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**SMART CITY STRATEGIES “LONDON-STOCKHOLM-VIENNA-KYIV”:
IN SEARCH OF COMMON GROUND AND BEST PRACTICES**

Abstract

The article aims to analyse the strategies of the selected progressive smart cities (London-Stockholm-Vienna) based on the methodology described below along with the strategy of the emerging smart city (Kyiv). The idea is to see which components of Smart Sustainable city Framework are covered by the “actual” strategies and how they are presented, which projects are currently underway and prioritised and how the evolvement process goes in different cities. We wanted to find common elements and approaches among the selected cities along with the best practices which can be taken into account by the cities when developing their own Smart City Strategy based on the experience already available.

Key words

Smart Sustainable city, strategy, ICT, sustainability, digitalization, “Triple bottom line”.

Introduction

Urbanization and its consequences combined with the fast ICTs development led to establishment of a new trend in urban studies during late 90th, a so called “Smart Sustainable cities” concept. Typing this term in search engine today will generate more than 15 million hits [1]. According to Navigant Research, the global market for smart city solutions and services is expected to grow from US\$40.1 billion in 2017 to US\$97.9 billion in 2026 [2]. The initially limited concept that focused only on technology aspect was successfully overcome by the following waves of smart cities that focus on actually making cities smart instead of just forming a market for tech solutions (i.e. Smart City 3.0 concept). However, nowadays, the concept still remains vague and uncertain, allowing basically any city in the world to claim its “smartness” and “sustainability”. For example, according to IHS Technology by 2025 we will have at least 88 smart cities worldwide, that are working on the integration of information, communications and technology (ICT) solutions across three or more different functional areas of a city (mobile and transport, energy and sustainability, physical infrastructure, governance, safety and security). While according to a new report from Navigant Research, there are more than 250 smart city projects from 178 cities around the world with the majority focus on government and energy initiatives [2].

In 2017, a number of cities that rely on a comprehensive smart city plan instead of simply implementing a few separate innovative projects without an overall smart plan increased tremendously [3]. For the years different academics (Cohen B, Giffinger R., Lombardi P., Schaffers H., Murray A., Minevich M. and Abdoullaev A etc.), institutions (EU, UN-Habitat, IESE, OECD) and businesses (Arup, IBM, Siemens, Ericsson) managed to produce many theoretical concepts on components and definition of the term.

However, the current article aims to review the question from the practical point of view, thus analysing 4 selected smart cities with formally accepted strategies and comparing them to understand what sustainability and smartness mean in a city context and what best practices can be applied by the emerging smart cities preparing their strategies and development plans. In order to address this aim, the paper sets the following research objectives:

- Based on our subjective criteria to select 3 cities that aim to become smart and sustainable and possess formally accepted strategies for development;
- To review their strategies, websites, positions in international rankings and development process;
- To create a comparison table and summarizing chart for the selected cities;
- To draw a conclusion on key pointers that allow to create a comprehensive and successful smart city strategy.

To achieve the aims we have used the methods of theoretical, logical and systematic analysis of literature (strategies, agendas, plans) along with the methods of comparative analysis.

Research Framework

The definition suggested by the ITU (International Telecommunication Union) for a Smart sustainable city is considered to be one of the most comprehensive till date. It states, that "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". They have identified 6 factors that are crucial for smart sustainable cities building and development: smart living, smart people, smart environment and sustainability, smart governance, smart mobility and smart economy.

Below you may find components distinguished by different schools (Table 1).

Table 1. Smart City components

| Author/Concept | Components |
|--|--|
| Barrionuevo, 2012, the basis for IESE Cities in motion index | <ul style="list-style-type: none"> ▪ Economic (GDP, sector strength, international transactions, foreign investment); ▪ Human (talent, innovation, creativity, education); ▪ Social (traditions, habits, religions, families); ▪ Environmental (energy policies, waste and water management, landscape); ▪ Institutional (civic engagement, administrative authority, elections). |
| Kourtit and Nijkamp 2012 | <ul style="list-style-type: none"> ▪ Economy and innovation: creative economic and entrepreneurial capital; ▪ Mobility: infrastructural, logistic, connectivity and communication capital; ▪ Society: social and cultural capital; ▪ Ecology: environmental and ambiance capital. |
| Giffinger R. et al. (2007) | <ul style="list-style-type: none"> ▪ Smart Economy (Competitiveness); ▪ Smart People (Social and Human capital); ▪ Smart Governance (Participation); ▪ Smart Mobility (Transport and ICT); ▪ Smart Living (Quality of life); ▪ Smart Environment (Natural resources). |
| Nam and Pardo, 2012 | <ul style="list-style-type: none"> ▪ Technology Factors (Physical infrastructure, Smart technologies, Mobile technologies, Virtual technologies, Digital networks); ▪ Institutional Factors (Governance, Policy, Regulations); ▪ Human Factors (Human infrastructure, Social capital). |
| ITU (International telecommunication Union) | <ul style="list-style-type: none"> ▪ 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. |
| Arcadis sustainable city index | <ul style="list-style-type: none"> ▪ People; ▪ Planet; ▪ Profit dimensions. |
| Networked Society Index Ericsson | <ul style="list-style-type: none"> ▪ Triple Bottom Line: <ul style="list-style-type: none"> - Social (Health, education, social inclusion), - Economy (Productivity and competitiveness), - Environment (Resources, pollution, climate change). ▪ ICT (affordability, usage, infrastructure). |

| Author/Concept | Components |
|-------------------------------|--|
| Smart City Wheel (Boyd Cohen) | <ul style="list-style-type: none"> ▪ Smart People (Embrace creativity, inclusive society, 21 century education); ▪ Smart Economy (Entrepreneurship, productivity, local and global interconnectedness); ▪ Smart Environment (Green buildings, green energy, green urban planning); ▪ Smart Governance (Enabling supply and demand side policy, transparency & open data, ICT and e-gov); ▪ Smart Living (Culturally vibrant and happy, safe, healthy life); ▪ Smart Mobility (Mixed-modal access, clean and non-motorized options, integrated ICTs). |

Source: Author's based on [4, 5, 6, 7, 8, 9, 10, 11]

As seen from the table above, most researchers cover in their analysis 4 dimensions: Smart People, Smart Economy, Smart Environment (that represent a so called "Triple bottom line") and Smart Governance that is included into each of the mentioned above dimensions but also represents the ability to ensure social stability, justice and participation. To this we add ICTs component as a helping tool to build a Smart City Framework. Author's generalization is presented below:

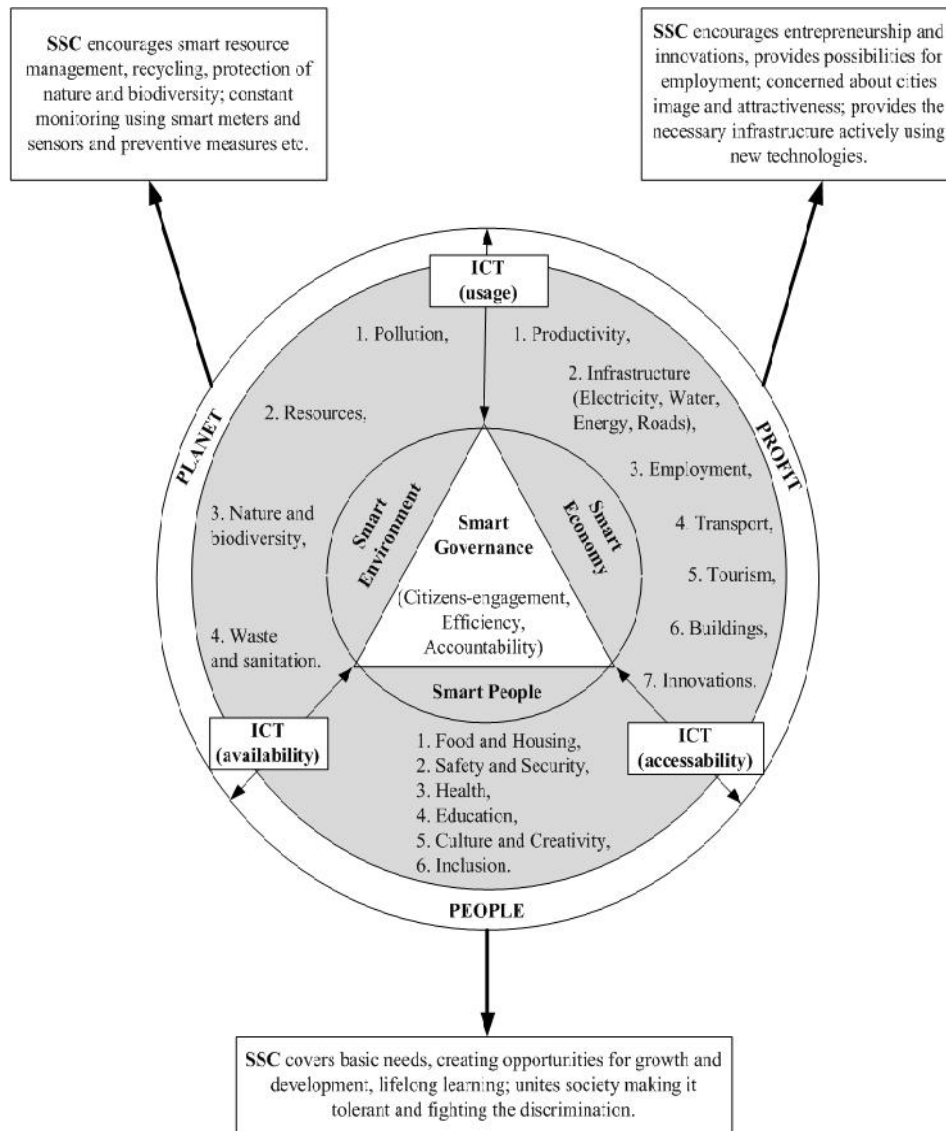


Fig. 1. Smart Sustainable city Framework
Source: Author's

In our research we would like to review which components are presented in the strategies of the selected Smart Cities.

Selection of Cities

Our aim is to compare three selected European cities strategies along with Kyiv Smart city that just started its way of “smartization”. We have used the following selection process:

- 1) Checked the top lists of the indexes that measure smartness and sustainability (Arcadis sustainable city index, Cities in motion index, Networked society index, Global Power City Index) (see Table 2);
- 2) Checked conformation to the general idea of smart city concept (definition, components);
- 3) Filtered the cities according to strategic approach to become smart (formally accepted);
- 4) Checked availability of the up-to-date information (See Fig. 2).

Table 2. European cities positions in different rankings measuring smartness and sustainability

| Ranking | Arcadis sustainable city index | Cities in motion index | Networked society index | Global Power City Index |
|---------|--------------------------------|------------------------|-------------------------|-------------------------|
| 1 | Zurich | London | Stockholm | London |
| 2 | Stockholm | Paris | London | Paris |
| 3 | Vienna | Berlin | Paris | Amsterdam |
| 4 | London | Amsterdam | Copenhagen | Berlin |
| 5 | Frankfurt | Zurich | Helsinki | Frankfurt |

*We have included only European cities in rankings, removing other continents.

Source: [8, 10, 11, 12]

Based on our methodology, we have selected 3 cities: Stockholm, London and Vienna along with Kyiv as mentioned above, since this city is actively developing its Strategy and concept and we are in a search of some best practices that might be applied here.

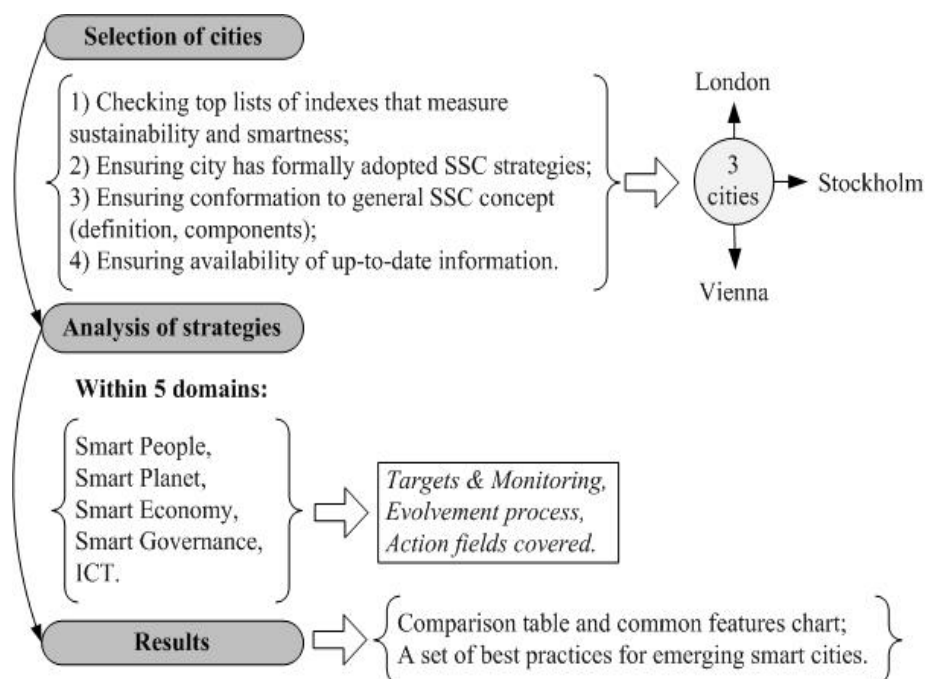


Fig. 2. Methodology of research

Source: Author's

Sector comparison according to Cities in Motions Index 2017 for the selected cities provides some basic overview of the strong and weak sides of each city (Fig. 3.).

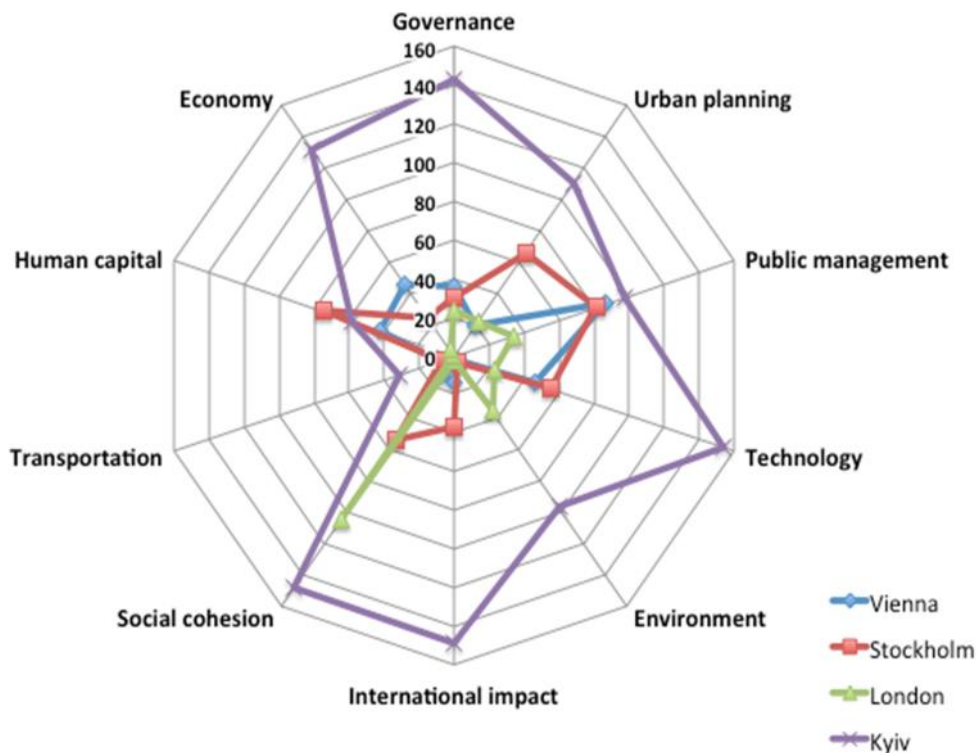


Fig. 3. Cities in Motion index comparison for the selected cities
Source: Author's based on [8]

Overall, Kyiv has the worst positions in most categories. For Vienna - Public management and Technology form the negative pick, for Stockholm - Public Management and Human Capital, for London - Social cohesion.

Smart City London Strategy

In December 2013 the Mayor's Smart London Plan was published, it outlines how data and technology can be used to improve Londoners' lives. The plan includes measurements of success and targets with the desired deadlines. The same year Smart London Board was established, it includes academics and entrepreneurs as a helping hand to authorities. In 2016 an updated version of plan was issued, outlining the progress in different areas.

According to Smart London Plan, Smart London is where the linkages between different city systems are better understood, where digital technology is used to better integrate these different systems, and London as a whole works more efficiently as a result - for the benefit of its inhabitants and visitors [13].

Smart City Vienna Strategy

The initiative "Smart City Wien" was announced by the Mayor of Vienna in march 2011 and after cooperation between civil society, research institutions, private sector and city administration the strategy was accepted in June 2014. The strategy states that its key goal for 2050 is to offer optimum quality of life, combined with the highest possible resource preservation, for all citizens, which can be achieved through the comprehensive innovations [14].

The evolvement of Smart City includes the following stages thus covering intermediate objectives:

- 1) Short-term planning (2012 – 2015) – Implementation of first measures/demo-sites;
- 2) Medium-term planning (Roadmap for 2020 and beyond) – Development of „Low Carbon“ Scenarios and package of measures;
- 3) Long term thinking (Vision 2050) – Includes CO2 Reduction, Energy-Efficiency and Production of renewable Energy.

Smart City Stockholm Strategy

A strategy for Stockholm as a smart and connected city has been formally adopted by the City Council of Stockholm on April 3, 2017. However, the actual development began much earlier. The city is a member of GrowSmarter EU project, which brings together cities and industry to develop and spread 12 smart city solutions in energy, infrastructure and transport sectors. City's Vision for 2040 states that by the year 2040, Stockholm should become the smartest city in the world. According to the strategy, a smart city is a city that utilizes digitalization and new technology to simplify and improve the life for its residents, its visitors and businesses [15].

Smart City Kyiv Strategy

The strategy was developed in 2015 and accepted in 2017, it supposes close cooperation between private, public sectors and end-users. Kyiv smart city is a modern city management model based on advanced knowledge and introduction of modern information and communication technologies aiming to create a comfortable urban environment along with a stable, successful and prosperous future of citizens [16].

According to strategy transformation into a smart city requires 3 levels of changes:

- 1) Technological changes (city is a system of systems: accumulation, storage and analysis of data; open data; creation of an open integrated architecture and operating platform of the city);
- 2) Changes in governance (integration and optimization of city governance: establishment of the department of innovations and information technologies, office of the mayor of "Smart city", situational centre (centralized management 24/7), e-services);
- 3) Society changes (participatory platform: society-university-business; social media as a cooperation tool; crowdsourcing, innovative cluster, hackathons, hubs, networks, citizens as smart users).

ICT and technology sector

London is one of the leaders in technologies and digitization, around 78% of adults own a smartphone and 90% of population have access to the internet. Free WI-FI is provided for over 80 public buildings and libraries. There are 40,000 digital businesses and 200,000 employees in London's technology sector.

High-speed affordable digital connectivity is a priority for the city. The Connectivity Advisory Group has been established and Connectivity Summits are being held constantly to ensure everyone in London has access to affordable high-speed connectivity. A connectivity map was created in 2014 to assist in decision-making process. Along with the Mayor's Digital Connectivity Rating Scheme (2015), which allows to rate the quality of digital connectivity in buildings and provides the corresponding status (a platinum, gold, silver or bronze) along with the possible improvements. Afterwards the rating is listed on a searchable property directory. Recently created London DataStore plays an important role in overcoming city challenges, it allows keeping citizens up-to-date and helps to create applications based on the raw data available [13].

Stockholm is believed to be one of the most connected cities in the world with the largest open fibre network Stokab. Starting from 1994 the City has strategically invested in the development of an open, fibre network for everyone. Stokab aimed to build a competition-neutral infrastructure to satisfy future communication needs, boost economic activity, diversity and freedom of choice, as well as minimising disruption to the city's streets [17]. So today the city enjoys 100% broadband coverage and ranks #1 in Networked society index 2016 [11]. Open Stockholm portal (2011) provides around 100 open data sources.

Vienna has its own information system wien.at Public WLAN with access points (~400) thrown around the city. Approximately 54,000 people are employed in 5,700 information technology businesses in Vienna [18]. Currently the City is working on The Digital Agenda Vienna, actively involving citizens (Stage I: Online Discussions).

Around 90% of people have access to internet in Kyiv. However, public Wi-Fi is available only in 7 outdoors public places and on 29 underground stations. The city has started to build its smart infrastructure only 2 years ago. The strategy has been accepted only this year [16]. Unfortunately, till now the quality of the online services provided by administrative authorities left much to be desired. The situation started to change only recently, in 2015 Digital Capital strategy (2015-1018) has been accepted by the city, it includes steps to create new informational-communication systems and subsystems along with new platforms, support existing

systems and to establish effective systems of information protection. Below we have composed a comparative table for some ICTs variables (Table 3).

Table 3. Some ICTs components comparison

| | Broadband download speed (mbps) | Mobile download speed (mbps) | Cost of broadband (\$/month) |
|------------------|---------------------------------|------------------------------|------------------------------|
| Stockholm | 26,18 | 21,48 | 44 |
| London | 24,21 | 24,7 | 18 |
| Vienna | 23,76 | 18 | 25 |
| Kyiv | 23,2 | 8,46 | 8 |

Source: [19, 20]

Smart people

The aim of the Smart City London states “To put Londoners at the core, with access to open data, leveraging London’s research, technology, and creative talent, brought together through networks, to enable London to adapt and grow and City Hall to better serve Londoners needs, offering a “smarter” experience for all [13].” Authorities stress the importance of human capital for future development. Basically they want to build smart city for smart people and by smart people, encouraging active citizen engagement in policy development. Mayor’s Digital Talent Programme (includes various courses) was launched to tackle skills gap and encourage digital inclusion and growth in tech sectors. According to Smart London Plan, city hopes employment in tech sector will increase to 200,000 by 2020 [21]. City works on Digital Health.London, a collaborative programme delivered by MedCity, and London’s three Academic Health Science Networks, it is supported by the Mayor’s office. The idea is to create a platform where digital health solutions are traded and favourable conditions are created for industry [22]. Another well-known successful project, Queen Elizabeth Olympic Park - a progressive park filled with innovative tech solutions that embeds five world class sporting venues, new low CO2 emission homes, a new international quarter for business, a world class cultural and education quarter and a new media and digital hub. It actively uses Internet of Things concept, weather stations and solar sensors are already at place while more are to follow [13].

In Stockholm Social sustainability section of the Strategy the following aims are stated [23]:

-)] Digital inclusion, where digitalization and new technologies are deployed to bridge social divides;
-)] Helping city dwellers to communicate, work, study, experience, and have an active life, based on each person’s unique circumstances;
-)] Increasing perceived safety, both in private and in public spaces, and creating vibrant and safe neighbourhoods.

There is a number of tools which aim to help elderly to stay in home and make their life easier using digital solutions (Stockholm Digital Care). Digitalization of schools made a priority through digital lift programme which includes providing Wi-Fi in all school buildings, the establishment of a new educational platform, the procurement of new infrastructure that will respond to the needs of the schools, an administrative support to manage the schools'. Another component is self-assessment tool for teachers to raise their digital maturity. In 2016 a tool that detects reading difficulties was launched, this technology scans eye movements during reading and using AI (artificial intelligence) identifies pupils who are at risk for reading and writing difficulties [23].

Vienna Smart City Strategy targets for Smart People component covers 3 areas: education, social inclusion and healthcare [14]. Education area focuses on lifelong learning and increase of the number of young people who continue to their higher level education. Vienna Business Agency has organized a number of events: annual Research Festivals since 2008 to raise technology awareness among citizen, especially youth; the vocational orientation workshop Future Jobs etc. Big attention is paid to increasing the role of nature and energy efficiency in our lives starting from the childhood (“Hanging Gardens” project) [24]. Social inclusion component covers active women inclusion into planning, decision-making and implementation processes; affordable and

high-quality housing for all; active participation at work, fair remuneration that covers basic needs; good neighbourly and safe life conditions for all. For example, WAALTeR project (2016-2019) aims to allow elderly to stay in their surroundings as long as they want having active living with the help of technological solutions (mobile emergency systems, indoor tumble detection sensors, tumble prevention systems and telemedicine), similarly to Stockholm Digital Care Programme [24]. Healthcare dimension aims to promote health literacy among citizens and provide medical care at the highest level for all citizens. The city encourages “Outpatient over inpatient” motto (letting people stay in their own home for as long as possible while offering top-notch nursing quality). Vienna also actively develops eHealth (the electronic health record, mobile monitoring equipment, measures for data protection and data security) and mobile Health systems (simple explanation of illness, transmitting data from sensors to doctor, booking appointments etc.) [24].

Kyiv Smart City strategy states that “Citizens is a key driver for city development”. The strategy sets the following targets:

- Enhancing possibilities of citizens to manage the city and impact the decisions;
- Opening access to databases, that can be used to address the needs of citizens;
- Involving citizens, businesses, IT specialists and experts to form city development agenda using online platform and social media channels;
- Establishing direct communication between citizens and authorities through city portal and social networks;
- Development of new partnership models to realize smart city projects;
- Establishment of independent expert council to monitor project selection and concept implementation;
- Establishment of projects pull along with the platform to look for alternative financing sources;
- Establishment of clear, effective estimation system for decisions and activities of municipal authorities (including establishment of online service to conduct these estimates);
- Encouragement and development of new educational forms and qualifications to stimulate innovations and sustainable development of Kyiv;
- Support and encouragement of new innovation formats for cooperation: hackathons, innovation and educational weekends, experimental labs etc. [16].

Some implemented solutions include: Participatory budget, E-petitions, E-portal to keep citizens up-to-date. City organizes free coding courses for kids. Also city aims to improve accessibility for people with disabilities (Open World UA - a project for blind people), improvement of educational services and health services (e-health system development). To decrease the danger of Ukrainian roads, “Smart roads” project will be implemented. The application will allow to track dangerous places where accidents took place and include voting for the locations that need to be upgraded first thing by local authorities [16].

Smart Environment

London is focused on encouraging new smarter heating, electricity, waste and water networks that use resources efficiently and do more with less investments. City’s performance data is an important component here. Right now main areas of data measurement include: The London Energy and Greenhouse Gas Inventory (energy consumption by homes, workplace, transport); The London Atmospheric Emissions Inventory (air pollution); Assessing London’s indirect carbon emissions [25]. By 2020 London aims to have the best air quality of any major world city, which will require significant (c. 50%) reduction in emissions from London’s transport sector. Mayor aims London to become a zero carbon city by 2050 [13]. Clean and efficient transport is encouraged through different measures. One of the recent decision (October 2017) includes a T-Charge (£10) which targets older more polluting vehicles (diesel and petrol vehicles registered before 2006) [25]. Among smart solutions are Smart LampPosts for electric car charging, green entrepreneurs competition, new agile logistics (zero emissions), re-usage of underground energy (Bunhill Energy Centre), numerous ideas for waste facilities in London (principle “Rubbish in - Resources out”). Much attention is paid to greening, green roofs and walls project has already 700 green roofs in central London, covering the area of over 175,000m² (green spaces map allows to see the progress). London fights food wastage and encourages food surplus usage to feed the needy, livestock or for composting and energy production. Since 2013 FoodSave prevented over 150 tonnes a year of food waste [25]. Right now two action plans have been developed and discussed publicly: Draft Solar Action Plan and Environment Strategy. So we should expect their acceptance shortly.

Environmental component is paid a great attention to in Stockholm Smart City Framework. City sets the following targets [23]:

-) To use digitalization and new technologies to make it easier for residents and businesses to be environmentally friendly;
-) To reduce energy consumption and carbon footprint;
-) To provide sustainable solutions for modern transport;
-) To use digitalization and new technologies to stimulate biological diversity and conservation;
-) To produce goods and services in a resource efficient way with minimal environmental impact.

Some smart solutions include: BigBelly (waste bins use solar power and pack the trash automatically when needed, notifying when they need emptying), Smart lighting (Sensor-controlled LED lighting for pedestrian and bicycle paths, self-controlled LED street lights with preset lighting schedules and remote-controlled lights). City actively develops the idea of eco-districts (Hammarby closed eco-cycle model, the Stockholm Royal Seaport etc.). And works with retrofitting of older buildings to make them more energy efficient [15]. Stockholm has also set target to become fossil-fuel free already by 2040. All public transport should become fossil-fuel free by 2025 (solutions include congestion charge, investments in clean transport etc.). For this Green IT concept was introduced, which is about using ICT to reduce environmental impact. This can be applied for energy-efficient buildings (monitoring and optimization), transportation (intelligent transport solutions (ITS)), digital meetings and mobile workings. The vision of 2040 includes targets to generate 10% of the city's energy by human powered vehicles and creation of 4 688 public roof gardens and offline zones [26].

Vienna sets objectives in several areas to ensure environmental sustainability (see Table 3).

Table 3. Environmental targets of Vienna Smart City

| Sector | Description |
|-------------|--|
| Energy | <ul style="list-style-type: none">) Increase of energy efficiency and decrease of final energy consumption per capita by 40% by 2050 (compared to 2005).) The per-capita primary energy input drop from 3,000 to 2,000 watt.) In 2030, over 20%, and in 2050, 50% of Vienna's gross energy consumption will originate from renewable sources. |
| Mobility | <ul style="list-style-type: none">) Strengthening of CO₂-free modes (walking and cycling), maintenance of high share of public transport and decrease of motorised individual traffic (MIT) in the city to 20% by 2025, to 15% by 2030, and to less than 15% by 2050.) By 2050, all motorised individual traffic within the municipal boundaries is to make so without conventional propulsion technologies.) By 2030, commercial traffic is to be largely CO₂-free.) Reduction of energy consumption by passenger traffic across municipal boundaries by 10% in 2030. |
| Buildings | <ul style="list-style-type: none">) Cost-optimised zero-energy building standards for all new structures, additions and refurbishments from 2018/2020.) Activities entail the reduction of energy consumption of existing buildings by 1% per capita and per year. |
| Environment | <ul style="list-style-type: none">) By 2030, the share of green spaces must be kept at over 50%.) In 2020, the savings achieved by municipal waste management have already attained approx. 270,000 tonnes of CO₂ equivalents as a result of further planned measures and improvements. |

Source: [14]

In autumn 2017 parliament has moved into temporary buildings on Heldenplatz, the sustainable and demountable modular system which is highly re-usable for other purposes. The city encourages greening of facades which helps with dust filtration and air improvement. And Vienne is proud of its first zero-energy

balance hotel (The Boutiquehotel Stadthalle) which is supplied with solar panels, photovoltaic panels, LED and energy-saving lamps [24]. Energy efficiency is also targeted via smart usage of energy from metro brakes, waste heat, e-taxis, CO2 neutral delivery etc. The city believes in active involvement of citizens in particular, through community-funded solar power plants.

Kyiv works towards establishment of comfortable, safe, healthy and smart urban environment according to its Strategy. In this dimension we may find ecological targets though they are quite vaguely separated:

-) Increasing standards of life, accepting European standards of urban sustainable development, decreasing CO2 emissions;
-) Ensuring effective usage of resources and cost cutting technologies [16].

The city also works on promotion of smart metering for energy consumption monitoring and adjustment.

Smart Economy

London promotes circular economy and leads an EU-funded network "Sharing cities". The City Hall aims to create and support a smart, connected businesses through numerous programs and networks (The Smart London Districts, The Smart London Infrastructure Network etc.). Moreover, the city supports a development and increase of the "innovation active" businesses (at least by 10% up to 2020). Private sector is involved in solving city challenges (Smart London Innovation Challenge programme, Tech.London) [13]. London takes measurements to protect its businesses infrastructure from cybercrime attacks. The city has leading positions in FinTech innovations, for example, a digital money index published by Imperial College London together with the municipality. Private and education sectors aiming to provide the needed skills and talents organized a Digital Business Academy - a free online learning platform. Smart London plan sets three priorities in working with business: Breaking boundaries, Scaling up innovations and Ensuring connectivity [13].

Stockholm demonstrates high economic growth along with a high employment rate. Financial component of Stockholm Smart city strategy includes:

-) Attractive, innovative and growing city, with the perspective of making an investment or establishing a business;
-) A central node in a global network of successful cities;
-) One of the best start-up scenes in the world;
-) Develops and grows through entrepreneurship and intrapreneurship in digitalization and new technologies;
-) Attracts talent and visitors, international and national;
-) Cost efficiently manages its public operations by making full use of digitalization and new technologies;
-) Has a wide range of businesses, with a favourable environment for an inclusive labour market [23].

Examples of smart solutions include traffic control, main bus lines (buses with many passengers) are prioritized at traffic lights. Buses that are behind the schedule are given preference. By 2040, the city aims to ensure max 3 min waiting time for public transport and 100% of Stockholm public transport to be driverless [26]. Automatic job centres will help to match available work with the needed competencies of human workers and autonomous jobots.

Vienna aims by 2050 to remain one of the ten European regions with the highest purchasing power based on per-capita GDP and strengthen its position as the preferred company headquarters city in Central/South-eastern Europe. Vienna believes in active entrepreneurship development and aims for 10,000 persons annually set up an enterprise in Vienna. City understands the importance of technology-intensive production and aims to increase its share of technology-intensive products in the export volume to 80% by 2050 [14]. Sharing economy principles also getting spread actively, for example, Library of things (Leila) project or EcoBuy Vienna which sets environmentally friendly procurement principles: minimal packaging, phosphate and formaldehyde-free products, no PVC, no chlorine bleach, no aggressive detergents, no tropical wood etc. [24].

Kyiv smart city strategy aims to establish innovative environment. Which includes support of innovative businesses and start-ups and removing barriers for them, development of new forms of cooperation between citizens, business and authorities. The city has launched "Property" system (2016) which allows to get information about the property and other objects of the city territory (vehicles, roads, parking, buildings etc.).

Kyiv was the first one to introduce electronic procurement system Prozorro to prevent corruption, ensure equal opportunities for all players and transparency of the processes [27].

Smart Governance

This dimension covers rather similar smart solutions across cities that involve citizens and encourage bottom-up approach in city development.

London among others uses crowdfund London platform that allows to gather money for the most important projects voted by citizens. Tech Londoners brings together innovators to solve city's challenges using digital tools. While Speed volunteering helps to mobilize the needed resources in a most optimized way. Citizens engagement is actively increased through hackathons (e.g. Climathon) [13].

In Stockholm, "Make a suggestion" app (2013) allows to notify authorities about any issues and deficiencies citizens experience [15].

Vienna is one of the first European cities to launch an Open Government Portal. "Sag's Wien" application allows citizens to communicate their concerns to the city administration in 30 seconds. While wiengestalten.at similarly to Speed Volunteering in London aims to provide information about volunteering in Vienna in a convenient form. Completed volunteering projects can also be accessed, with links to the people and/or organisations responsible [24].

All three cities contribute greatly to ensuring data openness and availability through Open data portals.

"1551" service in Kyiv works similarly to "Make a suggestion" app and offers citizens possibility to suggest improvements and mention complaints. Citizens have an option to influence urban development through Participatory budget. Which allows every citizen to participate in the distribution of the local budget through the creation of projects to improve the city and/or vote on them [27]. Open budget contributes to transparency and provides a real-time opportunity for all stakeholders to monitor the revenues and expenditures of the city budget, including the spending of public funds.

Conclusions

Based on our analysis each of the four analysed strategies has its own peculiarities that we have tried to summarize below:

Smart London city

It does not differentiate clearly Smart City Components as per outlined initially framework but all the dimensions are covered through the aims Smart London Plan sets. The version of 2013 included measurements and deadlines for some goals. In 2016 the plan was revised and status update provided for each goal. Activity areas are rather wide and cover all the dimensions of life, all the information is published on the City of London website. Innovations and tech solutions are put at the core of the Strategy.

Smart Stockholm city

Strategy sets goals within four sustainability components, however, the goals are rather vague without any measurement parameters. This was compensated in the 2040 Vision which sets numeric targets. The Strategy was adopted only recently even though smart solutions and projects have been there since late 90th. Digital Demo Stockholm arena as a product of public-private cooperation has been created to run innovative and smart projects. The City has built its competence on large-scale full cycle projects (Hagastaden, Stockholm Royal Seaport, Slussen etc.). Living Labs is one of the popular tools in Stockholm and the city itself presents "a Living Lab" being a part of GrowSmarter EU thus willing to cooperate and go international. The city heavily focuses on environmental component. Stockholm has also specified their standards for implementation and development of smart solutions to ensure their effectiveness and flexibility.

Smart Vienna city

Vienna has one of the most detailed strategies in terms of components and targets with time-lines, covering all the Framework dimensions. The Strategy has identified short-term and long-term goals (2030, 2050

milestones). Projects are presented on the website and updated continuously. The city actively involves different stakeholders into cooperation. Aspern city (2013) serves as a testbed for numerous technological solutions and Smart city implementation of the large scale, aimed to be completed by 2018. One of the general drawbacks is lack of monitoring and status updates on targets set.

Smart Kyiv city

The strategy was accepted just recently (2017) prior to preparing the needed infrastructure and users themselves. It mostly focuses on smart governance dimension and structural changes. The strategy does not include any set time-frames, which makes it vague and difficult for progress monitoring. Besides, environmental component is poorly presented in the strategy. Obviously, the city just makes its first steps on the way of smartization. However, the projects and their status are continually updated on website and any volunteers are encouraged for co-creation.

Below you may find a summarization table for the reviewed cities (Table 4).

Table 4. Comparison of the selected Smart cities

| | Vienna | Stockholm | London | Kyiv |
|--|---|--|--|--|
| Mercer Quality of living ranking 2017 | 1 | 20 | 40 | 174 |
| City in motion index 2017 | 15 | 25 | 2 | 119 |
| Population | 1 867 582 | 963 920 | 8 787 892 | 2 925 760 |
| Separate web-site | Yes | No. Part of the city website. | No. Part of the city website. | Yes |
| Adopted strategy (year) | Vision 2050 (2014) | Strategy for Stockholm as a smart and connected city (2017) | Smart London Plan (2013), updated version in 2016 | Kyiv smart city 2020 (2017) |
| Components | 1) Resource preservation; 2) Quality of life; 3) Innovations. | 1) Ecological; 2) Financial; 3) Social; 4) Democratic sustainability. | 1) Engaging citizens; 2) Enabling good growth; 3) Working with business. | 1) Comfortable and safe urban environment; 2) Smart and open city governance; 3) Innovative environment; 4) Central role of citizens. |
| Principles | 1) Openness; 2) Cooperation; 3) Efficiency. | 1) Collaboration; 2) Common IT-solutions (allowing multiple suppliers to develop and operate them); 3) Open and shared data; 4) Security and privacy. | 1) Technology and Innovations; 2) Collaboration and engagement; 3) Efficiency and resource management; 4) Open data and transparency. | 1) Citizens-orientation; 2) Widespread informatization; 3) Openness and cooperation; 4) Forward-looking way. |
| Core focus | Energy efficiency and resource preservation. | Green IT. | Innovations and citizens engagement. | Governance and digitalization. |

Source: Authors based on [13-16, 27, 28]

All four cities have some similar approaches to Smart city development within outlined domains, summarized in a scheme below:

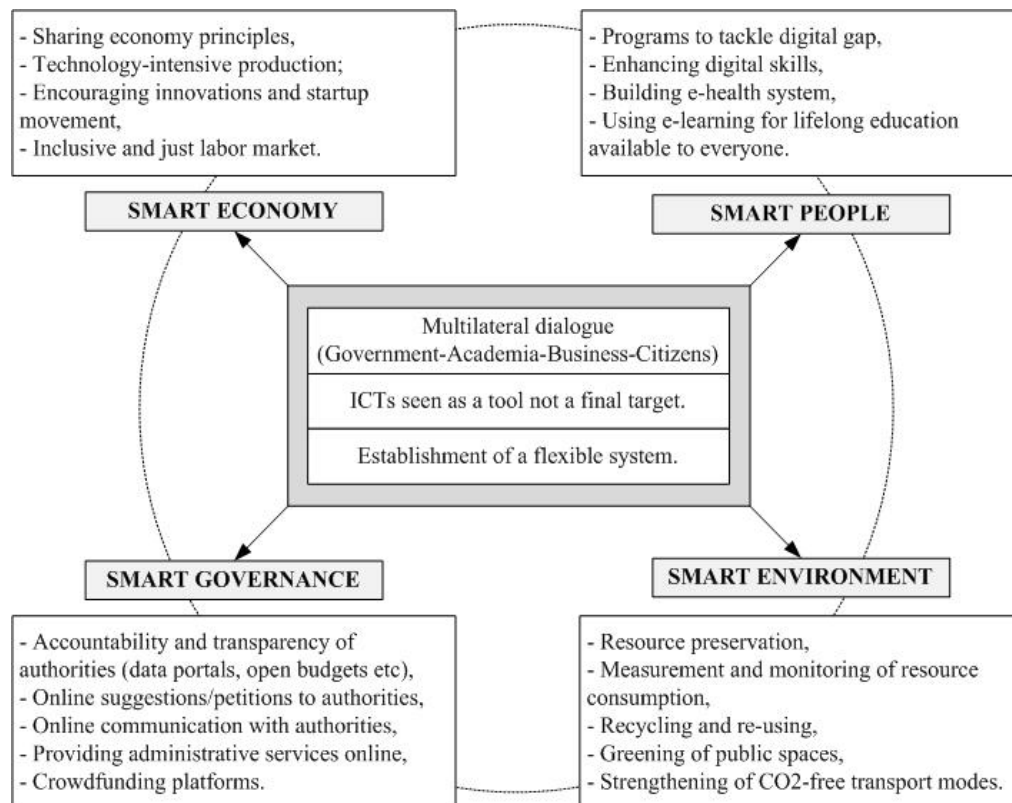


Fig. 4. Common approaches in the reviewed Smart Sustainable Cities

Source: Author's

And based on the studied strategies we have prepared a list of best practices that should help to create a successful smart city strategy for emerging smart cities:

-) The strategy should be a product of cooperation between different stakeholders (academics, business, municipality, civil society), outlining both interests and responsibilities of each group;
-) Encouragement of co-creation from different stakeholders;
-) The strategy may cover a wide spectrum of solutions but they should form one holistic system;
-) The strategy should include targets and tools to monitor their achievement;
-) Free access to up-to-date information with progress reviews is important;
-) Living Labs is a good tool for the initial results testing and spreading them for a wider market later;
-) Constant openness for public feedback is a must;
-) Even though strategy is a product of a common development, coordinating body should be established for the purposes of accountability, transparency and monitoring.

References

- [1] What being 'smart' means for cities (2017). Raconter [ONLINE] Available at: <https://www.raconteur.net/technology/what-being-smart-means-for-cities> [Last Accessed 24 January 2018].
- [2] Smart Cities. Navigant Research [ONLINE] Available at: <https://www.navigantresearch.com/research/smart-cities> [Last Accessed 24 January 2017].
- [3] K.Pyzyk (2018). 6 trends that will define smart cities in 2018. Smart Cities Dive. [ONLINE] Available at: <https://www.smartcitiesdive.com/news/6-trends-that-will-define-smart-cities-in-2018/513889/> [Last Accessed 24 January 2017].

- [4] K.Kourtit, P. Nijkamp (2013). THE 'NEW URBAN WORLD' – THE CHALLENGE OF CITIES IN DECLINE. Romanian Journal of Regional Science, [ONLINE] Available at: <http://www.rrsa.ro/rjrs/V7SP2.Kourtit.pdf>. [Last Accessed 24 January 2017].
- [5] 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 24 January 2017].
- [6] 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.smartcities.eu/download/smart_cities_final_report.pdf. [Last Accessed 24 January 2017].
- [7] 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 24 January 2017].
- [8] IESE (2016). Cities in Motion Index. [ONLINE] Available at: http://www.iese.edu/en/facultyresearch/research-centers/cgs/citiesmotionstrategies/?_ga=1.250510531.491872120.1449127639. [Last Accessed 24 January 2017].
- [9] 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 24 January 2017].
- [10] 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 24 January 2017].
- [11] Ericsson (2016). Networked City Index 2016. [ONLINE] Available at: <https://www.ericsson.com/res/docs/2016/2016-networked-society-city-index.pdf>. [Last Accessed 24 January 2017].
- [12] Global Power City Index (2017). [ONLINE] Available at: http://mori-m-foundation.or.jp/pdf/GPCI2017_en.pdf [Last Accessed 24 January 2017].
- [13] Smart London Plan (2013). [ONLINE] Available at: https://www.london.gov.uk/sites/default/files/smart_london_plan.pdf
*Updated Smart London Plan
https://www.london.gov.uk/sites/default/files/gla_smartlondon_report_web_4.pdf. [Last Accessed 24 January 2017].
- [14] Wien Smart City (2014). [ONLINE] Available at: https://smartcity.wien.gv.at/site/files/2016/12/SC_LF_Kern_ENG_2016_WEB_Einzel.pdf [Last Accessed 24 January 2017].
- [15] Stockholm Smart city [ONLINE] Available at: <http://international.stockholm.se/city-development/the-smart-city/>. [Last Accessed 24 January 2017].
- [16] KYIV SMART CITY Strategy (2017) [ONLINE] Available at: <http://kyivsmartcity.com/Kyiv-Smart-City-Concept.pdf>. [Last Accessed 24 January 2017].
- [17] Stokab [ONLINE] Available at: <https://www.stokab.se/In-english/> [Last Accessed 24 January 2017].

- [18] City of Wien official web-site (ICT strategy). [ONLINE] Available at: <https://www.wien.gv.at/ikt/> [Last Accessed 24 January 2017].
- [19] European digital city index (2016). [ONLINE] Available at: <https://digitalcityindex.eu/city/32>
- [20] BandwidthPlace [ONLINE] Available at: <http://www.bandwidthplace.com>
- [21] Digital Talent Programme. Available at: <https://www.london.gov.uk/what-we-do/business-and-economy/skills-and-training/digital-talent-london> [Last Accessed 24 January 2017].
- [22] Digital Health.London. Available at: <https://digitalhealth.london/> [Last Accessed 24 January 2017].
- [23] Smart and Connected City Stockholm (2017). Available at: <http://international.stockholm.se/globalassets/ovriga-bilder-och-filer/smart-city/brochure-smart-and-connected.pdf> [Last Accessed 24 January 2017].
- [24] Vienna Smart City projects. Available at: <https://smartcity.wien.gv.at/site/en/projects/> [Last Accessed 24 January 2017].
- [25] London City web-site [ONLINE] Available at: <https://www.london.gov.uk/what-we-do/environment> [Last Accessed 24 January 2017].
- [26] Welcome to the smartest city in the world (2016) [ONLINE] Available at: <http://international.stockholm.se/globalassets/ovriga-bilder-och-filer/smart-city/welcome-to-the-smartest-city-in-the-world-english-designfiction-sthlm-stad.pdf> [Last Accessed 24 January 2017].
- [27] Kyiv Smart City Projects [ONLINE] Available at: <https://www.kyivsmartcity.com/projects/> [Last Accessed 24 January 2017].
- [28] Mercer Quality of living ranking (2017). [ONLINE] Available at: <https://mobilityexchange.mercer.com/insights/quality-of-living-rankings> [Last Accessed 24 January 2017].