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SMART CITY PERSPECTIVES OF BLOEMFONTEIN, SOUTH AFRICA

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ABSTRACT

To handle rapid urbanization, there is need to find new ways to manage complexity, increase efficiency, reduce expenses, and improve quality of life. The new ways are rooted in the concept of 'smart city'. The concept theorize that emerging technologies would shape urban environments in varying ways that would include but not limited to the economy, mobility, governance, and living conditions of a city. While this concept is now a reality in major cities in developed economies, this is not the case in South Africa and the region. Against this background, an evaluation of socio-economic and environmental capital of Bloemfontein has been used as a case example to demonstrate the transformational requirements for a 'smart city' in South Africa. The evaluation utilised 74 indicators, and 30 factors of six smart characteristics, which include economy, environment, governance, living and mobility. Reviewed literature and semi-structure surveys were used for the evaluation, which suggests that Bloemfontein is lagging behind concerning key development indicators. In particular, the evaluation indicates that the city lag performance relative to mobility, economy, people and living sector, although environment and governance features appear to be promising. An overall evaluation of the indicators and factors points to a major scope for the city to transform to a smart city, if plausible actions are taken.

Keywords: Environmental capital; Smart city; Socio-economic capital; Urban Development, Mobility; Governance

1. INTRODUCTION

The changed scenario of globalisation, market economy and technological developments has brought obvious economic and social infrastructural advantages to cities.

These phenomena have offered cities the potential to combine safe and healthy living conditions, enjoyable lifestyles with low levels of energy consumption, and resource-use (Moussiopoulos, Achillas, Vlachokostas, Spyridi, Nikolaou, 2010).

However, technological advances and consequent increase in economic opportunities have encouraged higher influx of people to the cities. As a result, the pressure on the infrastructural and civic requirements of cities has increased, and in the wake of the scarce availability of resources, cities have had to contend with a range of physical and environmental ailments (Moussiopoulos et al., 2010; Saavedra & Budd, 2009). Cities in South Africa also contend with urban development issues. According to many scholars, this challenge warrants a change in development planning viewpoints (De Swardt, Puoane, Chopra & du Toit, 2005; McGillivray, 2005; Naude, Rossouw, Krugell, 2009; Ramutsindela, 2002; Saff, 2001).

Most of the cities in South Africa are planned and developed by the use of the Integrated Development Plans (IDPs) with the statutory backing of the Spatial Development Frameworks (SDF) (Municipal Systems Act, No 32, 2000; SDF, 2011). Sustainability has also been integrated to the planning process in South Africa (Todes, 2011; Todes, Oelfose, & Sim, 2009). As a result, some of the cities have envisioned in their vision documents to make the cities a globally safe and attractive place to live, work and invest. The mission envisaged is to improve social and economic livelihoods through public participation, effective and efficient integrated governance systems and programmes (IDP, 2012). Parallel arguments however have emerged that achievement of the envisioned goals in the changed scenario of globalisation and technological advancements through conventional approaches are uncertain (Visser 2001; De Swardt, Puoane, Chopra & du Toit, 2005). Many scholars have argued that cities must move from the normal planning process towards growth and development based on the smart city concept so as to make cities sustainable (Farmer, Frojmovic, Hague, Harridge, Narang, and Shishido, 2006; Giffinger, Fertne, Kramar, Kalasek, Pichler Milanović, & Evert, 2007; Horn, 2002; Kotze & Donaldson, 1998; Lotter, 2002; Nomdo & Coetzee, 2002; Odendaal, 2011; Prinsloo & Cloete, 2002; Saff, 1995, 2001; Turok, 2001; UN- Habitat, 2009; Visser, 2001). Further, with the increased influence of technological advancements and environment in the wake of climate change on the city life, there is a call to look into the possibility of making the cities smart.

Development of a smart city is based on the performance of demographic, social, economic, mobility and environmental characteristics of the city and their influence on each other as well as on the city as a whole. Before attempting to plan to transform a city into a smart city, it is pertinent to evaluate the potential and opportunities the city offers and the challenges it faces. Therefore, the objective of the paper is to present the results of a study that evaluated the performance of smart characteristics of a city based on the indicators and factors influencing the smart characteristics of the city.

For this purpose, Bloemfontein – a middle size growing city, which functions as the capital of Free State province of South Africa as well as the judicial capital of the country, was chosen as the study area in this investigation.

In this regard, the scope of the research was limited to the evaluation of the strength and weakness of the city based on smart city indicators in terms of demographic, spatial, socio-economic, and environmental characteristics, which could aid to evolve plausible planning approaches in order to transform the city into a smart city.

2. SMART CITY CONCEPT

A smart city is a well performing forward-looking middle size city built on the combination of endowments and activities of self-decisive, independent and participative responsive citizens (Giffinger, 2007). Smart city concept is considered in a holistic manner with reference to various aspects, which range from Information and Communication Technologies (ICT) districts to smart populace in terms of educational level (Blignaut, 2009; Odendaal, 2006). Use of modern technology in everyday urban life (Brown & Czerniewicz, 2010; Odendaal, 2003), which includes innovative transport systems, infrastructures and logistics as well as green and efficient energy systems are often integral part of a smart city. Further, there is a strong relationship between government and citizens in terms of good governance. Certain other factors of urban life, which are associated with smart city, are participation, security/safety, and cultural heritage (Giffinger et al., 2007; Komminos, 2002; Lombardi, 2011a; Odendaal, 2003; Shapiro, 2008).

Furthermore, the smart city concept is derived from the combination of concepts of the Connected city (smart logistics and sustainable mobility), the Entrepreneurial city (economic vitality), the Pioneer city (social participation and social capital), and the Liveable city (ecological sustainability) (Holland, 2008; Nijkamp & Kourtik, 2011). However, there is no agreement on the exact definition of a smart city, although a number of important dimensions have been identified. The dimensions include smart economy (related to competitiveness), smart mobility (related to accessibility and connectivity); smart environment (related to natural resources); smart human capital (related to people); smart living (related to the quality of life) and smart governance (related to participation) (Giffinger et al., 2007; Komminos, 2002; Lombardi 2011b; Shapiro, 2008; Van Soom, 2009). Thus, a middle-sized city is considered to be a smart city if it demonstrates forward-looking development in these six important characteristics on the basis of a combination of local circumstances and activities carried out by politics, business, and the inhabitants. These dimensions are connected with traditional regional and neoclassical theories of urban growth and economic development. Particularly, these six dimensions are based on the theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities (Lombardi, 2011b; Komminos, 2002; Giffinger et al., 2007; Shapiro, 2008; Van Soom, 2009).

Smart economy refers to parameters around economic competitiveness such as, innovation, entrepreneurship, trademarks, productivity and flexibility of the labour market as well as integration in the national and international market.

The level of qualification or education of the citizens as well as essentially describes smart people by the quality of social interactions and integration, participation in public life and the receptive attitude, and openness towards the outer world. Smart governance encompasses facets of political participation, services for citizens and the functioning of the administration. Local and international accessibility in the form of sustainable physical transportation system, and ICT refer to smart mobility.

Smart environment is expressed by attractive natural conditions, i.e., climate, green open space, level of pollution, resource management and efforts towards environmental protection. Smart living includes various indicators of quality of life such as, culture, health, safety, housing, tourism, etc., (Giffinger et al., 2007).

Further, the smart growth principles advocate that the growth of a city is to weave together the various discourses of physical and spatial issues into a rational sustainable development that integrates economic, environmental and social equity issues. It also incorporates the micro level design aspects, such as, neighbourhood patterns, streets, public spaces, and pedestrian zones, etc., that are traditionally not dealt at the macro level, which invokes the notions of urbanity, where density, proximity and the visual and physical integrity of cityscapes create a sense of coherent community (Calthorpe & Fulton, 2000; Kunstler, 2001; Turner, 2007). It is a strategy that targets the physical development of urban regions having strong social, economic and political components with public participation and inclusive multi-actor planning processes (Jailly, 2008; Scot, 2007).

In this regard a ranking of smart cities in Europe was carried out under the research project smart cities- Ranking of European medium sized cities, in an aim to rank the medium sized cities based on their smartness and see the perspectives for development (Giffinger et al., 2007). The ranking also illustrated the differences in the respective characteristics and factors, elaborating specific perspectives for development and positioning and identifying strengths and weaknesses for the considered cities in a comparative way. It was revealed that Scandinavian cities and cities from the Benelux countries and Austria are ranked in the top group in addition to Montpellier and Ljubljana. Luxembourg, British, Irish and Danish cities as well as Eindhoven, Regensburg, Ljubljana and Linz performed best in achieving smart economy. Scandinavian cities as well as Dutch cities and Luxembourg are better in creating smart people. Further, Scandinavian and Austrian cities are very good in smart governance. Smart mobility is observed to be very good in the cities from Benelux countries and Denmark. However, French, Slovenian and Greek cities as well as Timisoara, which have not performed so well in the other smart characteristics, are better in smart environment. The smart living condition is lead by Austrian, Belgian and Finnish cities as well as Luxembourg and Umeå (Giffinger et al., 2007). Thus, it is appears that a city does not have to perform exceedingly well in all the six characteristics to become smart.

However, there are several challenges to evaluate the performance of characteristics of a city.

Giffinger et al. (2007), Etzkowitz (2008), and Lombardi, Giordano, Farouh & Wael (2011) have employed different methodologies to evaluate the performance of indicators and characteristics for smart city development. Giffinger et al. (2007) employed a methodology based on aggregate data obtained on various aspects of a city and standardization of the indicators in order to evaluate the performance of each indicator. Further, triple helix model (Etzkowitz, 2008) and a revised triple helix model (Lombardi et al., 2011) were proposed.

While the triple helix model is based on the three traditional helices of university, industry and government, the revised model works on the presupposition that civic involvement along with cultural and social capital endowments form important components alongside the three traditional helices (Etzkowitz & Zhou, 2006) and operates in a complex urban environment (Lombardi, 2011a). The interplay between these actors and forces and their causal logics determines the success of a city in moving on the smart development path (Saaty, 2005). These methods require aggregate structured statistical data along with primary data, and are mostly suitable for cities having availability of such structured data.

3. STUDY AREA AND JUSTIFICATION OF ITS CHOICE

The study area considered for this investigation was Bloemfontein city of Free state, South Africa. It is located at the latitude of 29.133 and longitude of 26.214 and almost at the centre of the country. It is the fifth largest city and part of Mangaung Metropolitan Municipality in South Africa. It functions as the capital of Free State province as well as the judicial capital of the country. Besides, it is well known for its educational and health facilities in the central region of the country. The city is connected to all parts of the country by all the three modes of communication such as road, rail and air. One of the International airports of the country is also located in the city facilitating connecting flights to major cities of South Africa and abroad. Also, it houses a number of regional centres of business corporate houses and professional institutions. Further, because of the availability of adequate basic urban infrastructure facilities including existence of transport and communication services, presence of skilled manpower and its proximity to Johannesburg - the largest city in South Africa and Pretoria - the capital city of the country, it has attracted a number of domestic and multinational industrial companies. The presence of ICT sector and Internet is real in the city. However, the growth of industrial activities, influx of population and enhancement of tertiary (service related) activities are increasingly creating pressure on urban infrastructure, and civic facilities and services. In addition, an East and West divide is seen in the form of unequal economic and spatial development in the city apart from its inherited apartheid history and issues of social segregation. The location advantage, the status as Metropolitan Municipality, proactive effort and vision of the city to become a globally competitive, attractive and safe city to live and work, availability of educational and health facilities offer opportunities to the city to transform to a competitive and smart city in the region. Therefore, the city was chosen as the study area for this investigation.

4. METHODOLOGY, DATA AND PERFORMANCE EVALUATION

Quantitative survey methodology was adopted for primary data collection. Primary data were collected through systematic stratified random sampling method by using pre-tested schedules at household level in selected areas of city.

Sample household survey schedules, which constitute questions, related to demography, economy, transportation, communication, governance, environment, and living conditions of the city, were prepared and pretested in the study area before conducting the survey. The household survey was conducted in the year 2011 from a total number of 270 selected households in six selected sub urban areas (40-50 schedule in each area) representing city by employing unstructured direct interview method. Care was taken while selecting the survey areas, considering the unequal socio-economic and spatial development in the city so that there would be proper representation of the city.

Secondary data (statistical and time series data) were collected from reviewed literature, in addition to the review of IDP 2012 (IDP, 2012) for the Mangaung Metropolitan Municipality, which is the Metropolitan administrative authority of Bloemfontein city. The data collected from secondary sources were found to be scanty and were utilised only to check the correctness, adequacy and suitability of the primary data wherever possible. Further, based on the primary data collected and analysis, mathematical equations based on the weighted average method for development of indices in each parameter (i.e., smart indicators, smart factors and smart characteristics) to understand the performance of parameters for development of smart city were established. The mathematical indices are as follows

Smart Index of each Indicator: Smart index of each indicator is defined as a function of points assigned to the indicator by the people and percentage of people assigned a particular value. It is presented by:

$$\mathbf{SII} = \frac{\sum(\mathbf{P} * \mathbf{X})}{\sum \mathbf{X}}$$

Where SII = Smart index of individual indicators,
P= Index values assigned to each indicator by respondents
X = Number of respondents favoured an index value

Smart Factor Index: Smart factor index is a function of cumulative smart indices of each indicator under a particular factor and the weightages of each indicator under each factor. It is presented by:

$$\mathbf{SFI} = \frac{\sum(\mathbf{SII} * \mathbf{Y})}{\sum \mathbf{Y}}$$

Where SFI= Smart factor index

SII = Smart index of individual indicators,
Y= Weightage of each Indicator in each factor assigned by the respondents

Smart Characteristics Index: Smart characteristics index is a function of cumulative smart factor indices of each factor under each characteristic and the weightages of each factor under each characteristic. It is presented by:

$$\mathbf{SCI} = \frac{\sum(\mathbf{SFI} * \mathbf{W})}{\sum \mathbf{W}}$$

Where SCI = Smart characteristics index
SFI= Smart factor index
W= Weightage of each factor in each characteristics assigned by the respondents

The above three indices were employed to evaluate the performance of each indicator, each factor and each characteristics in a scale – 3 to + 3 to observe the performance of Bloemfontein as a Smart City.

5. FINDINGS AND DISCUSSIONS

Before using the data for analysis, its reliability was tested through Cronbach's alpha (α). The α values for the smart indicators varied between 0.91and 0.93. The standard deviation of each indicator was within acceptable limits. Therefore, the results of the performance evaluation of smart indicators, factors and characteristics of the city can be used to evaluate the potential and weakness of the city. The results are presented in Table 1 to 6. The performance of indicators and factors under each smart city characteristics are herein discussed.

5.1 Economy

The economic conditions of the city were evaluated based on eleven indicators, which were grouped under six factors. Table 1 presents the performance of the smart economy indicators, factors and characteristics of the city. It was observed that employment rate in knowledge intensive sectors, un-employability rate, GDP per employee and air transport for passengers have relatively high positive values. In contrast, companies with headquarters in the city, patent applications per inhabitant and importance as decision-making centre have high negative values. Other indicators such as, self-employment rate, new businesses registered, proportion in part-time employment, R&D expenditure have low to moderate positive values. However, air transportation of freight has a moderate negative index value. Thus, the performance of the six factors based on the performance of the indicators observed to vary from moderate negative (-1.5) to moderate positive (2.0) values.

Of the six factors, while productivity (1.4) and flexibility of labour market (1.4) have moderate positive values, factors such as entrepreneurship (1.15) and innovative spirit (0.03) have low positive indices. However, the performance of international integration is negative (-0.615) and economic linkage and trademarks (-1.5) are negative.

Consequently, the smart characteristics index of economy of the city was found to be very low (0.34), although observed to be positive indicating lower performance in this sector of development.

Table1. Smart economy indicators, factors indices of the study area

Smart Indicators	SSI	Standard Deviation	Smart factor	SFI	Smart characteristics	SCI
R&D expenditure	1.0	0.23	Innovative spirit	0.03	Economy	0.34
Employment rate in knowledge-intensive sectors	1.2	0.25				
Patent applications per inhabitant	-2.5	0.34				
Self-employment rate	1.1	0.15	Entrepreneurship	1.15		
New businesses registered in proportion of existing companies	1.2	0.18				
Importance as decision-making centre	-1.5	0.21	Economic image and trademarks	-1.5		
GDP per employed person	1.4	0.17	Productivity	1.4		
Unemployment rate	1.5	0.24	Flexibility in labour market	1.4		
Proportion in part-time employment	1.3	0.23				
Companies with HQ in the city quoted on the national stock	-2.75	0.35	International integration	-0.62		
Air transport of passengers	1.5	0.25				
Air transport of freight	-1.3	0.18				
$\alpha = 0.93$						

5.2 People

There were 14 indicators and seven factors employed to measure the performance of the smart people index of the city.

Out of 14 indicators, nine indicators were found to be in positive zone whereas five are in the negative zone and the index values vary from -2.4 to +2.2 (Table 2). Indicators such as the importance of knowledge centre, basic qualification of people, and participation in public life have high positive indices, while social and ethnic plurality, share of nationals born abroad, immigration friendly environment and participation in lifelong learning have high negative values. Indicators such as flexibility and perception getting a new job, knowledge about country and province, affinity towards lifelong learning, creative people have low to moderate positive values. However, share of foreigners, share of nationals born abroad, participation in life long learning, immigration friendly environment and participation in voluntary works have moderate to high negative indices. Based on the performance of indicators, it was found that except level of qualifications (1.61), and flexibility (1.5), which have moderate to high values, all the other five factors performs poorly (Table 2). The factors such as affinity to lifelong learning (0.36), creativity (1.0), participation in public life (0.8), and cosmopolitanism / open mindedness (0.5), have low positive indices and social and ethnic plurality (-1.95) has high negative values. The performances of these factors lead to a very low smart people index of the city (0.406).

Table 2. Smart people indicator, factor and characteristic indices of the study area

Smart Indicators	SSI	Standard Deviation	Smart factor	SFI	Smart characteristics	SCI
Importance as knowledge centre	1.85	0.36	Level of qualification	1.61	People	0.406
Population qualified	1.9	0.38				
Language skills	1	0.19				
Participation in life-long-learning	-1.5	0.21	Affinity to life long learning	0.36		
Bank loan per inhabitants	1.2					
Participation in language courses	1.5	0.27				
Share of foreigners	-2.5	0.24	Social and ethnic plurality	-1.95		
Share of nationals born abroad	-2.4	0.40				
Perception of getting a new job	1.5	0.35	Flexibility	1.5		

People working in creative industries	1.0	0.23	Creativity	1.0
Voters turnout at elections	2.0	0.34	Participation in public life	0.8
Participation in voluntary work	-1.2	0.21		
Knowledge about the Country and Province	1.5	0.22	Cosmopolitanism / Open-mindedness	0.5
Immigration-friendly environment	-1.0	0.25		
$\alpha = 0.92$				

5.3 Governance

The governance system of the city was assessed based on ten indicators and three factors. While one of the ten indicators, city representative per resident under participation in decision making has higher positive index value (1.9), six indicators that include female city representatives (1.3), expenditure of municipality per resident (1.4), perception of quality of schools (1.8), children day care (1.5), perception of transparency of bureaucracy (1.5) and perception of fighting against corruption (1.5), have indices varying between moderately to relatively high positive values. However, political activities of inhabitants (-1.5) and importance of politics for inhabitants (-1.5), have moderate negative indices. These indicators lead to three factors, which signify the performance of the governance sector. Of these factors, public and social services (1.57), and transparent governance (1.3) have moderate values, and participation in decision-making (0.36) has a low value. All the factors are confined to positive zones leading to smart governance index of 1.073, which indicates that this sector performs moderately in the development process.

Table 3. Smart Governance indicator, factor and characteristic indices of the study area

Smart Indicators	SSI	Standard Deviation	Smart factor	SFI	Smart characteristics	SCI
City representatives	1.9	0.28	Participation in decision-making	0.36	Governance	1.073
Political activity of inhabitants	-1.5	0.23				
Importance of politics for inhabitants	-1.5	0.24				
Female city representatives	1.3	0.19				

Expenditure of the municipal per suburbs	1.4	0.18	Public and social services	1.57	
Children in day care	1.5	0.24			
Perception of quality of schools	1.8	0.32			
Perception on transparency of bureaucracy	1.1	0.16	Transparent governance	1.3	
Perception on fight against corruption	1.5	0.26			
$\alpha = 0.94$					

5.4 Mobility

Smart mobility of the city was evaluated based on nine indicators, which were further grouped into four factors. It was observed that five of the indicators, public transport network per inhabitant (-1.5), access to public transport (-1.5), quality of public transport (-2.0), green mobility share (-2.0), and use of economical cars (-1.5), have moderate to high negative indices. However, (inter) national accessibility (1.5), traffic safety (1.5) and computers in households (2.0), have moderate to relatively high positive index values, although internet access in households (0.5) has a low index value. Consequently out of the four factors, two of them, local accessibility through public transport network per inhabitant (-1.675) and sustainable, innovative and safe transport systems (-0.45) have negative indices, whereas (inter) national accessibility (1.3) and availability of ICT infrastructure (1.25) have low to moderate positive values, which result in a very low (0.106) smart mobility index in the city.

Table 4. Smart mobility indicator, factor and characteristic indices of the study area

Smart Indicators	SSI	Standard Deviation	Smart factor	SFI	Smart characteristics	SCI
Public transport network per inhabitant	-1.5	0.26	Local accessibility Public transport network per inhabitant	-1.675	Mobility	0.106
Access to public transport	-1.5	0.25				
Quality of public transport	-2.0	0.32				
International accessibility	1.5	0.26	(Inter)national accessibility	1.3		

			International accessibility		
Computers in households	2.0	0.35	Availability of ICT-	1.25	
Internet access in households	0.5	0.12	infrastructure Computers in households		
Green mobility share	-2.0	0.40	Sustainable, innovative and	-0.45	
Traffic safety	1.5	0.28	safe transport		
Use of economical cars	-1.5	0.30	systems Green mobility share		
α = 0.92					

5.5 Environment

Under environment sector except two indicators, such as, green space share and individual efforts on protecting environment, which have equal low index values (0.5), all other seven indicators - fatal chronic respiratory diseases (1.5), use of electricity per GDP (1.5), use of water per GDP (1.8), summer smog (1.85), opinion on nature protection (2.0) and sunshine (1.75) have moderate to high positive indices. Thus, it was observed while two factors such as environmental protection (0.875) and attractiveness of natural conditions (1.125) have lower positive indices, the other two factors- pollution (1.69), and sustainable resource management (1.65) have moderate positive index values. Consequently, the smart characteristic index of environment is found to be 1.125. The index suggests that this sector performs relatively better than other sectors of the city.

Table 5. Smart environment indicator, factor and characteristic indices of the study area

Smart Indicators	SSI	Standard Deviation	Smart factor	SFI	Smart characteristics	SCI
Sunshine	1.75	0.32	Attractiveness of natural conditions Sunshine	1.125	Environment	1.125
Green space share	0.5	0.12				
Summer smog	1.85	0.33	Pollution	1.69		
Particulate matter	1.7	0.30				
Fatal chronic respiratory diseases	1.5	0.28				
Individual efforts on protecting nature	0.5	0.12	Environmental protection	0.875		

Opinion on nature protection	2.0	0.36		
Use of water per GDP	1.8	0.30	Sustainable resource management	1.65
Use of electricity per GDP	1.5	0.26		
$\alpha = 0.93$				

5.6 Living

The smart living condition of the city was evaluated based on twenty indicators, which were grouped into six factors. Of all the indicators, three indicators, museum visits (-2.2), overnights stay per resident per year (-2.0), and importance of tourist locations (-1.75), have high negative indices and perception of personal safety (-0.5) has low negative index. Theatre attendance (1.0), hospital beds per inhabitant (1.0), doctors per inhabitant (1.0), perception on personal risk of poverty (1.0), poverty rate (0.75), death rate by assault (0.75), average living area per person (0.75), crime rate (0.5), satisfaction with personal housing situation (0.25), have lower positive index values. However, quality of educational system (1.9), perception of quality of health system (1.8), life expectancy (1.75), cultural facilities (1.7), and access to educational system (1.2), has moderately high positive indices. These indicators lead to six factors. The factors include cultural facilities, health conditions, individual safety, housing quality, educational facilities, tourist attractiveness and social cohesion. It was observed that educational facilities (1.57) has moderately high positive index; while health conditions (1.387), social cohesion (0.875) and housing quality (0.7), cultural facilities (0.475) and individual safety (0.17), have low positive indices. However, tourist attractiveness (-1.875) has a relatively high negative index value. Overall, although positive, the smart living characteristics index comes to 0.443, which is on the lower side of the scale.

Table 6. Smart living indicator, factor and characteristic indices of the study area

Smart Indicators	SSI	Standard Deviation	Smart factor	SFI	Smart characteristics	SCI
Cinema attendance	1.7	0.28	Cultural facilities	0.445	Living	0.413
Museums visits	-2.2	0.33				
Theatre attendance	1.0	0.16				
Life expectancy	1.75	0.30	Health conditions	1.387		

Hospital beds per inhabitant	1.0	0.15		
Doctors per inhabitant	1.0	0.18		
Perception quality of health system	1.8	0.29		
Crime rate	0.5	0.12	Individual safety	0.17
Death rate by assault	0.75	0.15		
Perception on personal safety	-0.5	0.14		
Share of housing fulfilling minimal standards	1.0	0.19	Housing quality	0.70
Average living area per person	0.75	0.15		
Satisfaction with personal housing situation	0.25	0.08		
Students per inhabitant	1.5	0.25	Education facilities	1.57
Access to the educational system	1.2	0.22		
Quality of the educational system	1.9	0.32		
Importance of tourist location	-1.75	0.30	Tourist attractiveness	-1.875
Overnights per year per resident	-2.0	0.38		

Perception on personal risk of poverty	1.0	0.18	Social cohesion	0.875
Poverty rate	0.75	0.16		
$\alpha = 0.92$				

In summary, it was observed that indicators such as qualified people, knowledge centre, perception of quality of schools, quality of educational system, perception of quality of health facilities, life expectancy, and city representatives have relatively higher index values in comparison to other indicators with positive indices. However, patent applications per inhabitant, importance as decision-making centre, companies with headquarters, participation in life-long-learning, share of foreigners, share of nationals born abroad, political activity of inhabitants, importance of politics for inhabitants, public transport network per inhabitant, access to public transport, quality of public transport, green mobility share, use of economical cars, museums visits, importance of tourist location, and overnights per year per resident have moderate to high negative indices. Consequently, key factors such as economic image and trademarks, international integration, social and ethnic plurality, local accessibility to public transport network per inhabitant, and tourist attractiveness have high negative indices and are responsible for the poor performance of the various smart characteristics of the city. In a nutshell, the observed smart characteristics of the case city have low positive indices.

5.7 Discussion

The evaluation of smart characteristics reveals that the city is lagging behind in almost all the smart characteristics. Particularly, the city performs very poorly in mobility, economy, people and living aspects, although it performs relatively better in the environment and governance aspects. However, the comparative analyses of the findings of this investigation with findings of various scholars revealed that the city provides ample evidence of its potential to transform to a smart city. For example, according to Caragliu, Del Bo, & Nijkamp (2009), a city becomes smart if investments in human and social capital, traditional (transport) and modern (ICT) communication infrastructure, judicious utilisation and management of scarce resources, and participatory governance stimulate sustainable economic growth and a high quality of life. This leads to a networked infrastructure that improves economic and political efficiency and enables social, cultural and urban development, which means infrastructure in terms of physical and ICT connectivity. In this regard, although perform poorly, the economic and mobility aspects of Bloemfontein city provide evidences of promise, which offers opportunities for their development. Further, there should be a strong focus on the social inclusion of residents of the city and equitable urban growth and extent of benefits from the infrastructure and consequent economic growth of the cities.

The indicators under characteristics such as people, governance and living provide ample evidence of people's participation, and representation in decision making relating to the development of the city. The role of creative cultures in cities is also emphasized as creative capital co-determines, fosters and reinforces trends of skilled migration.

Although the presence of a creative and skilled workforce may not guarantee urban performance, yet in a knowledge-intensive, and increasingly, globalized economy, they will increasingly influence success of cities (Glaeser, 2005, Nijkamp, 2008). There is also need for adaptability of the people in terms of learning and innovation (Coe, Paquet, and Roy, 2001) and able to utilise the technology and benefit from them. In this context, Bloemfontein city is essentially performing at a higher level in terms of higher education, health, use of technology and creativity, which are essentially highly encouraging parameters for it to become a smart city.

Further, social and environmental sustainability are major strategic components of smart cities. With limitation of resources, cities need to increasingly base their development and wealth on their strengths concerning natural resources, tourism and natural heritages, and their renewable use, whereby achieving a balance between the growth enhancing measures and protection of weak links (Glaeser, 2005). It was further observed that Bloemfontein has a very congenial environment with adequate green space, low level of pollution, willingness for protection of environment, low crime occurrence, acceptable conditions for tourist attraction, and availability of awareness among people and organizations for the environment, which indicate that city has ample potential to develop to a smart city.

6. CONCLUSIONS AND RECOMMENDATIONS

A smart city is essentially regarded as a well performing city in most of the six smart characteristics and development is based on citizen participation. The purpose of developing such a city is to enhance the capability of the potentials of the city and judicious resource management for optimal development of the city. The assessment of the current scenario of Bloemfontein city shows that although the city is lagging behind in many of its developmental indicators, most factors and characteristics have positive indices. This indicates that the city has ample potential to become a smart city.

The city obviously has inherent negative attributes, which pertain to inequitable spatial and economic developments, and social segregation due to historical; reasons. Besides, there are severe constraints in the form of cultural rigidity, lack of social flexibility and ethnic plurality, handicap in international integration, inadequate mobility, which may stand on the way of its development towards a smart city. Notwithstanding these weaknesses, the city has a democratic governance system with forward-looking proactive initiatives by the decision makers and the people as a whole, which may aid the city to follow the smart growth principles. Thus, there is a need to strengthen these weaknesses of city and augment the positive indicators of the city observed from the evaluation.

These indicators also need to be integrated to development plans, while developing and prioritising the programmes and schemes for the development of the city.

The contribution of this article is twofold. First, it aids to understand of the perspectives of a city to become a smart city through the evaluation of various development indicators, which can be integrated to the existing planning processes.

Second, it offers an alternative indicator driven methodology based on the primary data for evaluation of smart indicators, factors and characteristics of a city, where statistically structured data are scarce.

It is well recognized that the whole evaluation was conducted based on primary data, and perceptions of the people surveyed, which essentially is a limitation of the study. Besides, although most of the smart indicators have been fairly modified to represent a South African city, yet some of the indicators need to be customised pertinent to local (city) conditions. Therefore, in order to evolve detailed planning guidelines for the development of smart city, detailed investigations for each characteristic and development of causal logics among the indicators and factors are needed, which provides further scope to continue this research.

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Notes:

The factors and indicators used for the evaluation in this study have been located and extracted from

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