL and ACC→QoL (H5) show high influence relationships because SE values are greater than 0.5.

Table 5
hypothesis tests

	Constructs			Integrated model	
				Unstandardized Estimate (UE)	**Standardized Estimate (SE)**
H1	Transparency (TRANS)	→	Quality of life (QoL)	0.323	0.812
H2	Collaboration (CO)	→	Quality of life (QoL)	0.441	0.685
H3	Participation and partnership (PP)	→	Quality of life (QoL)	0.314	0.548
H4	Communication (COM)	→	Quality of life (QoL)	0.331	0.567
H5	Accountability (ACC)	→	Quality of life (QoL)	0.350	0.646

Significance level $p < 0.001$

The results of the hypothesis tests prove that the elements that makeup Smart Governance strongly influence the QoL of the citizens. The results of SE and UE show that the theoretical model (Fig. 1), with the research hypotheses, was supported.

In order to evaluate the quality of the structural model and the measurement model, we used the results of the adjustment indices of the model: i) Chi-square value divided by the degree of freedom with a value of 12.9; ii) CFI=0.544; iii) NFI=0.526; iv) GFI= 0.708; v) AGFI=0.645; vi) RMSEA=0.12. These results indicate that the integrated model can be improved, with the exclusion of some variables using statistical criteria. It should be noted that the validation tests of the scale, CFA and hypothesis tests confirm the hypothesis of research.

As additional research, the database was used to evaluate the interaction between the constructs, using the SEM methodology to measure the correlation between constructs, in which the estimates of correlations among exogenous variables, expressed in SE values (Table 6).

Table 6
Correlation between constructs - Estimates of correlations among exogenous variables.

			Standardized Estimate (SE)
Transparency (TRANS)	←→	Quality of life (QoL)	0.876
Collaboration (CO)	←→	Quality of life (QoL)	0.824
Participation and partnership (PP)	←→	Quality of life (QoL)	0.732
Communication (COM)	←→	Quality of life (QoL)	0.858
Accountability (ACC)	←→	Quality of life (QoL)	0.458
Transparency (TRANS)	←→	Communication (COM)	0.981
Collaboration (CO)	←→	Participation and partnership (PP)	0.930

Significance level $p<0.001$

The results indicate that there is an important correlation between the constructs. It should be noted that TRANS, CO, PP, COM, and ACC are positively correlated to QoL, which contributes to the confirmation of the hypotheses of the research and proves that when the elements of governance are identified by the respondents, simultaneously there is the perception of higher QoL.

Another key aspect of these results is the identification of a high correlation between TRANS and COM, showing the need for Smart Governance to work to promote transparency in conjunction with communication actions. Also, a high correlation between CO and PP was identified, proving that Smart Governance will be more successful in QoL if this form combined with the actions of CO and PP, as a form of involvement of the different stakeholders.

5 Discussion

The results of the integrated model (Fig. 2) present relevant findings regarding the influence of Smart Governance on the Quality of Life (QoL) in the context of smart cities, regarding the aspects of Transparency (TRANS), Collaboration (CO), Participation and Partnership (PP), Communication (COM) and Accountability (ACC), in the public perception.

Hypothesis tests indicate that QoL is dependent and directly influenced by the elements that makeup Smart Governance. The results show that Transparency has a high influence on QoL in the context of smart cities (SE=0.812), since transparency makes efficiency and effectiveness in city governance possible, resulting in satisfactory service delivery, influencing the better social welfare, positively impacting the QoL of the citizens, which corroborates with the studies of Khademian (1998) and Chourabi et al. (2012).

The Collaboration construct presented an intense positive relation over the QoL (SE = 0.685). This result can be explained, in part, by the involvement of people in the governance process and the encouragement of citizens' CO, which can enable a sustainable environment in which people are agents of change, capable of collectively contributing to the promotion of improvements in social well-being and adequate QoL, as evidenced by studies by Capdevila and Zarlenga (2015) and Harisson et al. (2012). The empowerment of citizens in the decision-making process and in the construction of the smart city boosts the benefits because it is the inhabitants of the city who know the demands and can indicate effective solutions to the urban problems.

On the PP construct, it was also possible to confirm the high intensity in the positive relationship of influence on the QoL in the smart city (SE=0.548), which corroborates with the studies of Bonu (2004) and Evdorides and Shoji (2013), highlighting that the PP relates to the QoL of the citizens, because PP offers several benefits, such as economic development, social services, infrastructure, and others. Smart Governance can enhance the results of public resources with the association between private and non-governmental entities. The results of this research indicate that citizens believe the relationship between public and private institutions can generate significant benefits for the population of the smart city.

The hypothesis test confirmed the positive relationship between COM and QoL (SE=0.567), which is supported by the study by Capdevila and Zarlenga (2015), which states that COM facilitates the democratization of citizen insertion capacities, the participation in the development of the city, which improves the guarantees of the effective provision of public services to society, and consequently enabling a better QoL.

It was observed that ACC is positively related to QoL in the context of smart cities (SE=0.646), because it is through the ACC of the public manager, that efficient governance

becomes possible, enabling economic development, wellbeing and to QoL, corroborating with the studies of Coleman (1990) and Healey (2006). The ACC is the main driver of public management, because in this concept are involved the values of honesty, commitment to public resources, reduction of corruption and the concern to continue with strategic government projects, which go beyond party ideologies to the benefit of QoL of the population.

Based on the results of the research, it can be said that aspects of Transparency (TRANS), Collaboration (CO), Participation and Partnership (PP), Communication (COM) and Accountability (ACC) in the context of smart cities positively affect Quality of Life (QoL) in the perception of citizens. In this context, it is verified that the researched constructs and observable variables measured in this research contribute to improving the governance process of the cities, which improves the conditions of the social context of the cities, allowing greater socialization among the people and more significant commitment of the managers public, which results in the well-being of the population, making people happier, healthier, friendlier and more loving.

The findings of the research are in line with the studies proposed by Meijer and Bolívar (2016), Meijer et al. (2016) and Capdevila and Zarlenga (2015), when the authors emphasize that the idea of a smart city contributes to the development of policies that contribute to a better society, and consequently to improvements in the quality of life of citizens. It is noteworthy that the basis of smart cities is the combination of human capital, social capital, information and communications technology infrastructure, in order to generate economic development, improve well-being and quality of life (Capdevila and Zarlenga, 2015; Dumay, 2016). In this perspective, the research demonstrated that QoL is a fundamental goal for the sustainable development of smart cities (Hall, 2000; Giffinger et al., 2007; Nam and Pardo, 2011; Thuzar, 2011), which will be reached by the correct application of public resources and the efficiency of the application of the elements that makeup Smart Governance.

The application of multivariate data analysis, the use of statistical techniques for the validation of the scale, tests to evaluate the measurement model and the structural model, allow to affirm that hypotheses of the research were confirmed.

It is noteworthy that the study was limited to evaluate some aspects and variables that make up each construct, considering that there are other relevant aspects that interfere with the quality of life, in the context of smarts cities. Among the limitations of the study is the geographical scope, since the study is restricted to the citizens of the city of Natal, although this was chosen by the criterion of being the only Brazilian city to participate in the IEEE (2018a) Smart Cities Initiative. Another aspect of the research limitations is related to the use of the

Likert type scale (discrete scale), which can lead to response biases such as the Halo effect, which is expressed by misleading generalization, which has been minimized with the use of outliers elimination univariate and multivariate analyzes, as well as the statistical tests used in the research.

6 Conclusion

Based on the assumption that smart city's goal is to improve Quality of Life (QoL), the main contribution of this study is in confirming that QoL is influenced by the elements of Smart Governance. The results of the integrated model bring relevant findings regarding the influence of public governance on QoL in the context of smart cities, under the aspects of Transparency (TRANS), Collaboration (CO), Participation and Partnership (PP), communication and Accountability), which are positively related to QoL in the perception of citizens.

Among the findings of the research, it is worth mentioning that TRANS has the highest influence relation over QoL (SE=0.812) and among the others analyzed, it was the one that showed the greatest influence. This result highlights the importance of government sharing information with the use of ICT to contribute to reducing corruption and increasing the empowerment of citizens.

As the study works from the perspective of the citizens, the managerial contribution of this research is centered in the identification of strategic drivers that can help the smart city rulers in the development of public policies and actions of the municipal executive that involves the population, from the perspective of the elements which makes up Smart Governance, to improve QoL.

In relation to contributions to academic studies and to the advancement of science, this research collaborates, through a proposal of scale (Table 2), based on the perspective of the citizen, to build a Smart Governance, theoretically supported and statistically validated, contributing to the continuity of the studies on public governance, as a main vector for the support of smart city and promotion of QoL.

Based on the results and findings of the research, we suggest future studies that investigate issues related to the identification of other factors that influence public governance over QoL in the context of smart cities. Another important aspect is to investigate the programs and policies that the governments of smart cities use to operationalize the actions of TRANS, CO, PP, CO and ACC, in order to improve QoL. Another perspective for the development of new studies, refers to the analysis in other regional contexts, since the structural context of the city is a relevant factor for the practices of smart cities.

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