Journal of Cleaner Production 182 (2018) 717–726

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Smart city and quality of life: Citizens' perception in a Brazilian case study

Janaina Macke [a, *], Rodrigo M. Casagrande [b], João Alberto R. Sarate [c], Kelin A. Silva [d]

[a] University of Caxias do Sul (UCS), IMED Business School, Brazil
[b] ISAE (FGV), Paraná, Brazil
[c] IMED Business School, Brazil
[d] IMED Health School, Brazil

ARTICLE INFO

Article history:
Received 18 December 2016
Received in revised form
31 January 2018
Accepted 8 February 2018
Available online 10 February 2018

Keywords:
Smart city
Quality of life
Citizens' perception
Curitiba

ABSTRACT

Smart cities attract considerable attention from academics and urban planners mainly in the context of urban development policies. Based on technological innovations, smart cities are complex ecosystems that have the potential to improve urban livability, workability and sustainability through a network of people, processes and data. However, according to academics and urban planners the smart city concept favors technological products and solutions over end users and their quality of life. This perspective calls for an integrated analysis approach that considers the smart city as an organic whole, which encompasses objective and subjective quality of life domains (QOL). This paper aimed to evaluate the perception of quality of life in a smart city and to analyze the main elements of citizens' satisfaction with their home city. The research analyzed the city of Curitiba, in Southern Brazil, claimed to be a livable, green, and inclusive city and one of the ten smartest cities in the world. Interviews with 400 residents identified four main QOL domains: socio-structural relationships, environmental well-being, material well-being and community integration. The respondents' overall perception revealed their low satisfaction with the main elements that characterize Curitiba as a smart city. This finding calls for a better understanding of the planning and management of smart cities in conjunction with the QOL elements and their effects on citizens. The research provides some contributions to understand the interconnected facets of QOL domains in the Smart Cities context. From a smart city perspective, the research concludes that success within the domain of smart living can be achieved by providing the four factors revealed by the analysis. According to our results, meeting these criteria of success would improve citizen's quality of life, creating a stronger community within the city. Finally, the study provides relevant information for social researchers and urban planners by identifying factors that influence QOL perceptions and providing elements for political and academic debate.

1. Introduction

The 1987 Brundtland Commission's Report, 'Our Common Future', of the World Commission on Environment and Development (WCED) unveiled the need to break with a development paradigm focussed exclusively on economic aspects. The document discusses actions and strategies for sustainable development that ensure economic, social and environmental balance and equity (WCED, 1987).

The United Nations warns about the deadly clash between growing urbanization and climate change and unprecedented natural disasters caused by the huge impact of cities on the environment. The main challenge is that cities must act immediately to take measures to reduce greenhouse gas emissions and promote more environmentally sustainable and fair urban development (UNEP, 2016). Cities occupy only 4% of the Earth's surface, but consume 67% of energy and account for 70% of greenhouse gas (GHG) emissions (European Union, 2011).

Urbanization is expected to continue with around 60% of world population living in cities, in 2030 (UNEP, 2014). Almost all future population growth will be in urban areas – usually in expansion of slums (UNDESA, 2015) -, which enhance the key role of cities in addressing climate change.

* Corresponding author.
E-mail address: janaina.macke@imed.edu.br (J. Macke).

https://doi.org/10.1016/j.jclepro.2018.02.078
0959-6526/

On the other hand, cities are the source of innovations, not only regarding planning but also for new paradigms of life in society (Pratt, 2008; Richards, 2011). Cities are a source of creativity, innovation (Florida, 2003) and complex ecosystems, where different players with diverse interests are encouraged to collaborate in order to ensure a sustainable environment and an adequate quality of life (Capdevila and Zarlenga, 2015). Cities supported by learning, technology and innovation are characterized by intangible (e.g. creativity of people and institutions) (Hall, 2000; Scott, 2006; Evans, 2009) and tangible elements (e.g. institutions and digital infrastructure) (Caragliu et al., 2009; Capdevila and Zarlenga, 2015).

The association between tangible and intangible elements focussed on creativity and innovation, which contributed to the emergence of smart cities. The basis of smart cities is the combination of human capital, social capital and Information and Communication Technology (ICT) infrastructure in order to generate sustainable economic development and improve well-being and quality of life (Capdevila and Zarlenga, 2015; Coleman, 1990; Putnam et al., 1993).

According to the Smart Cities Council (2016), by 2020, 40 cities will be considered smart cities and, by 2025, that number will increase to 88. Among these, Rio de Janeiro and Curitiba in Brazil are considered to be the two out of eight smart cities in Latin America.

Since 2014, initiatives in Curitiba towards smart living have received more than 31 awards. Austin Rating and the news magazine IstoÉ conferred the city the Best City of Brazil award, Best Large City and Best City in the Job Market category. The study evaluated 5565 Brazilian municipalities, through 212 indicators related to social, economic, fiscal and digital areas, with a focus on equal opportunities among city dwellers (Prefeitura de Curitiba, 2016; IPPUC, 2017).

Curitiba is a city that can contribute to emerging and transitional concepts such as the smart cities (Carvalho et al., 2012). Many projects are being implemented to make the city smart. For example, in 2010, Curitiba, was the first city in the world to connect public buses to a 3G mobile-broadband network. Such innovation created new possibilities for traveller services that helped commuters plan their route and enabled them to purchase tickets wherever and whenever it is most convenient (UNhabitat, 2016).

The main challenges to a smart city project are economic development, social inclusion, security, sustainability, infrastructure, transportation, and housing. New information and communication technologies allowed for the democratization of citizens' inclusion capacity, which became empowered to participate in the innovation dynamics of their cities (Capdevila and Zarlenga, 2015). In this reading, the smart city should have "a strong governance-oriented approach which emphasizes the role of social capital and relations in urban development" (Albino et al., 2015, p. 4).

Frequent evaluations of the citizens' perceptions of urban innovations start becoming relevant. In this way, the smart city will be an authentic, tolerant and liveable, associated with creative population and knowledge economy based on economic prosperity, respect for the environment and concern for society (Evans, 2009).

A city is smart when aspects such as human and social capital and communication infrastructure (ICT) supported economic growth and a better quality of life. It should as well have a good natural resource management and participatory governance (Caragliu et al., 2009). It is considered that the key elements of smart city development are, *well-being* and *quality of life* and these can be understood as ongoing processes whose measuring is shaped and reshaped by the cities' institutions, social norms and cultural context. This affect the way urban innovations are selected, developed, and adopted (or not) (Scott, 2012; Astleithner et al., 2004). These studies raise the question that the human-nature relationship is being largely missed in the over digitized urban concepts.

In this line, quality of life has been moderated by different variables such as overcrowding (Pacione, 2003; McCrea et al., 2006), walkability (Frank et al., 2009; Rogers et al., 2011), social capital (Portes and Landolt, 2000; Rogers et al., 2011), sense of community (Magge et al., 2012; Dempsey, 2009), tourism motivation (Dan, 2012; Uysal et al., 2016), among others.

This research highlight four arguments in order to emphasize some research gaps. Firstly, it is important to combine objective and subjective quality of life (QOL) measurements (Cummins, 2000a; 2000b). This will allow a more comprehensive approach that takes into account environmental conditions and subjective well-being. Secondly, as demonstrated by Fahey et al. (2003), one can always expect to find individuals displaying combinations of good objective living conditions with low levels of subjective satisfaction and vice versa. When this happens in society as a whole it is something that bears investigation. Thirdly, the simultaneous evaluation of objective and subjective QOL domains allows the researcher to make comparisons among different cities, given that it takes into account their different cultural and social contexts (Fahey et al., 2003). Finally, quality of life is a key element for the smart city development (Hall, 2000; Nam and Pardo, 2011; Thuzar, 2011). Since smart cities are a fairly recent phenomena - the keyword search on the Web of Science ™ database revealed that more than 93% of related articles (2221 papers) were published after 2013 - the impact of the application of the smart cities concept on citizens' quality of life is still insufficiently investigated (De Jong et al., 2015; Wolfram, 2016). In fact, considering the search carried out in the Web of Science database, 156 papers addressed the concept of quality of life in smart cities and when the researchers looked for a similar concept (subjective well-being) only two proceedings (Oliveira and Painho, 2015; Oliveira et al., 2014) were found (Web of Science, 2016).

Starting from these gaps and the debate about QOL in smart cities, this paper sought to investigate the perception of quality of life in a smart city and to analyze the main factors of citizens' satisfaction with their city. The study examined the case of Curitiba, considered one of the ten smartest cities in the world and a model of transportation, urbanization and respect for the environment (Carvalho et al., 2012; IPPUC, 2017).

Beyond providing an integrated analysis approach that considered the smart city as an organic whole, the major contribution of the paper was the identification of the major factors of quality of life according citizens' evaluation. These factors revealed the needs of citizens by emphasizing a citizen-centric approach, when the citizens collaboratively work with policymakers to formulate and implement policies (Colldahl et al., 2013; Bibri and Krogstie, 2017). This research suggests that the quality of life dimensions can help to build the link between the smart city concept and sustainability more effectively.

2. Smart cities and the challenge of measuring quality of life (QOL)

The concept of smart city is akin to concepts such as intelligent city (Komninos, 2002), information city (Castells, 1996), wired city (Dutton, 1987), knowledge city (Carrillo, 2004; Edvinsson, 2006), or digital city (Yovanof and Hazapis, 2009) or ubiquitous city (Lee et al., 2008). These concepts share some similarities but each one focus on specific aspects of the use of technology in urban environments (Capdevila and Zarlenga, 2015).

The concepts such as, but not limited to *information city*, *ubiquitous city* or *digital city* present a technological perspective that puts Information and Communication Technologies (ICT) at the center of their development proposals (Yovanof and Hazapis, 2009; Capdevila and Zarlenga, 2015). According to Capdevila and Zarlenga

(2015), the concept *smart city* suggests that a city is *smart*, when it emphasizes the inventiveness and creativity of its citizens. The notion of smart city is closely linked to knowledge economy, changes in spatial agglomeration, and knowledge-based urban development (Edvinsson, 2006; Carrillo, 2004).

Discussions on the concept of smart city began in the 2000s and its focus has undergone changes. At first, the concern was with technologies and infrastructures, that is, considered *hard*, technical and structural aspects of *smart cities* (Hall, 2000; Odendaal, 2003). In 2005, the focus was on the prioritization of human and social capital, considered *soft* aspects (Giffinger et al., 2007; Nam and Pardo, 2011). From 2010, it incorporated the quality of life concept and the role of the end user: the citizen becomes, therefore, the key element in its development (Schaffers et al., 2011, Wolfram, 2012 Kramers, 2014, Papa et al., 2015). The most important concepts of smart city and its main characteristics are summarized in Table 1.

Table 1 demonstrates that the concept of smart city was initially centered on ICT-related topics to which holistic perspectives were gradually added. It included three main aspects: technology (hardware and software infrastructure), people (creativity, diversity, education) and institutions (policy and governance) (Nam and Pardo, 2011; Lee et al., 2014). Other definitions included 'intelligent economy', 'intelligent governance', 'intelligent mobility', 'intelligent environment' and 'intelligent life' (Giffinger et al., 2007; Lombardi et al., 2012).

2.1. Smart cities: elements and dimensions

In the context of smart cities, technology is the key to providing adequate infrastructure and services and immediate response in emergency situations (Lee and Lee, 2014). Other factors, such as investment in human capital and improvements in urban practices, are important conditions in this context (Thuzar, 2011; Neirotti et al., 2014). Smart cities are based on the combination of elements such as social capital, human capital, entrepreneurial capital and infrastructural capital (Caragliu et al., 2011, Kourtit and Nijkamp, 2012), as well as on changes in technological and social perspectives (Papa et al., 2013; Monfaredzadeh and Berardi, 2014; Ståhlbröst et al., 2015).

The above elements demonstrate that the concept of smart cities goes beyond technological issues: the role of the citizen, the exercise of citizenship and the monitoring and management of data are important issues in such context. A study titled *The Connected Sustainable Cities* (CSC), developed by MIT and Cisco under the *Connected Urban Development* (CUD) initiative, addresses governance through sustainable, intelligent, and efficient environment proposals through ubiquitous computing scenarios adapted to existing and hypothetical cities (Grabys, 2014).

By incorporating new dimensions beyond technology, the *smart city* concept comes close to the *sustainable city* concept (Monfaredzadeh and Berardi, 2014). The concept of sustainable city can be understood as cities that implement sustainable public policies (De Jong et al., 2015; Ahvenniemi et al., 2017; Bibri and Krogstie, 2017), considering the sustainability tripod – economy, people and environment (Elkington, 1997).

The notion of urban sustainability can also articulate the argumentative strategies of eco-energy efficiency and quality of life in the consideration of urban form as a determinant of sustainability (Breheny and Rookwood, 1996, p. 151).

Table 1
Smart city definitions and main characteristics.

Reference	Definition	Main Characteristic
Odendaal (2003, p. 586, p. 586)	"The concept is intrinsically linked to that of the knowledge-based economy: the use of research and new technology to explore new frontiers in science, industry and commerce. A smart city or region, defined in this paper, is one that capitalizes on the opportunities presented by Information and Communication Technology (ICT) in promoting its prosperity and influence. The notion of 'e-governance' provides us with another dimension of the interface between local government and ICT."	Innovation
Giffinger et al. (2007, p. 10, p. 10)	"In association with economy or jobs Smart City is used to describe a city with a 'smart' industry. That implies especially industries in the fields of information and communication technologies (ICT) as well as other industries implying ICT in their production processes. A Smart City has therefore smart inhabitants in terms of their educational grade. In other literature the term Smart City is referred to the relation between the city government responsible administration and its citizen."	Awareness
Caragliu et al. (2009, p. 47, p. 47)	"The concept of the 'smart city' has been quite fashionable in the policy arena in recent years. Its main focus seems to be on the role of ICT infrastructure, although much research has also been carried out on the role of human capital/education, social and relational capital and environmental interest as important drivers of urban growth."	Creativity
Nam and Pardo (2011, p. 288, p. 288)	"As we explored multiple conceptual dimensions of smart city, the concept is an organic connection among technological, human, and institutional components. Nowadays the usage of "smart" captures innovative and transformative changes driven by new technologies. However, social factors other than smart technologies are central to smart cities. In this sense, a socio-technical view on smart city is needed."	Participation
Schaffers et al. (2011, p. 432, p. 432)	"The point of departure is the definition which states that a city may be called 'smart' 'when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory government."	Learning
Batty et al. (2012, p. 516)	"Smart cities are equitable cities. We will develop infrastructures that are accessible to a wider range of interests and groups with differing levels of expertise and activism so that all are involved. Our focus on efficiency balanced against equity is central to this vision. The web based interactive systems which we consider to be basic to the kind of citizen science that we assume should be normal in the smart city will enable fairness to be progressed and balanced against competition."	Diversity
Wolfram (2012, p. 171, p. 171)	"Concepts of 'smart' or 'intelligent' cities currently enjoy great popularity. They offer frameworks for interpreting certain linkages between information and communication technology (ICT) and urban development, and put forward a particular agenda for action. In this, they claim a broad legitimacy for guiding stakeholders, drawing on findings from a number of strands of scientific inquiry."	Collaboration
Kramers (2014, p. 40, p. 40)	"Cities with strong environmental ambitions and a telecommunication industry seek to understand how best to utilise ICT as an enabler to reduce energy use."	Efficiency
Papa et al. (2013, p. 5).	"A smart city is generally meant as a city capable of joining 'competitiveness' and 'sustainability', by integrating different dimensions of development and addressing infrastructural investments able to support economic growth as well as the quality of life of communities, a more careful management of natural resources, a greater transparency and participation to decision-making processes."	Networking

Source: based on Papa et al. (2015) and enlarged by literature review.

The ability of the city to combine efficiency in the use of environmental resources and the quality of urban life is not, however, consensual (Acselrad, 1999). Some will argue, on the contrary, that energy efficiency and quality of life are attributes of dense and decentralized cities, by resorting to local sources of energy and food production in available rural soils (Breheney, 1997; Camagni et al., 2002;

2.2. Quality of life in cities

Quality of life is increasingly relevant in analysis/planning of policies and in territory management (Molina-Morales and Marínez-Fernández, 2010; Romice et al., 2016) particularly in the case of smart cities (Greco and Bencardino, 2014). Strong competition between urban centers in attracting investments and qualified human resources, coupled with citizens imbued with greater awareness of the growing demand for quality of life influenced local, regional and national policymakers (Santos et al., 2005).

Several definitions of quality of life have been proposed in the literature (Flanagan, 1978, 1982; Narayan et al., 2000; Cummins et al., 2003; Skevington et al., 2004). Quality of life is usually strongly associated with health, as seen in the Quality of Life Assessment (WHOQOL) developed by the World Health Organization (WHO, 2016a). According to the WHO, quality of life is the individual's perception of their position in life, within their cultural context and the value system in which they live and in relation to their goals, expectations, parameters and social relationships. The quality of life of an individual can be affected by their physical health, psychological state, level of independence and social relationships (Skevington et al., 2004).

The inclusion of sustainability dimension in a smart city project involves the adoption of smart technologies in order to mitigate environment impacts and implement policies of natural ecosystem regeneration (Ahvenniemi et al., 2017). These smart technologies will also need to be simple, integrated, cost-effective and resource efficient, and should have an impact not only on environmental sustainability goals, but also on economic issues and citizens' well-being (Schaffers et al., 2011; Colldahl et al., 2013). In addition to these factors, there are more specific goals that are also determinant for the citizens' well-being, such as: infrastructure for education and innovation, companies-governments partnerships, innovation and quality of services driven by citizens (Schaffers et al., 2011; Bibri and Krogstie, 2017).

Smart city projects have an impact on citizens' quality of life by promoting more informed, educated and participatory citizens. (Albino et al., 2015). The transition from a technocentric model to a model that incorporates the "human" factor avoids the misleading view that technology is capable of solving problems on its own (Nam and Pardo, 2011; Ståhlbröst et al., 2015). In addition, the city allows its members to participate in governance and city management and become active users (Schaffers et al., 2011; Bibri and Krogstie, 2017). It is a long-term, incremental process that integrates experimental, educational and community mobilization, framing public policies within a shared and coherent perspective (Colldahl et al., 2013).

Empirically, citizens evaluate their life experience and their relation with the city either positively or negatively according to their own conception on what is a good and rewarding life (Shin, 2015; Albino et al., 2015).

This evaluation can be made using different concepts about what makes a rewarding life. One possible differentiation between *quality of life* and *well-being* is proposed by Diener (2006). According to the author, *quality of life* is just the description of the circumstances of a person's life and it does not include their reactions to these circumstances; whereas *well-being* refers to the positive or negative assessments that people make about their lives - this includes reflective cognitive assessments and affective reactions to life events. On the other hand, authors such as Galloway (2005), Gasper (2010) and Scott (2012) argue that *well-being* is an element of the concept *quality of life*. The term *well-being* is more used to access the level of analysis of the individual; while *quality of life* allows inferring about a community, territory or society. For this reason, *well-being* is more commonly used in psychology, whereas *quality of life* is more widely adopted in public policies (Gasper, 2010).

Fahey et al. (2003, p.14) state that "*quality of life* in a society can be defined as the overall well-being of those living there. *Well-being* then reflects not only living conditions and control over resources across the full spectrum of life domains, but also the ways in which people respond and feel about their lives in those domains".

Considering the arguments above, this research considered the expression "subjective quality of life" more consistent with our objectives, because it combines the broader vision of *quality of life* concept with the notion of going beyond objective domains. The concept of *subjective quality of life* was popularized by Cummins (1993, 2000a; 2000b) through his understanding of *objective* and *subjective quality of life* domains, as well as the evaluation of domain satisfaction assigned by their importance to the individual.

According to Cummins (2000a; 2000b) *quality of life* is a universal construct containing *objective* (culturally defined) and *subjective* (individuals satisfaction) domains. After a deep qualitative investigation, he developed a Comprehensive Quality of Life instrument consisting of subjective and objective measurements of quality of life in each of the seven domains. The seven domains of life satisfaction are: material well-being, health, productivity, intimacy/friendship, safety, community, and emotional well-being (Cummins, 2000a, 2000b).

This study focuses on the subjective quality of life aspects and in those instruments that offer the possibility to access the citizens' perception of their bonds with the place in which they live (Jacobs, 1961; Van Kamp et al., 2003; Sirgy et al., 2006; Scott, 2012; European Union, 2016). This research expects to assess *quality of life* in a *smart city*, based on the following urban policies: housing diversity; adequate access to public transport; use of local products; opportunities for personal encounters; adequate economic base; resident-led processes; justice and equity; promotion of a sense of place; creation of new businesses that provide new products or services that protect or restore the environment (Geis and Kutzmark, 1995; Glavic and Lukman, 2007).

A survey that accesses citizen satisfaction with the quality of urban life and that allows to somehow identify the subjective quality of life perception is carried out by the European Commission (Eurobarometer) This survey analyzes the perception of quality of life in cities of the European Union through interviews about health care, employment and housing issues; economic situation; immigration; safety; challenges; pollution and climate change; administrative services; infrastructure and public transport.

In sum, this research adopted the definition of smart city according to Caragliu, Del Bo and Nijkamp (2011, p.6), which is a city where "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu, Del Bo and Nijkamp, 2011, p. 6). Considering the quality of life, this research assumed the Australian Centre on Quality of Life definition, which is based on Cummins (2000a): "Quality of life is both objective and subjective. Each of these two axes comprises several domains which, together, define the total construct. Objective domains are measured through culturally relevant indices of objective well-being. Subjective domains are measured through questions of satisfaction (Cummins, 2000a, p.3).

Therefore, the following question arises: are the citizens' expectations aligned with those of urban planners? A smart city should allow an organic connection amidst technological, human and institutional resources where innovative changes are driven by new technologies (Nam and Pardo, 2011). This study focuses particularly on the perception of quality of life of the most representative Brazilian smart city, Curitiba, located in the south region of Brazil. Curitiba exemplifies the development of a smart city in a developing country context.

3. Methods

3.1. Questionnaire design

In order to evaluate the perception of quality of life of Curitiba's residents, the researchers adopted the instrument used by the Eurobarometer (2016). The Eurobarometer is particularly valuable in its analysis of issues like participation, social relations and interaction, attitudes, and subjective evaluations of aspects of quality of life: health and health care, family life, social life, personal safety, financial situation, employment situation, and home and neighborhood (Fahey et al., 2003).

The *Flash Eurobarometer 419* is a survey carried out every three years since 2004. Its aim is to assess uniquely the "perception of quality of life in European cities". The last 2015 edition interviewed more than 40,000 people and its results were compared with those of preliminary studies. Participants classified quality level of services, such as education, cultural and sports facilities, as well as public transport and administrative services (Eurobarometer, 2016).

The research was carried out in 83 European cities, including Paris, Lisbon, Athens and Manchester. It included all capitals of the countries surveyed (except Switzerland) and about 500 citizens were interviewed in each city. The survey was conducted by the TNS Political and Social between 21 of May and 9 of June 2015 (Eurobarometer, 2016). A total of 40,798 respondents from different demographic groups were interviewed by telephone (landline and mobile) in their mother tongue. The sample generated data that allowed the analysis of the perception of quality of life. The methodology used was "Eurobarometer survey", coordinated by the Directorate General for Communication (Eurobarometer, 2016).

The results demonstrated that, in general, living in those cities generated a high level of satisfaction. With the exception of six cities, at least 80% of respondents declared to be satisfied with the city in which they live. As opposed to the 2012 survey, the 2015 results were stable in most of cities and there were few significant negative developments (Eurobarometer, 2016).

The present study applied the Eurobabometer questionnaire, version 2015. Reverse translation was used in order to guarantee understanding of variables. A preliminary test was performed with 15 interviewees, who understood fully the variables involved.

The final version contained 34 variables divided into two blocks: i) quality of life variables and ii) control variables: gender, age, educational background, family income, work (paid or not) and neighborhood. All items were measured using the original four-point scale (1 = strongly disagree; 4 = strongly agree or 1 = strongly unsatisfied; 4 = strongly satisfied). The decisions about the layout questionnaire and the final approval were taken by the group of four researchers during face-to-face meetings.

3.2. Survey procedures

In order to fulfil the study objectives, an on-site survey was conducted on November 2016 in fourteen neighborhoods in Curitiba: Ahú, Alto Boqueirão, Boa Vista, Boqueirão, Cabral, Cajuru, Centro, Centro Cívico, Largo da Ordem, Quitandinha, Osternack, Sítio Cercado, Uberaba, and Xaxim. Residents were sampled on weekdays and weekends between 8 a.m. and 8 p.m. On each location, the researchers approached the pedestrians randomly. The answers were noted in the printed form and, subsequently, organized in the Statistical Package for the Social Sciences (SPSS) database. After explaining the academic purpose of the research and the anonymity of the respondent, the researcher read each question and pointed out the possible answers, hence few questions were left unanswered. There were 400 respondents and the calculation of minimum sample size resulted in 398 respondents. The sample was stratified by gender, age and educational attainment, in the same proportion of the population.

3.3. Data analysis

Data were analyzed using descriptive statistics of respondents' profile; factor analysis allowed the identification of QOL factors; Cronbach's alpha was used for factor reliability and regression analysis, which identified the degree of influence of each factor in the general perception of QOL (Hair et al., 2003). The researchers used the software SPSS (Statistical Package for the Social Sciences, version 17) for data analysis. In the study conducted by Eurobarometer (2016), only descriptive and comparative statistics between cities were performed.

Descriptive and factorial analyses were used to reduce and summarize data (Hair, 2006). Factorial analysis is a multivariate technique of interdependence in which all variables are simultaneously considered, each related to the other, in order to study the interrelation between them and to reduce data (Hair, 2006). This type of analysis identified latent relationships and combined study variables (Hair, 2005). The factorial analysis allowed the identification of the main factors of quality of life according to citizens' perception.

Subsequently, linear regression analysis was used to identify the relative weight of each dimension in determining the respondents' general perception of social capital and competitiveness. This analysis allowed the researchers to identify the existence and strength of the relationship between two variables (Hair, 2006). The analysis of variance (ANOVA) aimed at verifying the difference between the means of two or more groups. Correlation analysis intended to assess the association between the QOL factors identified (Hair, 2006).

4. Citizen's perception on quality of life: results and discussion

4.1. The city of Curitiba: a snapshot of a smart city in a developing country context

Curitiba is renowned internationally for its sustainability programs. Leadership and adherence to intelligent transportation planning helped Curitiba to become a sustainable city and a benchmark for successful urban planning (Ojo et al., 2014). Its achievements are categorized into six topics: integrated urban planning, effective public transport system, environmental awareness, pedestrian priority zones, social justice and waste management system (Mills, 2006).

In 1964, the architect Jaime Lerner led a team from the Federal University of Paraná whose objective was the planning of Curitiba. The planning aimed at a strict control of urban sprawl, traffic reduction, preservation of Curitiba's historic areas and construction of a public transport system (Moore, 2007). Based on such innovations, Curitiba became known as a pioneer of the BRT - Bus Rapid Transit system or fast bus transportation - that offered

Table 2
Quality of life factorial results.

Factor	Items	Loading	Mean	Standard deviation
Socio-structural relations (0.657)[a]	23 - I feel safe in Curitiba	0.777	1.94	0.813
	22 - The administrative services of Curitiba help people efficiently	0.710	2.13	0,738
	24 - I feel safe in my neighborhood	0.673	2.19	0.923
	05 – I am satisfied with the State of the streets and buildings	0.419	2.39	0.883
Environmental well-being (0.633)[a]	07 - I am satisfied with Green spaces	0.727	3.20	0.780
	12 - I am satisfied with Cleanliness	0.667	2.79	0.906
	06 - I am satisfied with Public spaces	0.535	2.64	0.773
	04 - I am satisfied with Cultural facilities	0.492	3.03	0.783
	10 - I am satisfied with the Quality of the air	0.483	2.64	0.754
	19 - The presence of foreigners is good for Curitiba	0.430	2.99	0.827
Material well-being (0.660)[a]	15 – I am satisfied with the Life I lead	0.771	3.08	0.736
	14 – I am satisfied with the Financial situation of your household	0.737	2.66	0.748
	16 – I am satisfied with the Place where I live	0.677	3.05	0.833
Community integration (0.702)[a]	26 - Generally speaking, most people in Curitiba can be trusted	0.810	2.36	0.662
	27 - Generally speaking, most people in my neighborhood can be trusted	0.727	2.42	0,742
	28 - Generally speaking, the public administration of Curitiba can be trusted	0.456	2.00	0.795

[a] Cronbach's Alphas.

operational flexibility and speed, as well as low fuel consumption (Deng and Nelson, 2011).

Curitiba's experience is well known and exemplifies good urban planning practices through BRT investments and creation of green corridors (Cervero and Dai, 2014). In 2010 the city was awarded the *Globe Sustainable City Award*. An integrated urban planning (political, social, environmental, economic, cultural and technical), the implementation of actions using practical design solutions and the progressive introduction of "Euro 3" emission standards in the bus fleets were found to be the key for this achievement (Soltani and Sharifi, 2012).

Smart cities projects include the creation of open/green spaces, materials flow and recycling, land use planning, sustainable agriculture, natural resources and waste management. Curitiba proposes the separation of residues in dry, wet and solid recyclable materials and develops projects that encourage recycling in low income areas. Commitment to concepts such as accessibility, transparency, social justice, poverty reduction, and an efficient resources management helps the city to achieve remarkable results in sustainable development projects (Ojo et al., 2014).

The city's land occupation programme reduced traffic congestion, improved air quality and saved energy, while the neighborhood revitalization projects consolidated civic spirit (Hawken et al., 1999; Taniguchi, 2005). Private gardens and woods complement public green spaces that in 25 years has grown from 1.5 to 77 square meters per person which is six times World Health Organization recommendations (12 square meters) (WHO, 2016b). One of the most visited is the green park Botanical Garden, and covers an area of 178 thousand square meters with gardens and recreation spaces. Within the greenhouse, with an area of 458 m^2, species of typical plants of tropical areas can be found (Prefeitura de Curitiba, 2016).

Many of Curitiba projects are designed to be self-sustainable and to allow the operation of other programs. The "Green Exchange" program is a good example of this systemic approach to planning. For example, in the city slums, people receive rice, beans, eggs, bananas, carrots that the city purchase at low prices from areas with surplus production for each sorted garbage bag. The results are good nutrition and better public health. Besides this project, garbage collection in Curitiba is universal, which is almost 11% higher than the Brazilian standard. Most of the city's households (91.7%) have sewage treatment (IPPUC, 2011).

Curitiba was not richer or poorer than the other cities of the south of the country when it started its urban development program. Its social services were financed more effectively than probably any city in the northern hemisphere (Deng and Nelson, 2011). The city education network has child-oriented services, consisting of nurseries, child care centers and horticulture programs, as well as community solidarity actions (Hawken et al., 1999; Deng and Nelson, 2011).

4.2. Results

Descriptive analysis revealed the main characteristics of the sample: 55.0% of the interviewees were female; 48.0% were aged 30 years or less; 41.8% had secondary education; family income of 70.9% was up to 5 minimum wages; and 82.5% of the interviewed had a paid occupation.

Data were submitted to factor analysis using PCA (Principal Component Analysis), with varimax rotation and treatment listwise (a case was dropped from analysis in case value was missing) for the missing data. The index of Kaiser-Meyer-Olkin (KMO) adequacy of the sample was 0.760 and the Bartlett's Test of Sphericity - (significant to 0.000) indicated the factorability of data.

The final model of factorial analysis resulted in 16 variables, which meant that 12 variables were not present in the final model. These variables were removed, one by one, through communality analysis or when the loadings were inferior to 0.4. The exception was the variable "I am satisfied with living in Curitiba", which was used as dependent variable to the linear regression analysis.

Results of factor analysis converged in seven iterations and suggested that citizens' quality of life is explained by four domains, with 51.67% of total variance explained. The Cronbach's Alpha for this scale was 0.846, which represents a very satisfactory range for an exploratory study (Hair et al., 2003). It is possible to conclude that the items in each dimension of the construct are suitable for quality of life evaluation (Table 2).

After factorial analysis, the domains were submitted to linear regression analysis, in order to analyze the influence of each factor on the general assessment of QOL levels in Curitiba (Table 3).

These factors revealed the need for improvements for a smart city development approach and were discussed in the next section."

4.3. Discussion

Table 2 displays the variables used to perform QOL evaluation in this research. The most significant domain (*socio-structural relationships*) grouped variables related to a feeling of collectivism: safety (in the city and in the neighborhood), satisfaction with the state of the streets and buildings, and with the services provided by local government.

Table 3
Linear regression model.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	0.380[a]	0.144	0.142	0.712	0.144	67.169	1	398	0.000	
2	0.480[b]	0.231	0.227	0.676	0.086	44.428	1	397	0.000	
3	0.498[c]	0.248	0.242	0.669	0.017	9.070	1	396	0.003	1.01

Dependent Variable: I am satisfied to live in Curitiba.
[a] Predictors: (Constant), Material well-being.
[b] Predictors: (Constant), Material well-being, Environmental well-being.
[c] Predictors: (Constant), Material well-being, Environmental well-being, Socio-structural relations.

This group is formed by variables that express the way people interact with each other (safety) and with the city (administrative services, streets and buildings). The development of tangible and intangible infrastructure – "streets and buildings" and "feeling of safety" - should be fostered not only for the sake of economic and political efficiency, but to promote social inclusion, livability and good life (Greco and Bencardino, 2014). Low average variables (from 1.94 to 2.39) indicate the degree of dissatisfaction with the domain *socio-structural relationships*. In fact, the first and most important factor has the worst performance according to the residents' perception. This can be explained by the feeling of public insecurity (Narayan et al., 2000) - a psychosocial stressor - that exists in the country, especially in large Brazilian cities.

The second element identified was "environment well-being" which comprises the variables linked to satisfaction with public facilities. The exception is the "The presence of foreigners is good for Curitiba". One possible explanation might be that presence of foreigners is noticeable when people interact in public places. This dimension combined elements of the domain "health" (Cummins, 2000a) with "physical world" (Scott, 2012). Considering the WHOQOL instrument, it is possible to identify the factor "environment" as one of the six aspects of QOL (Hagerty et al., 2001).

Regarding environmental well-being, the population is partially satisfied with two variables: green spaces and cultural facilities. Besides the Botanical Garden, Curitiba has more than 26 parks and green spaces and about 81 million square meters of preserved green area. There are 55 square meters of green area per inhabitant, three times higher than the ratio recommended by the World Health Organization, which is 16 m^2 (Curitiba City Hall, 2016). The valuation of other variables (cleanliness, public spaces, air quality and the presence of foreigners) as partially unsatisfactory indicates there is room still for improvement.

The dimension "material well-being" encompasses more than just economic aspects. It brings together the following variables: "I am satisfied with the life I lead"; "I am satisfied with my financial situation"; "I am satisfied with the place where I live". Fahey et al. (2003, p. 1) state that "the nature of an individual's relationship with others in their household, their community and beyond, as well as institutions and policies, are fundamental influences on quality of life."

In the perception of the residents of Curitiba, there is a slight satisfaction with life and where they live and a slight dissatisfaction with the financial situation.

Finally, the fourth domain classified variables related to community integration (Scott, 2012), more specifically, trust: "Generally speaking, most people in Curitiba can be trusted"; "Generally speaking, most people in my neighborhood can be trusted; and "Generally speaking, public administration of Curitiba can be trusted". This element reflects the community spirit and it is related to a common basic assumption to any relationship: trust.

To authors that consider social capital a collective resource, trust occurs in a community of stable, honest and cooperative behavior, based on norms shared by the members of that community (Coleman, 1990; Putnam et al., 1993; Fukuyama, 1995; Briggs, 2008).

Economic activity is a crucial part of social life which is interconnected with a variety of norms, rules, moral obligations, and habits that together shape a social group. Considering economic life, the well-being of a nation as well as its ability to compete is significantly conditioned by a cultural feature: the level of trust inherent in society (Fukuyama, 1995). In other words, being able to trust a good neighbor and even trust unknown people was undoubtedly indicated as being an important QOL factor (Cummins, 2000a, 2000b; Scott, 2012).

In the case of Curitiba, there is a well-balanced distribution among factors considering the variance explained for QOL: the socio-structural relations factor, explains 14.45% of the total variance, followed by "environmental well-being" dimension (13.64%), "material well-being" (12.10%) and "community integration" (11.47%).

As in the Eurobarometer (2016) results, Curitiba residents rely more on their neighbors than on the residents of the city in general, hence they feel safer in their own neighborhood than in the city. This result refers directly to the concept of social capital: the greater the geographic and social proximity, the higher the level of social capital (Jacobs, 1961; Molina-Morales and Marínez-Fernández, 2010; Macke et al., 2012). Therefore, a community more easily recognizes the elements of life quality, as the greater the presence of social capital.

Linear regression enables the identification of the relative weight of each dimension in determining the general perception of respondents. For the linear regression analysis, variables were considered significant when $p < 0.05$ (margin of error of 5%). Beta is the relative weight of each variable and determines the order of their importance in the factor. R Square value (R^2) indicates the degree of explanation of the set of variables in relation to the dependent variable, i.e. the general perception regarding QOL. The authors used the stepwise model (Hair et al., 2003), which takes as input criterion of the variables in the model of their significance level.

The four domains identified (socio-structural relationships, environmental well-being, material well-being and community integration) were treated as independent variables and the variable "I am satisfied to live in Curitiba" was selected as a dependent variable. This variable encompassed all relevant aspects of QOL concept, and through them, citizens' overall perception of QOL could be evaluated.

The results revealed that "material well-being", "environmental well-being" and "socio-structural relationships" were significant elements for QOL perception (Table 3). The domain "community integration" was not included in the model due to its low level of significance. The standardized beta coefficient of 0.242 indicates that when these three factors increase by one unit, quality of life (dependent variable) increases by 0.242 units.

Human, social and community aspects may not be sufficiently integrated with smart cities development policies. Strengthening citizenship and distributing technology resources to different players can increase city resilience. This can be achieved through including

major and minor players who are given access to knowledge and resources to develop creative and innovative solutions.

5. Conclusion

From a smart city perspective, the research concludes that success within the domain of smart living can be achieved by providing the four factors revealed by the analysis: (i) socio-structural relations; (ii) environmental well-being; (iii) material well-being; and (iv) community integration. According to our results, meeting these criteria of success would improve citizen's quality of life, creating a stronger community within the city.

Considering these findings, the researchers recommend a strategy of interfacing policy, community and research for building quality of life in smart cities. This strategy should encompasses different knowledge techniques, including community policy forums, action researchers' interventions and policy formulation and implementation, among others. This means that citizens, policy-makers and researchers should be collaboratively involved in the decision-making processes.

The smart city concept adopted highly emphasizes a citizen-centric approach, which aims to consider the citizens' needs in order to sustain and provide a high quality of life. As objective indicators are not sufficient for a meaningful measurement of quality of life, the researchers recommend future studies on subjective quality of life in different contexts, considering as main the assumption that the cities are the new actor of sustainability in practice. Some of the questions include but are not limited to the following: In which extent the city of Curitiba can be considered a smart city? What elements are lacking and what others affect the quality of life of citizens in the context of smart cities? How does the smart city concept help to improve the human-nature resilience, thereby to help to accelerate the societal change/transitions? These questions can be recommended as future research aims.

In sum, the smart city concept is far from being restricted to the application of technologies to cities. The sustainable city is one that is constantly creating and developing its physical and social environments with a focus on quality of life.

The main challenge with regard to quality of life evaluation is considered to be the task of developing indicators, due to the wide range of different interests socially, physically and environmentally. In this sense, participatory democracy is vital, but may be weaken by the same central discourse that promote it. This means that considerable attention should be given to issues of representation, knowledge and power in developing quality of life indicators.

The present study goals were, firstly, the assessment of quality of life of a smart city according to its citizens (subjective domain) and the broader understanding of its concept. Secondly, the use of a recognized survey instrument in a developing country context and of statistical methods beyond the descriptive statistics applied in the original study. Thirdly, the possibility of repeating the study in other Brazilian cities and analyzing the behavior of variables compared with the results found. It would be possible still to compare cases of smart cities with cities that are not considered *smart* and analyze the differences between them. Fourthly, the study provides insights for social researchers and urban planners by identifying QOL explanatory factors and providing elements for political and academic debate. Finally, the research contributes to the theoretical discussion about QOL in smart cities and the construction of a theory of quality of life.

Acknowledgements

This work is being supported by the University of Caxias do Sul (Universidade de Caxias do Sul - UCS), the Faculty Meridional (Faculdade Meridional – IMED), the ISAE Curitiba (Instituto Superior de Economia e Administração), the National Counsel for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq) and the Coordination for the Improvement of Higher Education Personnel (Coordenação de Aperfeiçoamento do Pessoal de Nível Superior – Capes). The researchers also would like to thank three anonymous reviewers for their valuable comments and suggestions.

References

Acselrad, H., 1999. Sustainability and territoriality: meaningful practices and material transformation. In: Becker, E., Jahn, T. (Eds.), Sustainability and the Social Sciences: a Crossdisciplinary Approach to Integrating Environmental Considerations into Theoretical Reorientation. Zed Books, London, pp. 37–68.
Ahvenniemi, H., et al., 2017. What are the differences between sustainable and smart cities? Cities 60, 234–245.
Albino, V., Berardi, U., Dangelico, R.M., 2015. Smart cities: definitions, dimensions, performance, and initiatives. J. Urban Technol. 22 (1), 3–21.
Astleithner, F., et al., 2004. Institutions and indicators as socially constructed policy instruments: benefits and challenges of interactive research. Local Environ. 8 (6), 627–640.
Australian Centre on Quality of Life. About quality of life. Available at: http://www.acqol.com.au/.
Batty, M., Axhausen, K., et al., 2012. Smart cities of the future. Eur. Phys. J. 214 (1), 481–518.
Bibri, S.E., Krogstie, J., 2017. Smart sustainable cities of the future: an extensive interdisciplinary literature review. Smart Cities Soc. 31, 183–212.
Breheney, M., 1997. Urban compaction: feasible and acceptable? Cities 14 (4), 209–217.
Breheny, M., Rookwood, R., 1996. Planning the sustainable city region. In: Blowers, A. (Ed.), Planning for a Sustainable Environment. Earthscan, Londres, pp. 150–189.
Briggs, X.S., 2008. Democracy as a Problem Solving: Civic Capacity in Communities across the Globe. MIT Press, Cambridge, MA.
Camagni, R., et al., 2002. Urban mobility and urban form: the social and environmental costs of different patterns of urban expansion. Ecol. Econ. 40, 199–216.
Capdevila, J., Zarlenga, M.I., 2015. Smart city or smart citizens? The Barcelona case. J. Strat. Manage 8 (3), 266–282.
Caragliu, A., et al., 2009. Smart cities in europe. In: 3rd Central European Conference in Regional Science, pp. 45–59.
Carrillo, F.J., 2004. Capital cities: a taxonomy of capital accounts for knowledge cities. J. Knowl. Manag. 8 (5), 28–46.
Carvalho, L., et al., 2012. Green urban transport policies and cleantech innovations: evidence from Curitiba. Goteborg Hamburg. Eur. Plan. Stud. 20 (3), 375–396.
Castells, M., 1996. The rise of the network society. In: The Information Age: Economy, Society, and Culture, vol. 1. John Wiley & Sons, Chichester, UK.
Cervero, R., Dai, D., 2014. BRT TOD: leveraging transit oriented development with bus rapid transit investments. Transp. Pol. 36, 127–138.
Coleman, J.S., 1990. Foundations of Social Theory. Harvard University Press, Cambridge.
Colldahl, C., et al., 2013. Smart Cities: Strategic Sustainable Development for an Urban World. Master's dissertation. Blekinge Institute of Technology, Karlskrona, Sweden.
Cummins, R., 2000a. Objective and subjective quality of life: an interactive model. Soc. Indicat. Res. 52, 55–72.
Cummins, R., 2000b. Personal income and subjective well-being: a review. J. Happiness Stud. 1, 133–158.
Cummins, R.A., et al., 2003. Developing a national index of subjective wellbeing: the australian unity wellbeing index. Soc. Indicat. Res. 64, 159–190.
Dan, M.S.G., 2012. Tourist motivation and quality of life: in search of the missing link. In: Uysal, M., et al. (Eds.), Handbook of Tourism and Quality of Life Research: Enhancing the Lives of Tourists and Residents of Host Communities. Springer, Dordrecht, Netherlands, pp. 233–250.
De Jong, M., et al., 2015. Sustainable-smart-resilient-low carbon-eco-knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. J. Clean. Prod. 109, 25–38.
Dempsey, N., 2009. Are good-quality environments socially cohesive? Measuring quality and cohesion in urban neighbourhoods. Town Plan. Rev. 80, 315–345.
Deng, T., Nelson, J.D., 2011. Recent developments in bus rapid transit: a review of the literature. Trans. Rev. 31 (1), 69–96.
Diener, E., 2006. Guidelines for national indicators of subjective well-being and ill-being. J. Happiness Stud. 7, 397–404.
Dutton, W.H., 1987. Wired Cities: Shaping the Future of Communications. Macmillan, London.
Edvinsson, L., 2006. Aspects on the city as a knowledge tool. J. Knowl. Manag. 10 (5), 6–13.
Elkington, J., 1997. Cannibals with Forks: the Triple Bottom Line of the 21st Century Business. New Society Publishers, Stoney Creek.
Eurobarometer, 2016. Flash Eurobarometer 419-Quality of Life in European Cities. European Commission, pp. 1–172. Available at: http://ec.europa.eu/regional_

policy/sources/docgener/studies/pdf/urban/survey2015_en.pdf.
European Union, 2016. Quality of Life in European Cities: Flash Barometer 419. Available at: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/urban/survey2015_en.pdf.
Evans, G., 2009. Creative cities, creative spaces and urban policy. Urban Stud. 46, 1003–1040.
Fahey, T., et al., 2003. Monitoring Quality of Life in Europe, European Foundation for the Improvement of Living and Working Conditions. Office for Official Publications of the European Communities, Luxembourg.
Flanagan, J.C., 1978. A research approach to improving our quality of life. Am. Psychol. 33, 138–147.
Flanagan, J.C., 1982. Measurement of the quality of life: current state of the art. Arch. Phys. Med. Rehabil. 63, 56–59.
Florida, R., 2003. Cities and the creative class. City Commun. 2 (2), 3–19.
Frank, L.D., et al., 2009. The development of a walkability index: application to the neighborhood quality of life study. Br. J. Sports Med. 44 (13), 924–933.
Fukuyama, F., 1995. Trust: the Social Virtues and the Creation of Prosperity. Free Press, New York.
Galloway, S., 2005. Literature Review in Quality of Life and Well-being: Measuring the Benefits of Culture and Sport – a Literature Review and Thinkpiece. Scottish Executive Social Research, Glasgow.
Gasper, D., 2010. Understanding the diversity of conceptions of well-being and quality of life. J. Soc. Econ. 39 (3), 351–360.
Geis, D., Kutzmark, T., 1995. Developing sustainable communities. Publ. Manag. 77 (8), 4–13.
Giffinger, R., et al., 2007. Smart Cities: Ranking of European Medium-sized Cities. Centre of Regional Science (SRF). Vienna University of Technology, Vienna, Austria. http://www.smart-cities.eu/download/smart_cities_final_report.pdf (Accessed 03 July 2016).
Glavic, P., Lukman, R., 2007. Review of sustainability terms and their definitions. J. Clean. Prod. 15, 1875–1885.
Grabys, J., 2014. Programming environments: environmentality and citizen sensing in the smart city. Environ. Plann. D 32 (1), 30–48.
Greco, I., Bencardino, M., 2014. The Paradigm of the Modern City: SMART and SENSEable Cities for Smart, Inclusive and Sustainable Growth. Computational Science and its Applications – ICCSA. Springer Verlang, Berlin.
Hagerty, M.R., et al., 2001. Quality of life indexes for national policy: review and agenda for research. Soc. Indicat. Res. 55, 1–96.
Hair, J.F., et al., 2003. The Essentials of Business Research Methods. John Wiley & Sons, New York.
Hair, J.F., et al., 2006. Multivariate Data Analysis, 6 ed. Pearson Prentice Hall, Upper Saddle River.
Hall, P., 2000. Creative cities and economic development. Urban Stud. 37 (4), 639–649.
Hawken, P., et al., 1999. Natural Capitalism: Creating the Next Industrial Revolution. Little, Brown and Co, Boston.
IPPUC, 2011. Instituto de Pesquisa e Planejamento Urbano de Curitiba [Institute for Research and Urban Planning of Curitiba]. Desenvolvimento Sustentável: indicadores de sustentabilidade de Curitiba. IPPUC, Curitiba. Available at: http://ippuc.org.br/mostrarpagina.php?pagina=358&idioma=1&ampliar=n%E3o.
IPPUC, 2017. Premiações de Curitiba. Available at: http://www.ippuc.org.br/.
Jacobs, J., 1961. The Death and Life of Great American Cities. Vintage Books, New York.
Komninos, N., 2002. Intelligent Cities: Innovation, Knowledge Systems, and Digital Spaces. Taylor & Francis, London and New York.
Kourtit, K., Nijkamp, P., 2012. Smart cities in the innovation age. Innovat. Eur. J. Soc. Sci. Res. 25 (2), 93–95.
Kramers, A., 2014. Smart Cities and Climate Targets Reducing Cities' Energy Use with ICT and Travel Information [Doctoral Thesis]. http://www.diva-portal.org/smash/get/diva2:751909/FULLTEXT01.pdf (Accessed 13 September 2016).
Lee, H., Han, S.H., Leem, J.T.Y., Yigitcanlar, T., 2008. Towards ubiquitous city: concept, planning, and experiences in the Republic of Korea. In: Yigitcanlar, T., et al. (Eds.), Knowledge-based Urban Development: Planning and Applications in the Information Era. IGI Global, Information Science Reference, Hershey, Pa, pp. 148–169.
Lee, J.H., Hancock, M.G., Hu, M.C., 2014. Towards an effective framework for building smart cities: lessons from Seoul and San Francisco. Technol. Forecast. Soc. Change 89, 80–99.
Lombardi, P., Giordano, S., Farouh, H., Yosef, W., 2012. Modelling the smart city performance. Innovat. Eur. J. Soc. Sci. Res. 25 (2), 137–149.
Macke, J., et al., 2012. Social capital in collaborative networks competitiveness: the case of the brazilian wine industry cluster. Int. J. Comput. Integrated Manuf. 25, 1–8.
Magee, L., et al., 2012. Measuring social sustainability: a community-centred approach. Appl. Res. Qual. Life 7 (3), 239–261.
McCrea, R., et al., 2006. What is the strength of the link between objective and subjective indicators of urban quality of life? Appl. Res. Qual. Life 1, 79–96.
Mills, G., 2006. Progress toward sustainable settlements: a role for urban climatology. Theor. Appl. Clim. 84, 69–76. https://doi.org/10.1007/s00704-005-0145-0.
Molina-Morales, F.X., Marínez-Fernández, M.T., 2010. Social networks: effects of social capital on firm innovation. J. Small Bus. Manag. 48 (2), 258–279.
Monfaredzadeh, T., Berardi, U., 2014. How can cities lead the way towards a sustainable, competitive and smart future? WIT Trans. Ecol. Environ. 191, 1063–1074.
Moore, S.A., 2007. Alternative Routes to the Sustainable City. Lexington Books, Austin, Curitiba, and Frankfurt. Lanham, MD.
Nam, T., Pardo, T.A., 2011. Conceptualizing smart city with dimensions of technology, people, and institutions. In: The Proceedings of the 12th Annual International Conference on Digital Government Research, pp. 282–291.
Narayan, D., et al., 2000. Voices of the Poor: Crying Out for Change. Oxford University Press for the World Bank, New York.
Neirotti, P., De Marco, A., Cagliano, A.C., Mangano, G., Scorrano, F., 2014. Current trends in Smart City initiatives: some stylised facts. Cities 38, 25–36.
Odendaal, N., 2003. Information and communication technology and local governance: understanding the difference between cities in developed and emerging economies. Comput. Environ. Urban Syst. 27 (6), 585–607.
Oliveira, T.H.M., Painho, M., 2015. Emotion & stress mapping: Assembling an ambient geographic information-based methodology in order to understand smart cities. In: Information Systems and Technologies (CISTI), 10th Iberian Conference on Information Systems and Technology (IEEE), pp. 1–4.
Oliveira, T.H., et al., 2014. Development of an agricultural management information system based on Open-Source solutions. In: CENTERIS / ProjMAN / HCIST. Available at: www.elsevier.com/locate/procedia.
Ojo, A., Curry, E., Janowski, T., 2014. Designing next generation smart city initiatives – harnessing findings and lessons from study of ten smart city programs. In: 22nd European Conference on Information Systems (ECIS 2014).
Papa, R., et al., 2013. Towards an urban planners' perspective on smart city. TeMA J. Land Use Mob. Environ. 6 (1), 5–17.
Papa, R., et al., 2015. Smart and resilient cities. A systemic approach for developing cross-sectoral strategies in the face of climate change. TeMA J. Land Use Mob. Environ. 8 (1), 19–49.
Pacione, M., 2003. Urban environmental quality and human wellbeing: a social geographical perspective. Landsc. Urban Plann. 65, 19–30.
Portes, A., Landolt, P., 2000. Social capital: promise and pitfalls of its role in development. J. Lat. Am. Stud. 32, 529–547.
Pratt, A.C., 2008. Creative cities: the cultural industries and the creative class. Geogr. Ann. Ser. B. 90, 107–117.
Prefeitura de Curitiba [Curitiba local government], 2016. Curitiba acumula distinções em 35 prêmios de relevância nacional e internacional desde 2014. http://www.curitiba.pr.gov.br/noticias/curitiba-acumula-distincoes-em-31-premios-de-relevancia-nacional-e-internacional-desde-2014/38186 (Accessed 15 December 2016).
Putnam, R.D., et al., 1993. Making Democracy Work: Civic Traditions in Modern Italy. Princeton University Press, Princeton, N.J.
Richards, G., 2011. Creativity and tourism. State Art. Modes Creative Tour. Ann. Touris. Res. 38, 1225–1253.
Rogers, S.H., et al., 2011. Examining walkability and social capital as indicators of quality of life at the municipal and neighborhood scales. Appl. Res. Qual. Life 6 (2), 201–213.
Romice, O., et al., 2016. Urban design and quality of life. In: Fleury-Bahi, G., et al. (Eds.), Handbook of Environmental Psychology and Quality of Life Research. Springer, Berlin, pp. 241–273.
Santos, L.D., et al., 2005. O conceito de qualidade de vida urbana na perspectiva dos residentes na cidade do Porto. Estudos Regionais 9, 5–18.
Schaffers, H., et al., 2011. Smart cities and the future internet: towards cooperation frameworks for open innovation. Future Int. Assem 6656, 431–446.
Scott, A., 2006. Creative cities: conceptual issues and policy questions. J. Urban Aff. 28 (1), 1–17.
Scott, K., 2012. Measuring Wellbeing: towards Sustainability? Routledge, London.
Shin, D.C., 2015. How people perceive and appraise the quality of their lives: recent advances in the study of happiness and wellbeing. In: CSD Working Papers, pp. 1–35. Available at: http://escholarship.org/uc/item/0hq2v2wx.
Sirgy, M.J., et al., 2006. The quality-of-life (QOL) research movement: past, present, and future. Soc. Indicat. Res. 76 (3), 343–466.
Skevington, S.M., et al., 2004. The World Health Organization's WHOQOL-BREF quality of life assessment: psychometric properties and results of the international field trial. A report from the WHOQOL group. Qual. Life Res. 13 (2), 299–310.
Smart Cities Council, 2016. http://smartcitiescouncil.com/article/smartest-city-latin-america-one-may-surprise-you (accessed 20.07.16).
Soltani, A., Sharifi, E., 2012. A case study of sustainable urban planning principles in Curitiba (Brazil) and their applicability in Shiraz (Iran). Int. J. Dev. Sustain. 1 (2), 12–134.
Ståhlbröst, A., Bergvall-Kåreborn, B., Ihlström-Eriksson, C., 2015. Stakeholders in smart city living lab processes. In: American Conference on Information Systems, Puerto Rico. Available at: https://www.diva-portal.org/smash/get/diva2:1006027/FULLTEXT01.pdf.
Taniguchi, C., 2005. Curitiba and sustainability. In: Charlesworth, E.R. (Ed.), Cityedge: Case Studies - Contemporary Urbanism. Architectural Press, Oxford, pp. 198–208.
Thuzar, M., 2011. Urbanization in South-East asia: developing smart cities for the future? Reg. Outlook 96–100.
UNDESA, United Nations, 2015. World Population Prospects: The 2015 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.241. Available at: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf.
UNEP, 2014. Climate Finance for Cities and Buildings - a Handbook for Local Governments. UNEP Division of Technology, Industry and Economics (DTIE), Paris, pp. 1–68. Available at: www.unep.org/publications.
UNEP, 2016. The Emissions Gap Report 2016. United Nations Environment

Programme (UNEP), Nairobi.
UNhabitat, 2016. Urbanization and Development: emerging futures. World Cities Report. Available at: https://unhabitat.org/books/world-cities-report/.
Uysal, M., et al., 2016. Quality of life (QOL) and well-being research in tourism. Tour. Manage 53, 244–261.
Van Kamp, I., et al., 2003. Urban environmental quality and human well-being: towards a conceptual framework and demarcation of concepts; a literature study. Landscape Urban Plan. 65 (12), 5–18.
WCED - World Commission on Environment and Development, 1987. Report of the World Commission on Environment and Development: Our Common Future. United Nations, New York. http://www.un-documents.net/our-common-future.pdf. (Accessed 14 November 2016).
Web of Science, 2016. Search on "Topic": "smart Cit*" and "quality of Life" OR "subjective Well-being". http://webofknowledge.com/. (Accessed 30 November 2016).
Wolfram, M., 2018. Cities shaping grassroots niches for sustainability transitions: conceptual reflections and an exploratory case study. J. Clean. Prod. 173, 11–23.
Wolfram, M., 2012. Deconstructing smart cities: an intertextual reading of concepts and practices for integrated urban and ICT development. In: Proceedings REAL CORP 2012: RE-mixing the CITY – towards Sustainability and Resilience?, pp. 171–181.
World Health Organization WHO, 2016a. The World Health Organization Quality of Life (WHOQOL). http://www.who.int/mental_health/publications/whoqol/en/.
World Health Organization WHO, 2016. Urban Green Spaces and Health - a Review of Evidence (2016). Available at: http://www.euro.who.int/en/health-topics/environment-and-health/urban-health/publications/2016/urban-green-spaces-and-health-a-review-of-evidence-2016.
Yovanof, G., Hazapis, G., 2009. An architectural framework and enabling wireless technologies for digital cities & intelligent urban environments. Wireless Pers. Commun. 49 (3), 445–463.