Anna M. Pozdniakova,
Postgraduate, Research Centre of Industrial Problems of Development of NAS of Ukraine
5 Svobody Sq., Derzhprom, 7 port., 61002 Kharkiv, Ukraine, mira37cle@gmail.com

SMART SUSTAINABLE CITIES: THE CONCEPT AND APPROACHES TO MEASUREMENT

Abstract
This article considers ICTs and the related Smart Sustainable city concept as tools to overcome urban challenges of the 21st century. The aim is to investigate different approaches applied to measuring "Smartness" and "Sustainability" of cities. Using our selection model, we identified 5 specific indexes for detailed comparison along with their results, namely which cities are the smartest and the most sustainable worldwide. We have also outlined the major concerns and limitations that exist in the indexes we covered in our research. This article is the first step on the way to developing a Smart Sustainable city index for Ukrainian cities.

Key words
Smart city, ICTs, informatization, sustainability, well-being, quality of life.

Introduction

Cities are sophisticated space-oriented formations that include a limited area, an urban environment (a complex of factors that impact objects and subjects presented within the area) and citizens. They quickly develop within time and space. The modern city can be compared with a lab, where the individual simultaneously creates and is a product of the surrounding environment [1].

Historically, cities were never considered as "places for developing human potential and talents". Ancient cities were created to protect citizens from foreign enemies. During the pre-industrial era, cities were centers of trade and crafts, and were later shaped as centers of industrialization. And only in the post-industrial era has the city become a center of intellectual development and innovations in all segments of the urban environment, marking a transitional stage for the establishment of a smart society [1].

Fast development of ICTs (Information and Communication Technologies), along with the cost reduction of mobile applications, free social media, cloud technologies and developments in the field of storage, processing and analysis of data have led to the emergence of new tools for understanding, communicating and forecasting urban functions [2].

Recently, the world has started to consider ICTs as tools of the 21st century that can help overcome the challenges posed by urbanization. Particularly, high levels of pollution, congestion, increasing demand for scarce resources, demographic changes, the ageing of population and related necessity of smart health solutions, and migration.

Related work

The topic has been actively studied and developed by many prominent academics, including Cohen [3], Giffinger [4], Lombardi [5], Schaffers [6], and Murray et al. [7]. Many famous institutions have taken part in the establishment of different indexes that measure sustainability and smartness, such as IESE [8], European Commission [9], ITU [10], OECD [11], and UN-Habitat [12], along with private institutions like Arcadis [13], Ericsson [14], and Huawei [15].

United Nations Habitat started a World Urban Campaign, including the "100 cities initiative," which is a forum for the best stories of changes in cities that aim for a smarter urban future [12]. The Smart Cities Challenge program was launched in 2010 by IBM with the idea of delegating experts to 100 cities around the world to help them deal with urbanization challenges [16].

Moreover, in the recently accepted 2030 Agenda for Sustainable development there is a specific goal (number 11) closely connected to the topic of our research, namely, “make cities and human settlements inclusive, safe, resilient and sustainable” [17].

Currently many cities are joining the "United for Smart Sustainable Cities" (U4SSC) initiative that encourages the use of ICTs to reach the goal of becoming smart and sustainable.

Objective and method

Different cities around the globe would like to join the concept of smart sustainable development to claim that they were able to implement “smart solutions” and prepare infrastructure for them so that they can be considered smart and sustainable.

But it is extremely difficult to confirm and validate such claims since there is not one generally accepted definition of “Smart Sustainable city” (SSC), and no common concept for comparing cities and their accomplishments.

Taking this into account, the aim of this article is to investigate different approaches applied to measuring smartness and sustainability of cities. The study compares the different methodologies and shortcomings to compose a Smart Sustainable city index for Ukrainian cities. The index will then serve as a tool to measure the progress of the concept’s implementation and will be comparable within the international agenda.

A method of theoretical, logical and systematic analysis of the literature (scientific papers, policy documents and statistical sources) was used to study various concepts of the “Smart Sustainable city,” along with the different methods for measuring “smartness” and “sustainability”. Methods of comparative analysis to compare various indexes among cities, along with descriptive and correlation analysis, were used in the article to consider the links between ICTs and selected socio-economic indexes.

Approaches to identify SSC

The concept emerged in the late 90s, while today it is being studied by academics, the business sector and governments. Each of these domains reviews the concept in a different way, which builds a broader common picture. Different terms can be encountered throughout the literature - “Digital city”, “Knowledge city”, “Green city”, “Creative city” - but even though the concepts might differ they all try to connect ICTs with economic, political and socio-cultural changes. Each concept aims to create a modern city with properly functional information processes and mechanisms that encourage creativity and innovations along with smart and sustainable solutions [18].

No doubt that technological solutions are the core component of the smart city concept. However, the definition of “smartness” cannot be limited only by the usage of ICTs. For example, Nam and Pardo in their work state that ICTs are only a tool for reaching the goal, not the goal itself [19].

Some authors add to the concept the word “sustainable” to the smart city concept, thus bringing the dialogue to a new level. We think it is important to investigate this question in more detail.

We find a definition of sustainable development in Brundtland Commission's report. It is stated that sustainable development is a "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" [20].

The International Telecommunication Union (ITU) outlines four main aspects on which the sustainability of a city is based:

- Economic: The ability to generate income and employment for the livelihood of the inhabitants;
- Social: The ability to ensure well-being (safety, health, education etc.) of the citizens can be equally delivered despite differences in class, race or gender;
- Environmental: The ability to protect future quality and reproducibility of natural resources;
- Governance: The ability to maintain social conditions of stability, democracy, participation, and justice [21].

As for the “smart” component in the concept, researchers distinguish two possible approaches [22]:

- Normative, which treats “smartness” as a desirable outcome and not as a tool;
- Instrumental, in which “smartness” is a tool to reach a set target, be it “sustainability” or something else.

In another work by Murray, Minevich, and Abdoullaev, three ways for cities to move to sustainability are described:

- Knowledge cities, which focus on lifelong learning and personal growth;
- Digital cities (cyber-cities), driven primarily by investments from large information and communications technology vendors aiming to connect everyone and everything by the means of high-speed networks, servers and data warehouses;
- Eco-cities, aiming for environmental sustainability using renewable resources [23].

But the authors stress that the ideal city requires the integration of all three approaches, which will lead to a new urban planning approach, namely, the smart city [23].

In 2014, ITU analyzed approximately 116 definitions of smart cities. They were obtained from a variety of sources including academic/research communities, government initiatives, international organizations, and corporate/company profiles. Six main factors for further analysis were chosen: smart living, smart people, smart environment and sustainability, smart governance, smart mobility and smart economy [10].

Based on the analysis, ITU suggested the following definition for a smart sustainable city: "A smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" [10].

In sum, it is hard to provide one common definition for SSC because the concept possesses some qualities and characteristics to make life of a city’s inhabitants better. In general, the characteristics can be grouped within 4 dimensions: Smart People, Smart Economy, Smart Environment, representing so-called triple bottom line, and Smart Governance. To this we add an ICTs component as a helping tool (Fig 1.).

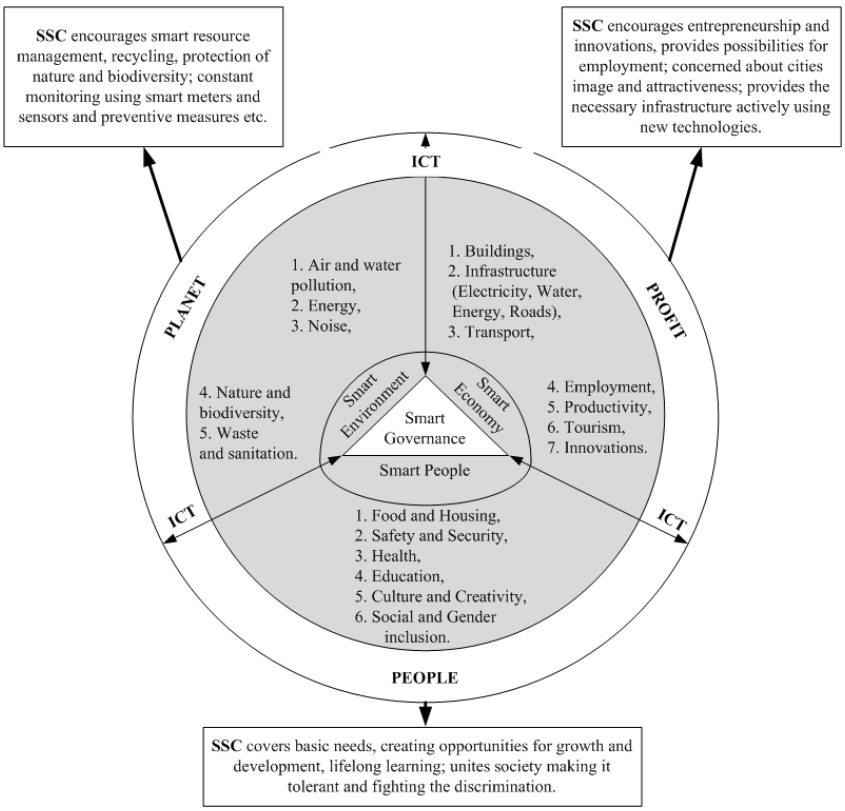

Fig.1. SSC components
Source: Author’s

A smart sustainable city:

- Meets the needs of its present generation;
- Provides equal opportunities for growth and development of each individual's potential;
- Does not compromise the ability of future generations to meet their needs;
- Does everything mentioned above in a smart way, using ICTs and other means.

*Smart way - the most optimal, safe way that does not break local and global environmental limitations.

We believe that "smart" answers the question "how?". "Sustainability," by contrast, answers the question, "What's the target?".

ICTs as a tool to improve quality of life

The spreading of ICTs (digitalization) is one of the most crucial stages in the process of preparing the foundations for the generation and usage of smart solutions. The next stage is informatization, which encourages communication and supports functionality. In the future, it allows taking into consideration social and environmental aspects, which is our final target.

Nowadays around 95% of the global population is covered by mobile-cellular networks, and around 40% of the world population is now estimated to be using the Internet. However, our world still faces digital gaps between developed and developing countries, as well as within some countries, based on gender and wealth [24].

In 2014, the adoption of The Connect 2020 Agenda was an important step. The Agenda specifies four main goals:

- Growth – enabling and fostering access to and increased use of ICTs.
- Inclusiveness – bridging the digital divide and providing broadband for all.
- Sustainability – managing challenges resulting from ICT development.
- Innovation and partnership – leading, improving and adapting to the changing technology environment [25].

Countries that adopted the Agenda committed themselves to the shared vision of "an information society, empowered by the interconnected world, where telecommunications/ICTs enable and accelerate social, economic and environmentally sustainable growth and development for everyone" [25].

Since 2009, ITU annually publishes reports that feature key ICT data and benchmarking tools to measure the information society, including the ICT Development Index (IDI).

IDI includes 3 sub-indexes:

1) ICT access (weight in index - 40%)
   - Fixed-telephone subscriptions per 100 inhabitants;
   - Mobile-cellular telephone subscriptions per 100 inhabitants;
   - International Internet bandwidth (bit/s) per Internet user;
   - Percentage of households with a computer;
   - Percentage of households with Internet access.
2) ICT use (weight in index - 40%)
   - Percentage of individuals using the Internet;
   - Fixed-broadband subscriptions per 100 inhabitants;
   - Active mobile-broadband subscriptions per 100 inhabitants.
3) ICT skills (weight in index - 20%)
   - Adult literacy rate 100;
   - Secondary gross enrolment ratio;
   - Tertiary gross enrolment ratio [24].

The diagram below (Fig.2.) shows the IDI distribution among countries. All countries roughly fall into three groups:

- Countries with low level of ICTs development (26%) - [1;3],
- Countries with average level of ICTs development (38%) - (3;6],
- Countries with high level of ICTs development (36%) - (6;10].

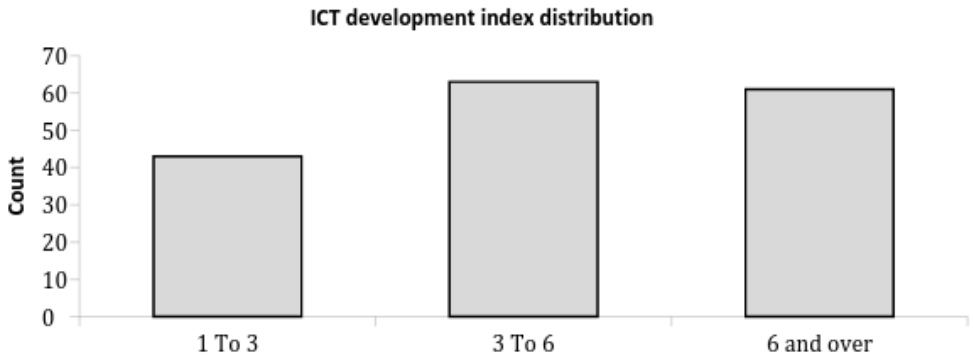

Fig.2. ICT development index distribution (2016)
Source: [24]

We have compared the level of IDI along with Human Development Index [26] and Corruption Perception Index [27] (see Fig.3. and Fig.4.), since these two indexes can be helpful in getting a general picture of the quality of life in different countries. Results show a positive correlation, indicating that there is a relationship. The correlation suggests that ICTs can be one of the tools for improving the wellbeing of people.

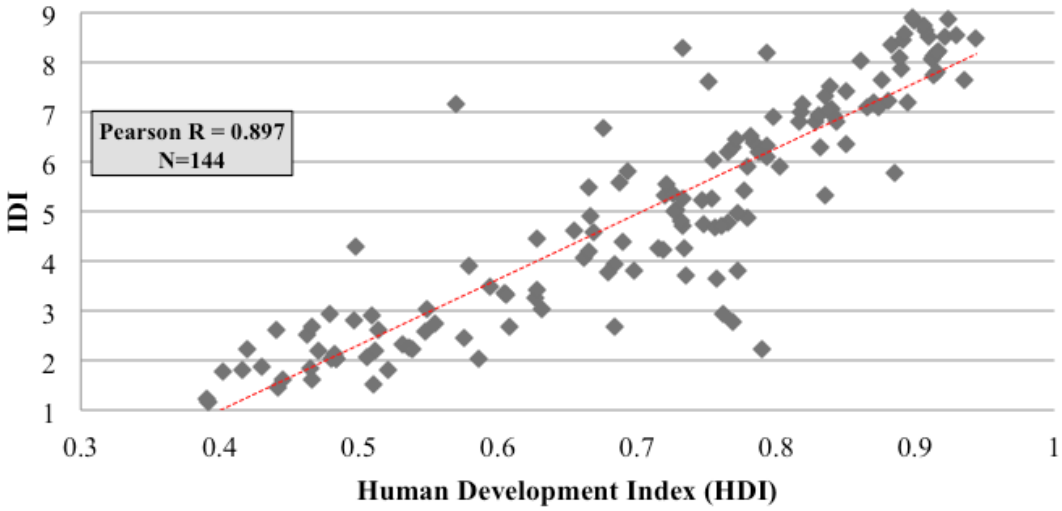

Fig.3. Correlation between IDI and HDI (2016)
Source: [24,26]

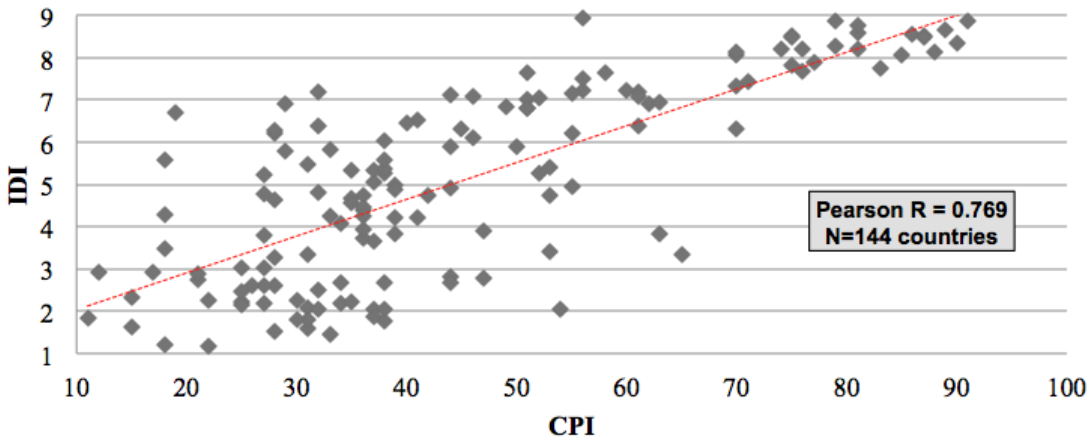

Fig.4. Correlation between IDI and CPI (2016)
Source: [24,27]

It is worth mentioning that dynamic ICTs development might also impose certain risks, particularly in the area of cybersecurity. The Global Cybersecurity Index (GCI) [28] measures the commitment of countries to cybersecurity. It is a composite indicator covering legal measures, technical measures, organizational measures, capacity building, and cooperation.

We have built a correlation chart between GCI and IDI. The results show that even countries with high level of ICTs development do not always have a good level of protection from cybercrimes (see Fig.5., Cluster 3). This question requires extra attention because any decision or tool should be not only effective but also safe.

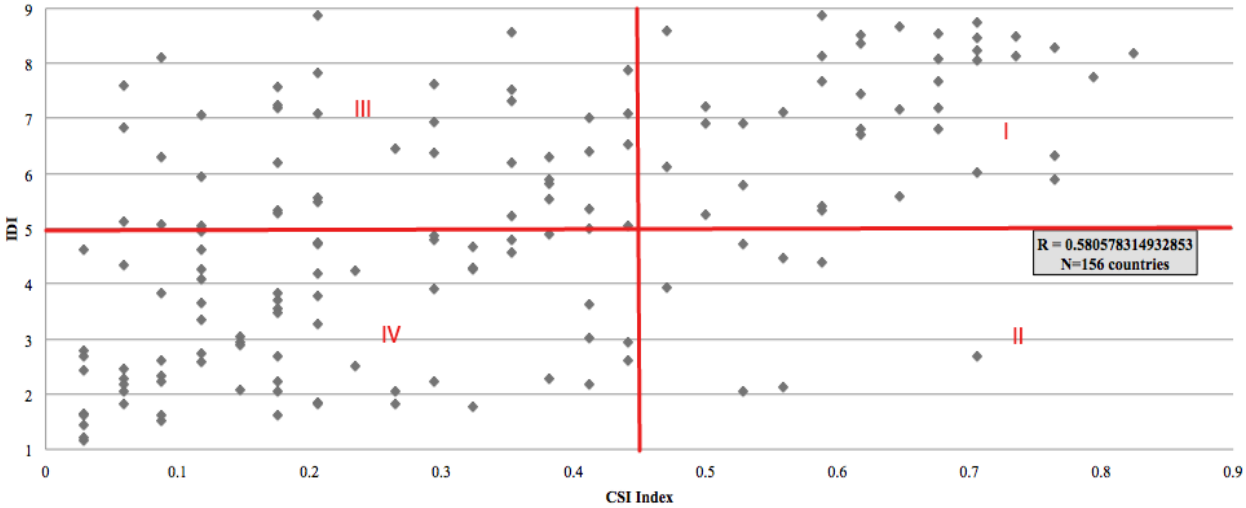

Fig.5. Correlation between IDI and CSI.
Source: [24,28]

Studies reveal that ICTs create new jobs on the market, save money thanks to moving off-line state services to online, encourage innovations in health and education, and incorporate smart systems in environmental protection and infrastructure, such as smart grids and intelligent traffic systems etc. [14].

Cooperation, digitalization, automatization, smartization, and the "Internet of things" are only several examples that ICTs bring to our society. Applied separately, however, none of these concepts guarantees improvements in sustainability or wellbeing. That is left to people and society, who must turn to wise governance to turn these concepts into the effective tools.

Measuring "Smart Sustainable cities"

Indexes allow analyzing trends and estimating the influence of political decisions that are taken to improve citizen wellbeing. They help identify the main areas that require more attention from managers and city leaders, as well as areas that are the most successful. Indexes serve as a tool to compare cities with each other on the initial stage of concept implementation and as a tool to measure the progress of a city within a defined time period. We outlined the ways in which indexes can be useful for different stakeholders (Fig.6.).

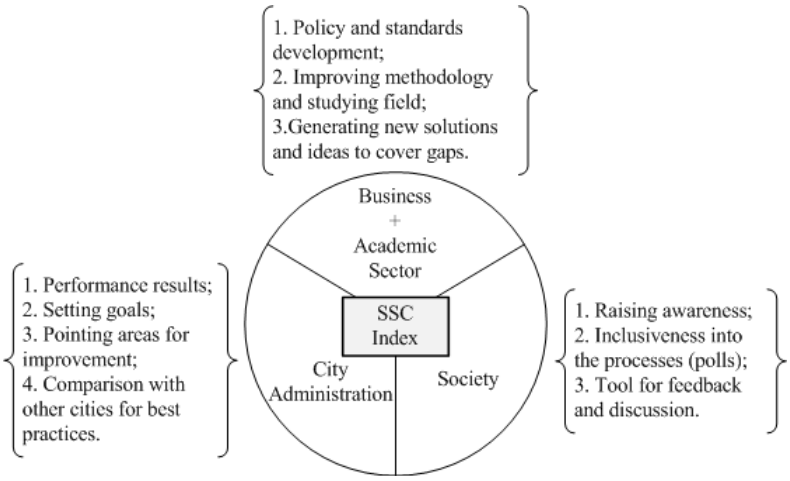

Fig.6. Index positioning in SSC concept for different stakeholders
Source: Author's

We can distinguish several types of indexes using different criteria. There are international indexes that cover cities from different countries worldwide, and national ones that rank cities within one country (e.g. Italy Smart system, and China smart system indexes). In terms of actors, we can outline indexes developed by the academic sector (e.g. Vienna University of Technology and IESE business school), by the private sector (e.g. Ericsson and Siemens) and government. Moreover, we can specify indexes that measure only one characteristic of smartness/sustainability or a complex of those.

In our current research, we decided to focus on international indexes that compare cities from different countries and estimate "smartness/sustainability" as a complex parameter. Below is the methodology of our selection process (Fig.7.).

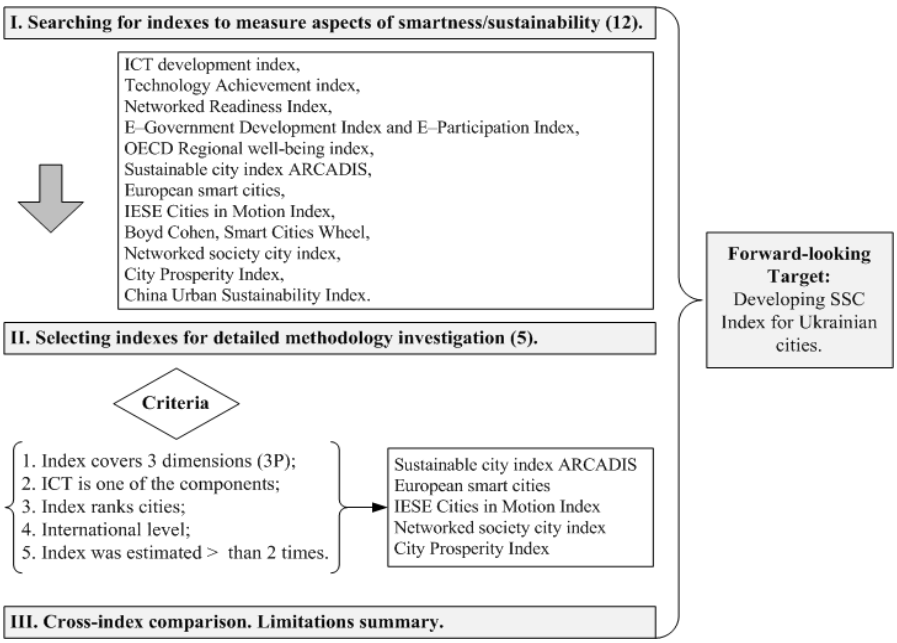

Fig.7. Selection methodology
Source: Author's

We provide more details for the selected indexes and summarize the information into the table in the following section.

ARCADIS sustainable cities index

The ranking is published by consultancy company Arcadis, starting from 2015 when the company selected 50 prominent cities worldwide. They were ranked as places to live according to their environmental footprint and financial stability, taken together. Due to the changes in the number of cities and parameters it is hard to compare the results dynamically. The rating is based on 3 components ("3P" concept): people, planet and profit. They cover social, economic and environmental aspects of development (see Fig.8.). In the 2016 report, 32 parameters were used to analyze 100 cities [13].

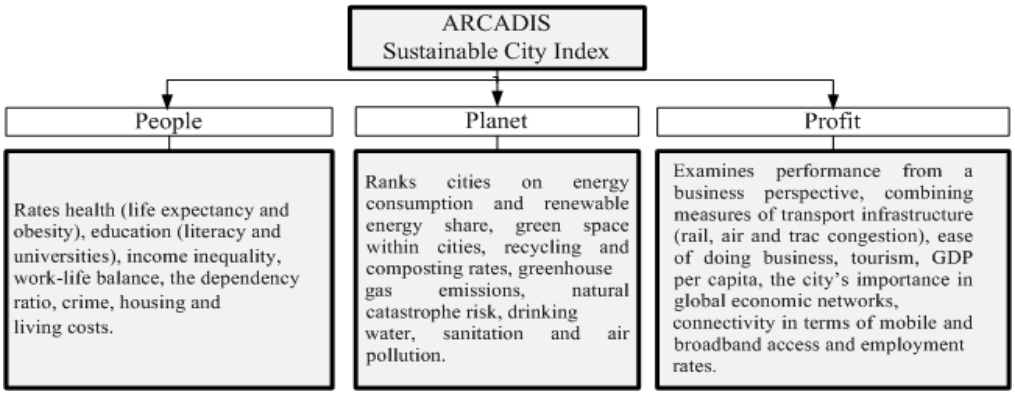

Fig.8. Arcadis sustainable city methodology

Source: [13]

Parameters within each category are averaged to calculate each component's score. Each city is then assigned a percentage score, which shows its place in relation to the others.

European cities dominate the general rankings, taking 16 out of 20 top positions, followed by prominent Asian cities like Singapore (2 place), Seoul (7th place), and Hong Kong (16th place).

The results show that most cities are unable to successfully balance between the three categories of "people", "planet" and "profit". Being a leader in one of these areas does not automatically guarantee leadership in others [13].

Table 1. Leaders in Acradis sustainable city index

General Index	People	Profit	Planet
Zurich	Seoul	Singapore	Zurich
Singapore	Rotterdam	Hong Kong	Stockholm
Stockholm	Hamburg	London	Geneva
Vienna	Vienna	Dubai	Vienna
London	Berlin	Zurich	Frankfurt
Frankfurt	Prague	Edinburgh	Wellington
Seoul	Amsterdam	Prague	Rome
Hamburg	Munich	New York	Sydney
Prague	Muscat	Paris	London
Munich	Montreal	Stockholm	Hamburg

Source: [13]

The researchers recommend that cities pay more attention to the "people" component since its development can help improve the other components.

Cities in Motion Index

This index was developed by the Spanish business school IESE in 2013. Its developers believe that civil society will be able to change cities from "smart" to "wise". The version of 2016 index covers 10 dimensions (77 components) and 181 cities [8]. The dimensions include:

1) Human capital. Human development is one of the priorities for every city. That's why smart management includes attraction and development of talents, improvement of the education system, and the encouragement of creativity and innovations.

2) Social cohesion. It measures the consensus that exists between different social groups and individuals. Within cities, examples may include consensus between people with different incomes, culture, age and profession.

3) Economy. Includes all the steps that are aimed to facilitate economic development of the area and, in perspective, lead to the increase in living standards.

4) Public management mainly deals with the effectiveness of city administration and includes tax policy, finance system, the international importance of a city, and opportunities for leaders to freely express their opinion in different sources (e.g. Twitter).

5) Governance, which typically shows the effectiveness of state intervention. But since in cities citizens are the focal point of all events, this dimension covers public participation and involvement of civil society, along with the business sector, as well as the implementation of e-governance.

6) The environment. This dimension covers measures that are necessary to fight pollution, such as support for green buildings, renewable energy projects, and the effective management of resources.

7) Mobility and transportation. Requires a balance between the needs of the citizens to reach a necessary point of destination and the resulting levels of pollution that are caused.

8) Urban planning. The main target of this dimension is the improvement of the living area, such as the establishment of compact, well connected cities with available public services.

9) International outreach. Covers the position of the city on an international arena, brand creation, and its acceptance and openness.

10) Technologies allow estimating ICTs availability and coverage, along with the quality of the provided web-services.

IESE analysts apply the DP2 technique for index estimation. Methodology is based on the difference between the actual value of the indicator and set targeted value. After this, cities get split into 4 categories: high performance (index>90), relatively high (between 60 and 90), average (between 45 and 60) and low (below 45).

The top ten cities include four European and four US cities, with New York taking the top place.

The following conclusions were drawn from the analysis:

1) It is impossible to build one model of success. Cities should begin from the vision of what exactly they would like to build and what should be improved.
2) It's not enough to be a leader in one of the directions, because this causes unbalanced development and does not lead to sustainability.
3) There are no ideal cities and changes happen very slowly.
4) Cities do not operate isolated, that's why city leaders should be able to estimate possible threats and opportunities within the national context [8].

Networked society index

In 2016, Ericsson and Sweco (leading consultancy in sustainable development) conducted a new research that covered 41 cities. The main target of this index is to measure the performance of cities from two perspectives: their ICT maturity and their sustainable urban development (the Triple Bottom Line) [14]. ICT maturity is measured based on infrastructure, affordability and usage, while the Triple Bottom Line covers 3 dimensions: social, economic and environmental (see Fig. 9).

This is a hierarchical index model, where sub-indexes possess different weights. The authors use geometrical aggregation and a "Min-Max" normalization model.

The aim of the study is to find how ICTs can help speed up the achievement of Sustainable Development Goals.

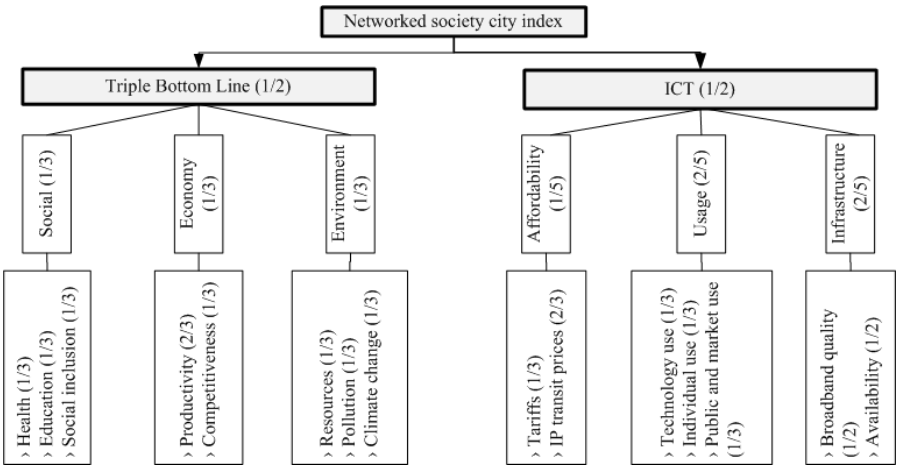

Fig.9. Index methodology

Source: [14]

It is worth mentioning that none of the cities in the ranking can be considered environmentally sustainable, even those taking the leading positions.

The study reveals that ICT maturity has higher correlation with socio-economic development than with environmental sustainability. Nonetheless, Ericsson states that ICTs have positive impact on the levels of CO2 emissions and may allow decreasing those by up to 15% by 2030 [14].

Among the top-10 there are six European cities, with Stockholm taking the top position, and three Asian cities.

City Prosperity Index

The index was founded by UN-Habitat in 2012 as a tool to measure the city's sustainability [29]. In 2013, the organization received numerous requests from the cities worldwide to estimate their level of prosperity and this made initiative global. The tool is based on four scenarios:

- Global city ranking (local and global monitoring),
- Basic City Prosperity Index (initial analysis, results are internationally comparable),
- Extended City Prosperity Index (In-depth Diagnosis Comparable within country),
- Conceptual City Prosperity Index (Policy performance and urban monitoring tool).

The version of 2015 covers 60 cities worldwide. Dimensions used for the index are presented in the table below.

Table 2. Components of City Prosperity Index

Category	Sub-category	Indicator
Productivity (1/6)	Economic Strength	City Product per capita
	Employment	Unemployment Rate

Category	Sub-category	Indicator
Infrastructure (1/6)	Housing Infrastructure	- Improved Shelter - Access To Improved Water
	Social Infrastructure	Physicians Density
	ICT	Internet access
	Urban mobility	Traffic fatalities
Quality of life (1/6)	Health	- Life Expectancy at birth - Under-Five Mortality Rate
	Education	- Literacy Rate - Mean Years of Schooling
	Safety and security	Homicide Rate
Equity and Social Inclusion (1/6)	Economic equity	- Gini Coefficient - Poverty Rate
	Social inclusion	- Slum Households - Youth Unemployment
	Gender Inclusion	Equitable Secondary School Enrolment
Environmental Sustainability (1/6)	Air Quality	PM2.5 Concentration
	Waste management	Waste Water Treatment
	Energy	- Share of Renewable Energy - CO2 Emissions
Governance and Legislation (1/6)	Participation	Voter Turnout
	Institutional Capacity	Days to Start a Business

Source: [29]

Cities are classified using the scale 0 - 100, where levels between 80 and 100 mean very solid prosperity. Among the leaders six European cities, Oslo takes first place. We have created a common table for the indexes described above.

Table 3. Indexes measuring smartness/sustainability

Index	Created by	Year/frequency	N of cities	What's measuring
Arcadis Sustainable Cities Index	Arcadis and the Centre for Economic and Business Research	2015/annually	100	Urban sustainability that encompasses measures of the social, environmental and economic health of cities.
Cities in Motion Index	IESE Business School	2013/annually	181	Future sustainability of the world's main cities as well as the quality of life of their inhabitants.
Networked society city index	Ericsson	2011/annually	41	Describes the development status of cities worldwide in terms of their ICT maturity and triple bottom line effects derived from ICT.
City Prosperity Initiative (CPI)	UN-Habitat	2012, 2015	60	The way cities create and distribute socio-economic benefits or prosperity and the overall achievements of the city.
European Smart cities	Vienna University of Technology	2007, 2013/annually	90	City functioning in six characteristics (smart economy, smart mobility, smart environment, smart people, smart living, smart governance).

Source: Author's based on [8, 13, 14, 29]

We have built a table with the leading cities from different indexes to compare the results. By color we have selected cities that met at least three out of four indexes (see Table 4).

Table 4. Cross-index results comparison

Arcadis sustainable city index	**Cities in motion index**	**Networked society index**	**City prosperity index**
Zurich	New York	Stockholm	Oslo
Singapore	London	London	Copenhagen
Stockholm	**Paris**	Singapore	Stockholm
Vienna	San Francisco	Paris	Helsinki
London	Boston	Copenhagen	Paris
Frankfurt	Amsterdam	Helsinki	Vienna
Seoul	Chicago	New York	Melbourne
Hamburg	Seoul	Oslo	Montreal
Prague	Geneva	Tokyo	Toronto
Munich	Sydney	Seoul	Sydney
100	181	41	60
8 European cities	4 European cities	6 European cities	6 European cities

Source: Author's based on [3, 11, 15, 16]

In all indexes, European cities prevail in the leading top-10 list. Stockholm, London, Seoul and Paris are the cities that are met 3 out of 4 indexes.

There is also another index (European Smart cities by Vienna University of Technology), which does not fully qualify according to our methodology to be included into our study due to its geographic limitations (only European cities of medium size are included). But we still consider the index as worth mentioning in our work due to the detailed methodology it is based on.

Accordion to the concept, "A Smart City is a city well-performing in a forward-looking way in six characteristics (smart economy, smart mobility, smart environment, smart people, smart living, smart governance), built on the "smart" combination of endowments and activities of self-decisive, independent and aware citizens" [30].

The study includes 74 indicators that were combined in 31 factors to illustrate 6 criteria mentioned above. The study of 2015 included 90 medium-sized cities (300.000 – 1 mln) from 21 countries. The first study was conducted in 2007. In 2015, the top-10 list included three cities from Denmark, three cities from Finland, and two cities from Austria, along with Luxembourg and one city from Norway [30].

Limitations of indexes measuring smartness/sustainability

Having examined many indexes, we think it is important to describe the constraints that exist in such indicators since they should be taken into account when creating the index for Ukrainian cities.

1) From methodological point of view, a high correlation takes place between the components of the index. This should be taken into account when assigning weights to the components in the general index to avoid the double-counting issue. There is also lacking one common, clear, user-friendly, statistically significant procedure for aggregation and weighting of the different components. It is the subjective decision of the researcher [31];

2) From statistical point of view, it is often impossible to receive all the necessary data on the city level. Most data are available on the regional, district or national levels. Researchers must use average values, which can lead to distortions of the final result accuracy.

3) In terms of comparability, in most cases it is impossible to compare the results for different years, due to the changes in methodology and the number of cities that participate.

4) In terms of coverage, most studies focus on big prominent cities (typically capitals), avoiding medium and small-size cities [32].

Conclusions

Indexes are great and important tools for city leaders and managers to monitor weaknesses along with the impact particular steps might have on city positions, and for the business sector and academics to develop smart solutions for particularly problematic areas. They serve as indicators for society to raise awareness and engage people in the development and decision-making processes. They could be a starting point for the common dialogue to make our cities safer, more environmentally- and citizen-friendly, as well as a great tool to monitor progress.

The current article reviews the SSC concept and provides the authors' interpretation of the term and concept. Our main aim was to investigate different concepts and methodologies that allow measuring Smart Sustainable Cities and comparing them worldwide. We have conducted an initial index selection process, setting the criteria to find the indexes that suit our studying purposes the best. As a result, we have selected five indexes, analyzed them in more detail, and presented the summarized results into the table. We have also created a comparison table for the results that indicate common trends, even though different methodologies are applied.

In our opinion, all indexes have their own advantages and disadvantages. For example, in the Arcadis Sustainable Cities Index, Cities in Motion Index and City Prosperity Index, the "Technology" component is quite poorly presented and has low weight. The Networked Society Index and Arcadis Sustainable Cities Index lack a "Governance" component in their methodology. European Smart Cities Index is the only index that includes medium sized cities instead of just capitals, and also includes quite interesting components (open-mindedness, engagement in creativity industries etc.), but they are difficult to measure in cities beyond the European Union.

We would like to base our future index on the idea of multi-level analysis, varying from a simple comparison tool to a proper performance analysis tool (based on City Prosperity Index) and the model of Ericsson Networked Society Index (due to the high weight/importance of Technology component), but including a Governance component. It is desirable to take as a basis internationally approved methodology to ensure in the future that our cities are comparable within international frameworks. But our current goal is to create a tool to analyze the cities and set the standards for them within the national boundaries, which allows us to monitor progress.

We also believe that our first and foremost aim should be not for the Smart Sustainable cities themselves, but for the encouragement and development of intelligent behavior and smart citizens that will be able to implement and develop this concept in future.

References

[1] N.Yarosh, A smart city a city of tolerance. The Economic journal, 2014, issue 2 (34), pages 76-84.

[2] IBM (2009). A vision of smarter cities.. [ONLINE] Available at: https://www-03.ibm.com/press/attachments/IBV_Smarter_Cities_-_Final.pdf. [Last Accessed 8 February 2017].

[3] B. Cohen (2011). The Top 10 Smart Cities On The Planet. [ONLINE] Available at: http://www.fastcoexist.com/1679127/the-top-10-smart-cities-on-the-planet. [Last Accessed 8 February 2017].

[4] R. Giffinger, et al. Smart Cities Ranking of European Medium-sized Cities. Centre of Regional Science, Vienna UT, Oct. 2007. 28 p. [ONLINE] Available at: http://www.smart-cities.eu/download/smart_cities_final_report.pdf. [Last Accessed 8 February 2017].

[5] P. Lombardi, New Challenges in the Evaluation of Smart Cities, Network Industries Quarterly, Vol. 13, 2011. [ONLINE] Available at: http://newsletter.epfl.ch/mir/index.php?module=epflfiles&func=getFile&fid=241&inline=1. [Last Accessed 8 February 2017].
[6] H. Schaffers, N. Komninos, P. Tsarchopoulos, M. Pallot, B. Trousse, et al., Landscape and Roadmap of Future Internet and Smart Cities, 2012, 222 pp.
[7] Art Murray, Mark Minevich and Azamat Abdoullaev (2011). The Future of the Future: Being smart about smart cities. [ONLINE] Available at: http://www.kmworld.com/Articles/Column/The-Future-of-the-Future/The-Future-of-the-Future-Being-smart-about-smart-cities-77848.aspx. [Last Accessed 8 February 2017].
[8] IESE (2016). Cities in Motion Index. [ONLINE] Available at: http://www.iese.edu/en/faculty-research/research-centers/cgs/cities-motion-strategies/?_ga=1.250510531.491872120.1449127639. [Last Accessed 8 February 2016].
[9] The European Innovation Partnership on Smart Cities and Communities. [ONLINE] Available at: http://ec.europa.eu/eip/smartcities/. [Last Accessed 8 February 2017].
[10] ITU-T Focus Group on Smart Sustainable Cities (2014). Smart sustainable cities: An analysis of definitions. [ONLINE] Available at: http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx. [Last Accessed 8 February 2017].
[11] OECD (2016). Regional Well-Being. [ONLINE] Available at: https://www.oecdregionalwellbeing.org. [Last Accessed 8 February 2017].
[12] UN-Habitat. The 100 Cities Initiative. [ONLINE] Available at: http://mirror.unhabitat.org/content.asp?typeid=19&catid=634&cid=9297&activeid=7545. [Last Accessed 8 February 2017].
[13] Arcadis (2016). Sustainable cities index 2016. [ONLINE] Available at: https://www.arcadis.com/media/0/6/6/%7B06687980-3179-47AD-89FDF6AFA76EBB73%7DSustainable%20Cities%20Index%202016%20Global%20Web.pdf. [Last Accessed 8 February 2017].
[14] Ericson (2016). Networked City Index 2016. [ONLINE] Available at: https://www.ericsson.com/res/docs/2016/2016-networked-society-city-index.pdf. [Last Accessed 8 February 2017].
[15] Huawei (2016). Assessment of Strategy and Execution of the UK's Leading Smart Cities. [ONLINE] Available at: https://www.huawei.eu/sites/default/files/Huawei_UK_Smart_Cities_Report.pdf. [Last Accessed 8 February 2016].
[16] Smarter Cities Challenge, IBM. [ONLINE] Available at: https://smartercitieschallenge.org. [Last Accessed 8 February 2017].
[17] Transforming our world: the 2030 Agenda for Sustainable Development (2015). [ONLINE] Available at: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E. [Last Accessed 8 February 2017].
[18] Ari-Veikko Anttiroiko, Pekka Valkama, Stephen J. Bailey, Smart Cities in the New Service Economy: Building Platforms for Smart Services, Springer-Verlag London 2013, 22 June 2013. https://www.researchgate.net/publication/257334202_Smart_Cities_in_the_New_Service_Economy_Building_Platforms_for_Smart_Services.
[19] T. Nam, T. A. Pardo (2011). Conceptualizing Smart Sustainable City with Dimensions of Technology, People, and Institutions. [ONLINE] Available at: http://www.ctg.albany.edu/publications/journals/dgo_2011_smartcity/dgo_2011_smartcity.pdf. [Last Accessed 8 February 2017].
[20] Sustainable development - concept and action, UNECE. [ONLINE] Available at: http://www.unece.org/oes/nutshell/2004-2005/focus_sustainable_development.html. [Last Accessed 8 February 2017].
[21] Key performance indicators definitions for smart sustainable cities, ITU (2015). [ONLINE] Available at: https://www.itu.int/en/ITU-T/ssc/Pages/KPIs-on-SSC.aspx. [Last Accessed 8 February 2017].
[22] Höjer, M., Wangel, J.: Smart Sustainable Cities: Definition and Challenges. In: Hilty, L.M., Aebischer, B. (eds.) ICT Innovations for Sustainability. Advances in Intelligent Systems and Computing 310. Springer

International Publishing (2014, in press).
[23] Art Murray, Mark Minevich and Azamat Abdoullaev (2011). The Future of the Future: Being smart about smart cities. [ONLINE] Available at: http://www.kmworld.com/Articles/Column/The-Future-of-the-Future/The-Future-of-the-Future-Being-smart-about-smart-cities-77848.aspx. [Last Accessed 8 February 2017].
[24] Measuring the Information Society Report 2015, ITU [ONLINE] Available at: http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2015/MISR2015-w5.pdf. [Last Accessed 8 February 2016].
[25] Connect 2020 Agenda for global telecommunication/information and communication technology development. [ONLINE] Available at: https://www.itu.int/en/connect2020/PublishingImages/Pages/default/Connect-2020.pdf. [Last Accessed 8 February 2017].
[26] Human Development Index (HDI). [ONLINE] Available at: http://hdr.undp.org/en/content/human-development-index-hdi. [Last Accessed 8 February 2017].
[27] Corruption perceptions index. [ONLINE] Available at: http://www.transparency.org/research/cpi/overview. [Last Accessed 8 February 2016].
[28] The Global Cybersecurity Index (GCI) (2015). [ONLINE] Available at: http://www.itu.int/dms_pub/itu-d/opb/str/D-STR-SECU-2015-PDF-E.pdf. [Last Accessed 8 February 2017].
[29] City prosperity index. (2015). [ONLINE] Available at: http://unhabitat.org/wp-content/uploads/2016/02-old/CPI_2015%20Global%20City%20Report.compressed.pdf. [Last Accessed 8 February 2017].
[30] "European Smart Cities". [ONLINE] Available at: http://smart-cities.eu./. [Last Accessed 8 February 2017].
[31] HANDBOOK ON CONSTRUCTING COMPOSITE INDICATORS: METHODOLOGY AND USER GUIDE – ISBN 978-92-64-04345-9 - © OECD 2008.
[32] Roberta De Santis and Alessandra Fasano and Nadia Mignolli and Anna Villa. Smart city: fact and fiction. MPRA Paper No. 54536, posted 20. March 2014. [ONLINE] Available at: https://mpra.ub.uni-muenchen.de/54536/1/MPRA_paper_54536.pdf [Last Accessed 8 February 2017].