

## Evaluation of Pioneering Smart City Applications Across the Globe

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### ABSTRACT

The smart city concept is emerging as a strategy to confront the problems faced in cities. A smart city is a place where, traditional networks and services are made more flexible, efficient and sustainable to improve urban operations for the benefit of its residents via information, digital and telecommunications technologies. In this study smart city phenomenon offer significant economic, educational, environmental and social contributions is analysed from a global perspective, with a focus on its implementation around the world. In this context it is aimed to explain the definition and features of the smart city concept; to highlight the main achievements of the smart city concept; to discuss Seoul, London and New York City, which are among the leading cities in smart city applications according to the Eden Strategy Institute's Top 50 Smart City Government Ranking of 235 potential smart cities in the world for 2020/2021; and to reveal the applications that make these cities smart and the role of city governments. Smart city experiences in these three leading cities are discussed comparatively in the context of literature research and ten basic factors consisting of vision, leadership, budget, financial incentives, support programmes, talent-readiness, people-centricity, innovation ecosystems, smart policies, track record. When the cities in the top 50 smart city rankings are considered holistically, the three indicators that the cities are most successful in are Track record, Vision and People-centricity, while the indicators they are less successful in are Financial incentives, Support programmes and Innovation ecosystems. Seoul, like all leading smart cities, is very successful in terms of Track record indicator; London in terms of Vision and Track record indicator; and New York in terms of Vision indicator. The results show the importance of inter-sectoral impacts and socially connected aspects of smart city initiatives and provide guidance for planners, designers and politicians.

## Dünyada Öncü Akıllı Şehir Uygulamalarının Değerlendirilmesi

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### ÖZET

Akıllı şehir kavramı şehirlerde karşılaşılan sorunlarla yüzleşmek için bir strateji olarak ortaya çıkmıştır. Akıllı şehir, bilgi, dijital ve telekomünikasyon teknolojileri aracılığıyla kentsel operasyonların sakinlerinin yararına iyileştirilmesi için geleneksel ağların ve hizmetlerin daha esnek, verimli ve sürdürülebilir hale getirildiği bir yerdir. Bu çalışmada önemli ekonomik, eğitimsel, çevresel ve sosyal katkılar sunan akıllı şehir olgusu dünya çapındaki uygulamalarına odaklanılarak küresel bir perspektiften analiz edilmiştir. Bu çerçevede akıllı şehir kavramının tanım ve özelliklerini açıklamak, akıllı şehir kavramının temel kazanımlarını vurgulamak, Eden Strateji Enstitüsü'nün 2020/2021 yıllarına yönelik dünyada 235 potansiyel akıllı şehri düzeyindeki "En İyi 50 Akıllı Şehir Hükümeti Sıralaması"na göre akıllı şehir uygulamalarında öncü kentlerden Seul, Londra ve New York'u ayrıntılı olarak ele alarak bu şehirleri akıllı yapan uygulamaları ve şehir yönetimlerinin rolünü ortaya koymak hedeflenmiştir. Bu üç önde gelen şehirde akıllı şehir deneyimleri literatür araştırması ve on temel faktör (vizyon, liderlik, bütçe, mali teşvikler, destek programları, yeteneğe hazırlık, insan odaklılık, inovasyon ekosistemleri, akıllı politikalar, geçmiş performans) bağlamında karşılaştırmalı olarak ele alınmıştır. İlk 50'de yer alan şehirler bütüncül olarak ele alındığında şehirlerin en başarılı oldukları üç gösterge Performans geçmişi, Vizyon ve İnsan merkezlilik olurken daha az başarılı oldukları göstergeler Finansal teşvikler, Destek programları ve Inovasyon ekosistemleri olmuştur. İncelenen üç şehir bu faktör ortalama değerleri açısından ele alındığında; tüm öncü akıllı şehirler gibi Seul Performans geçmişi göstergesi bağlamında; Londra Vizyon ve Performans geçmişi göstergesi bağlamında; New York ise Vizyon göstergesi bağlamında çok başarılıdır. Çalışmanın sonuçları akıllı şehir girişimlerinin sektörler arası etkilerinin ve sosyal bağlantılı yönlerin önemini göstermekte olup plancılara, tasarımcılara ve politikacılara yol gösterici niteliktedir.

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## **INTRODUCTION**

Urban areas, consisting of towns, cities and suburbs, have high population density and advanced technology and infrastructure; In urban areas, most residents do non-agricultural work, unlike in rural areas (URL 1). Mass movement of people to cities increases the population density in the city. The world's urban population, which was 751 million in 1950, has rapidly increased to 4.2 billion in 2018 (United Nations, 2018). The United Nations (2018) predicts that approximately 68% of the world's population will live in urban areas by 2050. Fast-paced urban growth has thrown open the door to a mounting number of complex infrastructural and social issues in the urban environment globally (Zheng et al., 2020). Cities playing a prime role in social and economic aspects worldwide also have a huge impact on the environment. The metabolism of cities generally consists of the input of goods and the output of waste with consistent negative externalities, which amplify social and economic problems. Cities rely on too many external resources and, as a matter of fact, they are consumers of resources. Nowadays most resources are consumed in cities worldwide, contributing to their economic importance, but also to their poor environmental performance (Albino et al., 2015). As economic activities focus on the city, urban population and urban space, and therefore natural resource use and environmental problems, increase. City density also impact on other urban problems such as poverty (Cavada et al., 2017), difficulty in city management, traffic congestion, health (The Umbrella Internet of Things, 2017). In the 21st century, the global economy and social development are characterized by economic globalization, informatization, and urbanization. In this regard, smart cities (SCs) come into the forefront of the urban discourse to cope with urban problems and improve the life of cities of the future. The SC has emerged as an area of growing interest in government, industry, and academia (Zheng et al., 2020).

The SC initiative is one of the strategic responses of governments to the challenges faced in cities (Ojo et al., 2014). In most cases, the SC is more about regeneration than building a completely new urban environment (Glasmeier and Christopherson, 2015). A SC is an urban strategy using technology and promising to improve the quality of life for citizens (Dameri, 2017; Vasseur and Dunkels, 2010). This concept uses technology and big data as basic information. Many cities have started to implement SC approaches with the idea that they can respond to population density and other urban problems.

The SC is focused on service, infrastructure and city management technology. The SC concept considers the use of fully or semi-automatic systems that can calculate and respond to human activities, managing their results and expectations efficiently and in the best way (Cavada et al., 2017). In SCs, functional problems such as transportation are expected to be corrected with technology support to make the current system more efficient and predictable (Glasmeier and Christopherson, 2015). Smarter cities improve amenities, facilitate mobility, provide efficiency, save energy, improve air and water quality, detect and fix the problems quickly, recover quickly from disasters, collect data to make better decisions, and physical infrastructure to use resources effectively. They improve their data (Nam and Pardo, 2011). Mohanty et al. (2016) also stated that SC applications can reduce energy consumption, water consumption, carbon emissions, transportation requirements and resource waste in the city.

In this study, considering that "SCs offer significant economic, educational, environmental and social contributions", It is aimed (1) to explain the definition and components of the SC concept, (2) to emphasize the basic gains of the SC concept, (3) to discuss Seoul, London and New York City, one of the leading cities in SC applications, in detail and to guide planners, designers and politicians by revealing the applications that make these cities SCs. In this context, within the theoretical framework of the study, the concept of SC was defined and was examined in the historical process, and SC components were explained. The study focused on Seoul, London and New York City, which are successful cities in the context of SC applications around the world, and SC policies in these cities were explained in detail. A general evaluation of these leading cities was made in the context of SC

applications examined in the "Discussion and Conclusion" section. In this context, the similar and different features of SC applications are revealed, and the indicators in which they are the best in the ranking and those in which they are lower in the ranking compared to other indicators are pointed out.

## METHOD

In this article, it is aimed to understand the indicators and current practices that make SC applications successful in the context of leading cities and to make useful inferences in terms of urban policy, planning and design. There are many SC performance measurement methodologies focused on inputs (e.g., amount of investment), outputs (e.g., number of sensors), or outcomes (e.g., energy savings) (Wollman, 2022) and there are many rankings measuring cities SC performances (e.g., IESE Cities in Motion Index produced by University of Navarra Business School, Smart City Index produced by the IMD World Competitiveness Center’s Smart City Observatory in collaboration with the World Smart Sustainable Cities Organization). However, while the master thesis, on which this manuscript depends and focuses the Covid-19 epidemic’s impacts to SC performances, was being prepared Eden Institute’s SC Rankings was very popular and key factors were suitable in terms of our research aims. Thus, Eden Institute’s SC Rankings was adopted to determine the pioneer SCs as case study. In this context, the cities of Seoul, London and New York City, which ranked 2nd, 3rd and 6th among 235 cities across the globe in the Eden Strategy Institute's The Top 50 Smart City Government Rankings (2020/2021) (Table 1, Table 2) were discussed via a comprehensive literature review.

**Table 1**  
*2020/21 top 10 Smart City Government Rankings of Eden Strategy Institute*

<b>Ranking</b>	<b>Previous Ranking</b>	<b>City</b>	<b>Total Score</b>	<b>Vision</b>	<b>Leadership</b>	<b>Budget</b>	<b>Financial Incentives</b>	<b>Support Programmes</b>	<b>Talent-Readiness</b>	<b>People Centricity</b>	<b>Innovation Ecosystem</b>	<b>Smart Policies</b>	<b>Track Record</b>
1	+1	Singapore	35.8	3	3	3	4	4	4	4	3.9	3.9	3
2	+1	<b>Seoul</b>	<b>34</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>4</b>
3	-2	<b>London</b>	<b>33.1</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3.1</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>4</b>
4	+5	Barcelona	32.1	3	3	3	3	3	3	3.1	4	3	4
5	-	Helsinki	32	3	3	4	3	3	4	3	2	3	4
6	-2	<b>New York City</b>	<b>31.9</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2.9</b>	<b>4</b>	<b>3</b>	<b>3</b>
7	-1	Montreal	31.8	3	3	3	3	3	3	2.9	3	4	3.9
8	+2	Shanghai	31.3	3	3	2.1	3.1	4	3	4	3	2.1	4
9	+3	Vienna	31.2	4	3	3	2	3	3.1	3.1	3	4	3
10	+3	Amsterdam	31.1	3	4	3	3	2	3	3.9	3.1	3	3.1
<b>50 city’s mean score</b>				<b>3.02</b>	<b>2.86</b>	<b>2.73</b>	<b>2.47</b>	<b>2.56</b>	<b>2.76</b>	<b>3.02</b>	<b>2.58</b>	<b>2.74</b>	<b>3.28</b>

Source: Prepared by authors using Eden Strategy Institute, 2021

**Table 2**

2020/21 top 10 Smart City Government Rankings of Eden Strategy Institute

<b>Vision:</b> A clear and well-defined strategy to develop a “SC”
<b>Leadership:</b> Dedicated City leadership that steers SC projects without major discontinuities
<b>Budget:</b> Sufficient funding for SC projects
<b>Financial Incentives:</b> Financial incentives to effectively encourage private sector participation (e.g. grants, rebates, subsidies, competitions) specifically in SC projects and initiatives
<b>Support Programmes:</b> In-kind programmes to encourage private actors to participate (e.g. incubators, events, networks) specifically in SC projects and initiatives
<b>Talent-Readiness:</b> Programmes to equip the city’s talent with smart skills
<b>People-Centricity:</b> A sincere, people-first design of the future city, with no systematic disregard for human life or basic human rights
<b>Innovation Ecosystems:</b> A comprehensive range of engaged stakeholders to sustain innovation and partnerships where the city government was instrumental in sustaining and catalysing them
<b>Smart Policies:</b> A conducive policy environment for SC development (e.g. data governance, IP protection, urban design)
<b>Track Record:</b> The government’s experience in catalysing successful SC initiatives, with no systematic or widespread failure

Source: Eden Strategy Institute (2021)

Eden Strategy Institute’s The Top 50 Smart City Government Rankings (2020/2021) holistically evaluated 235 potential smart cities across the globe (Table 1) via an extensive study focusing explicitly on the role of city governments in driving SC development in context of ten key factors outlined Table 2. Having assigned a score from one to four for each of the ten criteria, a total score was calculated for each city which then determined their positions on the rankings. Cities with a high score, meaning those which were the most exemplary across the ten factors, were positioned at the top of SC rankings (Eden Strategy Institute, 2021).

In the study the comparison of Seoul, London and New York cities in context of SC policies are made via not only Eden Strategy Institute’s Top 50 Smart City Management Rankings and ten evaluation factors but also via the literature review findings about SC applications. In this literature review process SC applications of three cities are obtained via articles, SC plan & policy documents of local governments & research authorities and web sites about SC applications. The Eden Strategy Institute’s assessment results support the literature review results and enable a holistic evaluation.

## FINDINGS

### Smart City Concept

SC is a much-debated approach on whether it is a new concept, a new model, a city concept, and it does not have a clear/fixed definition. SC definitions also vary depending on the number of dimensions included in the concept of SC and the breadth of its scope (government, economy, infrastructure, environment, etc.).

International Organization for Standardization- ISO (2015) describes SC as “a new concept and a new model, which applies the new generation of information technologies, such as the internet of things, cloud computing, big data and space/geographical information integration, to facilitate the planning, construction, management and smart services of cities.”; and ISO emphasizes that intelligent systems should not be limited to Information and Communication Technologies (ICT)-based systems, but can even refer to intelligent creative design or new organisations. The concept of the SC is far from being limited to the application of technologies to cities (Albino et al., 2015).

Due to another comprehensive definition by ITU-T Focus Group on Smart Sustainable Cities (ITU, 2014) “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”.

A city has an important role in social and economic aspects worldwide and has a huge impact on the environment (Mori and Christodoulou, 2012). All key city actors need to work together, using all their resources, to overcome the challenges they face and grasp the opportunities available so they can thrive. The “smartness” of a city defines its ability to bring together all its resources (people, organizations, finance, facilities and infrastructure, etc.), to achieve the goals it sets effectively and smoothly, and to fulfil the goals it sets. Therefore, in SC systems, there are efficient individual works that act in an integrated and consistent manner to benefit from potential synergies and ensure the holistic functioning of the city and facilitate innovation and growth (ISO, 2015).

Cavada et al. (2017) discussed the definition of SC from three perspectives: commercial, academic, national and international. In commercial terms, SC is focused on the idea of making cities more efficient, with major organizations such as IBM, CISCO and ARUP. Commercial and smart products such as systems that measure air quality, systems that provide parking and traffic information, etc. are produced. Academically, SCs aim to improve the quality of life. Nationally and internationally, SC is an urban concept that affects cities both nationally and internationally. This concept has created competition for smarter, more effective development. In some cases, cities are producing SC proposals to compete and receive European Union funding. According to Mohanty et al. (2016) a SC is a place where, traditional networks and services are made more flexible, efficient and sustainable to improve urban operations for the benefit of its residents via information, digital and telecommunications technologies.

Every city has a different solution to the urban problems it faces. Therefore, the SC is flexible and permanent. Technology is closely related to SCs, but smart cities are not entirely about technology. Thanks to technology, innovations are created to solve urban problems. Technology also helps to use resources more effectively and efficiently. In addition to focusing on physical infrastructure, smart cities aim to improve the quality of life in cities.

### ***Evolution & Development of the Concept of Smart City***

In his article titled “The Rise of The Smart City”, Anthopoulos (2017) states that the SC concept has begun to emerge with different terms and perspectives regarding the evolution of urban technology. The first conceptual examples of the SC emerged in 1997 with the term virtual city or web city.

Cities with completely different degrees of complexity emerged in the 21st century with the digital revolution. Rapid development in hardware and software design has encouraged cities to use ICTs consisting of communication devices and/or applications, such as radio, television, cellular and smart phones, all kinds of computers, network, hardware and software, satellite systems, videoconferencing, etc. Then the cities have been labelled in different terms such as wired city, virtual city, intelligent city, digital city and finally, SC. Consequently, ICT has recently become part of a common debate on urban development because of the ubiquity of digitalization (Bayramoğlu Barman, 2020). According to Cocchia (2014) leading concepts related to the SC paradigm are *wired city*, *virtual city*, *ubiquitous city*, *intelligent city*, *information city*, *digital city*, *smart community*, *knowledge city*, *learning city*. Bayramoğlu Barman (2020) emphasises that all the definitions are about connectivity and knowledge sharing via digitalization and ICT.

In general, researchers have searched for the roots of SCs based on the relationship between the city and technology. “Technology” is part of the evolution of smart cities, although the terms used may

differ when it starts to appear or is mentioned in the definition of the city concept. It can be said that the SC concept is not a new city concept, since technology has basically been used in city development a long time ago. SC is a development of previous city concepts such as *digital city*, *intelligent city*, *virtual city*. Some researchers even do not make any distinction between digital city and intelligent city (Trencher, 2019).

The first generation of the SC is 'Smart City 1.0' or "first-generation paradigm", which focuses on the widespread use of smart technologies for corporate and economic interests. In Smart City 1.0, with a techno-economic and centralized approach, technology and data are framed as the strongest and most desired driving forces produced to overcome sustainability, high quality of life and social dilemmas. Later, the SC concept turned into Smart City 2.0. 'Smart City 2.0' is framed as a decentralized, people-centric approach where smart technologies are employed as tools to tackle social problems, address resident needs and foster collaborative participation. In the transition from Smart City 1.0 to 2.0, there were stages such as the emergence of the Internet of Things, overwhelming amounts of data, experimental/guide solutions, strategic road maps, using a data-oriented strategy, and focusing on a citizen-oriented approach. Although academic scholarship is yet to integrate explicitly the term 'Smart City 2.0', this conception corresponds with notions of people centred 'second-generation' SCs and 'alternative' SCs moving beyond the top-down, techno-economic objectives of first-generation. The comparative framework in Table 3 shows the contrasting objectives within the SC paradigm and differing conceptions of the desirable role of the citizen (Trencher, 2019).

**Table 3**

*Comparison of Key Attributes in the First- and Second-Generation Smart City Paradigms (Trencher, 2019)*

<i>Key Attributes</i>	<i>Smart City 1.0</i>	<i>Smart City 2.0</i>
<i>Focus of vision</i>	- Technology and economy	- People, governance and policy
<i>Role of citizens</i>	- Passive role as sensors, end-users or consumers	- Active role as co-creators or contributors to innovation, problem solving and planning
<i>Objective of technology and experimentation</i>	- Optimise infrastructures and services - Serve demand side interests and spur new business opportunities - Address universal technical agendas (energy, transport, economy)	- Mitigate or solve social challenges - Enhance citizen wellbeing and public services - Address specific endogenous problems and citizen needs
<i>Approach</i>	- Centralised (privileged actors) - Exogenous development	- Decentralised (diverse actors) - Endogenous development

### ***Basic Gains of the Smart City Concept***

The SC concept is emerging as a strategy to confront problems such as rapid urbanization and urban population growth (Mohanty et al., 2016). In many cases, the SC is about regeneration rather than building a completely new urban environment (Glasmeier and Christopherson, 2015).

The purpose of the SC is to improve people's quality of life and make people's lives easier with the help of technology. SCs should provide benefits and solve the city's problems. The SC should provide benefits such as a better quality of life for its residents and visitors, economic competitiveness to attract industry and talent, and an environmentally conscious focus on sustainability (Mishra, 2020). SC applications, which offer technological solutions in many local service areas such as transportation, infrastructure, energy and environment, are important in using the city's resources efficiently, protecting the environment and maximizing economic benefit. In SCs, which are developed with the support of technology, the quality of services offered to urban residents also increases (Erkek, 2017). With the introduction of new or even upgraded infrastructure based on ICT, cities are becoming more efficient,

sustainable and friendlier to citizens by improving their quality of life in all aspects. These positive changes can be seen in economy, governance, mobility, environment and living (Weber et al, 2019).

Developing SCs can benefit synchronized development, industrialization, informationization, urbanization and agricultural modernization and sustainability of cities development. The main target for developing SCs is to pursue: (1) convenience of the public services; (2) delicacy of city management; (3) liveability of living environment; (4) smartness of infrastructures; (5) long-term effectiveness of network security (ISO, 2015)

According to McKinsey Global Institute (2018), smart technologies should be able to improve key indicators such as safety, time and convenience, health, environmental quality, social connectedness, cost of living and jobs by 10-30%. In transportation, technologies can make daily commutes faster and calmer. By 2025, cities using smart mobility applications will be able to reduce commuting times by an average of 15-20%. A SC can also help cities fight crime and improve other aspects of public safety by using technology that helps prevent crime. In cities that deploy a range of practices to maximum effect, deaths from homicide, road traffic and fires can be reduced by 8-10%. Technology can also help cities become catalysts for healthier individuals, such as improved chronic disease care, the use of data to fight preventable diseases, and new ways to engage patients.

SC aims to integrate technological development with different functions/components such as mobility, energy management, natural resources, water and waste cycle, air quality, land use, service network, construction, etc. but also contributes to economy, social inclusion, increased employment and citizen security etc. (Campisi et al., 2021). Integrated SC projects need various representatives from different disciplines to implement a project with a wide range of problems (Beurden et al., 2017). For SC projects to be implemented correctly, careful project planning is required. The beginning of any SC project planning process is a SC plan or strategy. According to Beurden et al. (2017), the types of plans that can be the starting point for smart city implementation are: (1) General SC Strategy, (2) Strategic Energy Action Plan and Strategic Energy and Climate Action Plan, (3) Sustainability or environment plan, Energy vision & plan, (4) Urban restructuring, rehabilitation, real estate project development, (5) Master plans and zoning plans for areas, (6) Renovation and/or maintenance plans for buildings and urban infrastructures such as electricity networks, (7) Transport and mobility plans, (8) Sustainable Urban Mobility Plans, (9) Framework Program 7 (FP7) and (10) Horizon 2020 research and innovation-based projects, (11) Bottom-up initiatives.

### ***Characteristics and Components of the Smart City***

Definitions aimed at understanding the features of a SC include the uses of dimension, component, success factor, element, etc. terms (Bayramoğlu Barman, 2020; Cohen, 2014; Giffinger and Haindlmaier, 2010; Mohanty et al., 2016; Nam and Pardo, 2011). However, the use of the term component is more common. SC components have also been widely used under six headings: economy, people, governance, mobility, environment and living. Smart Economy is related with business ecosystems that create dynamic, flexible, innovative and collaborative networks. Smart People component attaches importance to quality in education and social interaction in the context of social and human capital. Smart Governance necessitates transparency and participative and strategic decision-making. Smart Mobility depends on the availability of ICT infrastructure and sustainable transport systems. Smart Environment component requires a healthy and attractive environment. Smart Living component is related with all quality-of-life indicators such as urban facilities, safety, touristic attractivity etc.

Albino et al. (2015) outline the most common characteristics of SCs in the light of various academics of the phenomenon: (1) a city's networked infrastructure that enables political efficiency and

social and cultural development (2) an emphasis on business-led urban development and creative activities for the promotion of urban growth (3) social inclusion of various urban residents and social capital in urban development (4) the natural environment as a strategic component for the future.

### **Smart City Applications Across the Globe**

Cities are areas of creativity and economic growth: the potential for exchanges, optimization and new solutions is unique and enormous (Huovila et al., 2017). SC services offer effective solutions to urban problems. Thus, many countries are introducing SC services. The direction of SC development in each city is changing (Kim, 2022). There are hundreds of SC projects currently being developed around the world (Appio et al., 2019). Innovative and smart solutions for cities are already available but their uptake is low, one of the reasons being that often the impacts of the SC solutions cannot be objectively verified and because of lack of evidence that these solutions can also be applied in other contexts and cities. In response, some cities and countries (Netherlands, Zaragoza, Vienna, Tampere etc.) have developed their SC strategies (Huovila et al., 2017).

This section describes SC applications in three cities: Seoul, London, and New York. These three cities were selected as representatives of cities with high SC ratings from various continents according to the Eden Strategy Institute. This study, which covers three cities with different urban conditions on different continents, aims to examine the programs and policies of the cities discussed.

#### ***Seoul's (South Korea) Smart City Applications***

According to Eden Strategy Institute, Seoul ranks 2nd in the 2020/2021 Top 50 Smart City Government Rankings with 34 points. Seoul is the capital of South Korea and the country's largest metropolis with a population of over 10 million people. Having hosted the Olympic Games, the FIFA World Cup, and 2010's G-20 summit, Seoul is world renowned as both a highly advanced economy and leading tourist destination. Smart Seoul 2015 was announced in June 2011 to uphold Seoul's reputation as a global ICT leader by boosting its sustainability and competitiveness through smart technologies (Hwang, 2013). The Seoul Metropolitan Government (Seoul e-Government) is leading the world in smart governance by continuously striving to take advantage of rapid developments in smart technologies worldwide. Seoul's Metropolitan Government (SMG) wants to realize relevant innovations in public services under the new citizen-centred management paradigm based on communication, transparency, sharing and collaboration. The goals of Seoul e-Government are to provide customized public services to citizens, create jobs, and build new growth engines (Shin, 2016). Smart Seoul 2015 was announced in June 2011 to uphold Seoul's reputation as a global ICT leader by boosting its sustainability and competitiveness through smart technologies. The "Smart Seoul" focuses initially on several well-balanced smart factors, and ultimately on much smarter city management and a better quality of life for Seoul's citizens. Smart Seoul is not Korea's first attempt to incorporate ICT in city-development strategies (Table 4). In 2004, Korea initiated the u-City project whereby ubiquitous computing technologies were applied to strengthen cities' competitiveness. Smart Seoul 2015 was adopted to overcome the limitation & failure of u-Seoul regarding life quality improvements of Seoul's citizens (Hwang, 2013). SMG has developed e-government initiatives that incorporate advanced ICT to improve its administration's efficiency and quality when serving its citizens. Its "Global Digital Seoul 2020: Smart City Seoul with New Connectivity, New Experience" plan seeks to continue reinventing governance, to move from a citizen-oriented approach to a more citizen-led one (Eden Strategy Institute, 2018). To sum up, smart city applications sharing public information thus strengthening the city-citizen relationship and developing apps to enhance the quality and efficiency of public services (Table 4) in Seoul have positive contributions within the framework of planning & design via enabling a high qualified city to its citizens and developing citizen-led, thus successful & applicable policies.



**Table 4**  
*Seoul's Smart City Applications*

PROGRAMME	INTERPRETATION
IT Superhighway (e-Seoul net, u-Seoul net)	Optical cable network connecting 36 major administrative offices, including 25 district offices and HQ, using the exclusive high speed communication network in the subway tunnels.
Free Public WiFi	Free Wi-Fi is available at tourist attractions, traditional markets, parks, main roads, etc. (1600 sites covering 13.69 % of total Seoul area) via cooperation between SMG and 3 telecom companies. There are 5200 wireless access points in the city.
Free Smartphone Charging Service	There is a Free Smartphone Charging Service, launched in cooperation with LG U-plus & Woori Bank, with 5700 chargers in 350 areas consisting Municipal Library, Seoul Art Center, History Museum, etc.
Seoul Website	The website, which facilitates communication with citizens and can be easily used from various devices, underwent a general renovation in 2012.
Oasis of 10 Million Imagination	Citizen suggestion adoption system which reflects citizens' creative idea or policy suggestion to real life after citizens vote or examination from experts/officials.
Information Communication Plaza	This service discloses all non-confidential administrative information (e.g. documents, financial information, budget information, meeting information, service contract results, statistics, publicly available data, publicly announced information, etc.) approved at the manager or higher level.
M-Voting	M-Voting is a smartphone app with mobile voting function. By using M-Voting, SMG collects citizens' opinions for administrative decision making and policy planning. It helps SMG solve diverse urban problems and realize "cooperative governance", one of key basis of Seoul.
Smart Complaint Report	Citizens can report inconveniences in life and incidents with smart phones (e.g. damaged road, littering, illegal parking, facility security, etc.)
Bukchon IoT Project	Bukchon Hanok Village is one of the major tourist attractions of Seoul where a lot of museums, restaurants, and traditional houses are concentrated and has more than a million a year. Bukchon IoT Project solves urban issues (residents' problems such as increased inconvenience due to increase of tourists, limited development of Hanok area; small business owners' problems such as unsatisfactory vitalization of business zone; tourists' problems such as lack of guide for free Wi-Fi, experience & attraction, and food) using Internet of Things (IoT).
WeGO- World e-Governments Organization of Cities and Local Governments	SMG is the president city of WeGO since 2010. Currently, WeGO has 74 member cities worldwide.
Smart Work Center	Seoul Metropolitan Government is piloting a "Smart Work Center" project, allowing the government's employees to work from 10 offices – Smart Work Centers – located much closer to their homes.
Smart Metering Project	Seoul's Smart Metering Project aims to reduce the city's total energy use by 10 per cent, and in 2012, Seoul is piloting a program installing smart meters in 1,000 households.
Community Mapping	Citizens can participate in the administration of the city via "Community Mapping". Using ICTs such as geographical-information systems, the m.Seoul platform and social networks, citizens will be able to raise the issues of greatest concern to their neighborhood or community.
3-Dimensional Spatial Information	The city's 3D spatial information system has services such as Geographical Information, "Tour with a Theme Information" and "Urban Planning". In terms of urban planning it is useful in monitoring the environment, preventing disasters and constructing disaster-resilient infrastructure.
Citizen-developed Services	Services of NFC (near field communication)-based Mobile Payment, Virtual Store, School Newsletter Application.
Seoul Open Data Square	Seoul Open Data Square is a key building block to the Information Open Square. Opened in April 2012, the website discloses public information under ten categories: General administrative work; Welfare, culture and tourism; City management; Environment; Safety/security; Education; Health; Industry; Economy; and Transportation.
Online Reservation System for Public Services	Seoul's next-generation online reservation system allows citizens to search for, book and pay for public services instantly. The one-stop, integrated reservation system lists services under categories such as education, infrastructure, cultural tourism, commodities and medical treatment.

Source: Prepared by authors using Hwang, 2013; Shin, 2016.

### ***London's (United Kingdom) Smart City Applications***

According to the Eden Strategy Institute, London ranks 3rd in the 2020/2021 Top 50 Smart City Government Rankings with a score of 33.1. London is a city of nine million inhabitants, 33 local authorities and many more public agencies. It is also home to globally renowned universities, cultural institutions. London is the tech capital of Europe – by size, level of investment and the presence of more than a third of Europe's billion-dollar companies (Greater London Authority, 2018).

The Mayor of London launched the 'Smarter London Together' roadmap in 2018 with a plan to transform London into the smartest city in the world. The Smarter London Together roadmap (Table 5) is a non-statutory document adopted by the Mayor of London. The roadmap builds on the last Smart London Plan in 2013 (updated in 2016) and is a new approach based on collaborative missions. It calls for the city's 33 local authorities and public services to work and collaborate better with data and digital technologies and helps to realise the seven statutory Mayoral strategies in: transport, the environment, health inequalities, housing, culture, economic development, and the London Plan (Greater London Authority, 2018). The city of London has based its SC initiative on four dimensions: (1) technology innovation; (2) open data and transparency; (3) collaboration and engagement; (4) efficiency and resource management. Lee et al. (2014) similarly explain six enablers of SC development: urban openness, service innovation, partnership formation, urban proactiveness, infrastructure integration, and SC governance (Appio et al., 2019). London's Chief Digital Officer has set out key priorities for smart London for the 2021 to 2024 Mayoral term: Digital Connectivity, City Data, Open Innovation, Digital Inclusion and Participation (URL 2). To sum up, smart city applications (Table 5) prioritized city data, digital inclusion & connectivity, innovation and participation for smart London have positive contributions within the framework of planning & design and collaborative policy.

**Table 5**  
*London's Smart City Applications*

MISSION	INITIATIVE	PROGRAMME
More user-designed services	<ul style="list-style-type: none"> <li>Leadership in design and common standards to put users at the heart of what we do</li> <li>Develop new approaches to digital inclusion to support Londoners' access to public services</li> <li>Launch the Civic Innovation Challenge to spur innovation from the tech sector</li> <li>Explore new civic platforms to engage citizens and communities better</li> <li>Promote more diversity in tech to address inequality</li> </ul>	<ul style="list-style-type: none"> <li>Talk London</li> <li>Civic Innovation Competition</li> <li>Civic Crowdfund</li> </ul>
Strike a new deal for city data	<ul style="list-style-type: none"> <li>Launch the London Office for Data Analytics (LODA) programme to increase data sharing and collaboration for the benefit of Londoners</li> <li>Develop a city-wide cyber security strategy to coordinate responses to cyber-threats to businesses, public services and citizens</li> <li>Strengthen data rights and accountability to build trust in how public data is used</li> <li>Support an open ecosystem to increase transparency and innovation</li> </ul>	<ul style="list-style-type: none"> <li>Londra Datastore</li> <li>London Air Quality Map</li> <li>London Development Database (LDD)</li> <li>Responsible data collaboration for local government</li> <li>London web maps and data services</li> <li>Planning Datahub</li> <li>Infrastructure Mapping Application</li> <li>Cultural Infrastructure Map</li> </ul>
World-class connectivity and smarter streets	<ul style="list-style-type: none"> <li>Launch a new Connected London programme to coordinate connectivity and 5G projects</li> <li>Consider planning powers, like requiring full fibre to the home for all new developments, to enhance connectivity in the future</li> <li>Enhance public wifi in streets and public buildings to assist those who live, work and visit London</li> <li>Support a new generation of smart infrastructure through major combined procurements</li> <li>Promote common standards with smart tech to maximise benefits</li> </ul>	<ul style="list-style-type: none"> <li>Connected London</li> <li>Connected London Map</li> <li>Urban Connected Communities Fund</li> </ul>
Enhance digital leadership and skills	<ul style="list-style-type: none"> <li>Enhance digital and data leadership to make public services more open to innovation</li> <li>Develop workforce digital capability through the Mayor's Skills for Londoners Strategy</li> <li>Support computing skills and the digital talent pipeline from early years onwards</li> <li>Recognise the role of cultural institutions engaging citizens in the digital world</li> </ul>	<ul style="list-style-type: none"> <li>Digital Talent Programme</li> <li>Adult Education Budget</li> <li>Digital Inclusion &amp; City Hall</li> </ul>
Improve city-wide collaboration	<ul style="list-style-type: none"> <li>Establish a London Office of Technology &amp; Innovation (LOTI) to support common capabilities and standards for future innovation</li> <li>Promote MedTech innovation in the NHS and social care to improve treatment</li> <li>Explore new partnerships with the tech sector and business models</li> <li>Support better GLA Group digital delivery to improve effectiveness</li> <li>Collaborate with other cities in the UK and globally to adopt and share what works</li> </ul>	<ul style="list-style-type: none"> <li>London Office of Technology and Innovation</li> <li>London GovTech</li> <li>Smart Energy</li> </ul>

Source: Prepared by authors using Greater London Authority, 2018; URL 2.

***New York’s (United States of America) Smart City Applications***

According to Eden Strategy Institute, New York ranks 6th in the 2020/2021 Top 50 Smart City Government Rankings with a score of 31.9. In April 2015, Mayor de Blasio announced the release of “One New York: The Plan for a Strong and Just City,” a comprehensive plan for a sustainable and resilient city for all New Yorkers that addresses the profound social, economic, and environmental challenges ahead (NYC Mayor’s Office of Tech and Innovation, 2015). This plan (Table 6) envisions a city with a dynamic, thriving economy that is also a responsible steward of the environment and is resilient against shocks both natural and manmade. To sum up, SC applications (Table 5) in line with New York city’s SC plan envision a dynamic, environmental responsible and resilient city at five dimensions including Smart Buildings + Infrastructure, Smart Transport + Mobility, Smart Energy + Environment, Smart Public Health + Safety and Smart Government + Community. Additionally, all these dimensions have positive contributions within the framework of planning & design and policy.

**Table 6**  
*New York City’s Smart City Applications*

DIMENSION	PROGRAMME	INTERPRETATION
Smart Buildings + Infrastructure	Smart Indoor Lighting	The introduction of smart lighting solutions into New York City’s buildings is saving millions of dollars in energy expenses while reducing greenhouse gas emissions.
	Wireless Water Meters	Each day, over 1 billion gallons of clean, fresh water is distributed to the city’s 8.5 million residents. New York City’s Department of Environmental Protection (DEP) has installed the world’s largest advanced Automated Meter Reading (AMR) system to manage this level of water consumption efficiently. In 2011, DEP introduced the Leak Notification program, which notifies registered customers of possible water leaks.
Smart Transport + Mobility	Responsive Traffic Management	Through Midtown in Motion program - a smart city approach to traffic management- of the Department of Transportation, New York City is using real-time traffic information to reduce congestion, improve the flow of traffic, and decrease carbon emissions
	Traffic Signal Priority	City’s Department of Transportation (DOT) and the Metropolitan Transportation Authority (MTA) introduced Transit Signal Priority (TSP), an urban traffic management system that improves the efficiency and dependability of bus mass transit. A bus equipped with the in-vehicle TSP system requests priority service as it approaches an intersection and can change the normal signal operation to improve the flow of bus traffic.
Smart Energy + Environment	Smart Waste Management	New York City is improving the collection of garbage and recyclables and reducing the city’s carbon footprint with the introduction of new smart waste and recycling systems with integrated real-time sensors and compaction.
	Water Quality Monitoring	New York City has some of the best water in the country, and the quality of that water is maintained through constant real-time monitoring at its source. Connecting New York City to real-time information about its watershed ensures that New Yorkers can continue to enjoy clean and safe water.
Smart Public Health + Safety	Air Quality Monitoring	New York City’s air quality is improving faster than that of most other big U.S. cities thanks to the City’s data-driven air quality management practices. To inform New York City’s effort to reduce the pollutants in its air, the Department of Health and Mental Hygiene (DOHMH) conducts regular air quality surveys measuring fine particulates, nitrogen oxides, sulfur dioxide, elemental carbon, and ozone levels. Data from the Community Air Survey is used to introduce regulations targeting major local pollution sources.
	Real-Time Gunshot Detection	New York City’s urban public safety data collection system, the largest in the country, has been further enhanced with state-of-the-art real-time acoustic gunshot monitoring equipment. The New York City Police Department (NYPD) operates the largest urban public safety and security data collection and processing system in the United States. The Domain Awareness System (DAS) incorporates thousands of NYPD video feeds, license plate readers, radiation and chemical sensors and 911 reports into a centralized clearinghouse. It also integrates data feeds from various City agencies and from some private and commercial buildings.
Smart Government + Community	Snow Plow Tracking	New York City, receives around two feet of snow every winter, uses high-tech GPS equipment and geographic information software to provide its residents with real-time web-based snow plow tracking information during the winter months
	New York City 311 24/7 Service Requests	New York City’s 311 is a mobile-friendly, user-oriented service that facilitates and improves the interaction between the City’s government and its residents. As the city’s main source of government information and non-emergency services, residents can access 311 via phone, web, text, social, and mobile to submit service requests or obtain community information.

Source: Prepared by authors using NYC Mayor’s Office of Technology and Innovation, 2015.

## DISCUSSION

In this section, the three cities that are in the top 10 of “Eden Strategy Institute's Top 50 Smart City Government Rankings” and examined in detail in the article are compared in the context of the ten key SC factors / indicators: Vision, Leadership, Budget, Financial, Support programmes, Policies, Ecosystems, People-centricity, Talent-readiness and Track record (Figure 1, Figure 2).

*Vision:* The cities in the top 50 are distributed within the range of 2-4 points in the context of "*a clear and well-defined strategy to develop a SC*" while the mean is 3.02 point. While London and New York City have the highest score (4.0 point) among the cities examined, Seoul is a city with an average score (3.0 point) in the context of this indicator.

*Leadership:* The cities in the top 50 are distributed in the range of 1-4 points in the context of "*dedicated city leadership that steers SC projects without major discontinuities*" while the mean is 2.86 point. While Seoul has the highest score (4.0 point) among the cities examined, London and New York City have 3 points in the context of this indicator.

*Budget:* The cities in the top 50 are distributed between 1.1-4 points in the context of "*Sufficient funding for SC projects*" while the mean is 2.73 point. All the cities examined in the context of this indicator have 3 point.

*Financial incentives:* The cities in the top 50 are distributed between 1-4 points in the context of "*financial incentives to effectively encourage private sector participation specifically in SC projects and initiatives*" while the mean is 2.47 point. All the cities examined in the context of this indicator have 3 point.

*Support programmes:* The cities in the top 50 are distributed between 1.1-4 points in the context of "*in-kind programs to encourage private actors to participate specifically in SC projects and initiatives*" while the mean is 2.56 point. All the cities examined in the context of this indicator have 3 point.

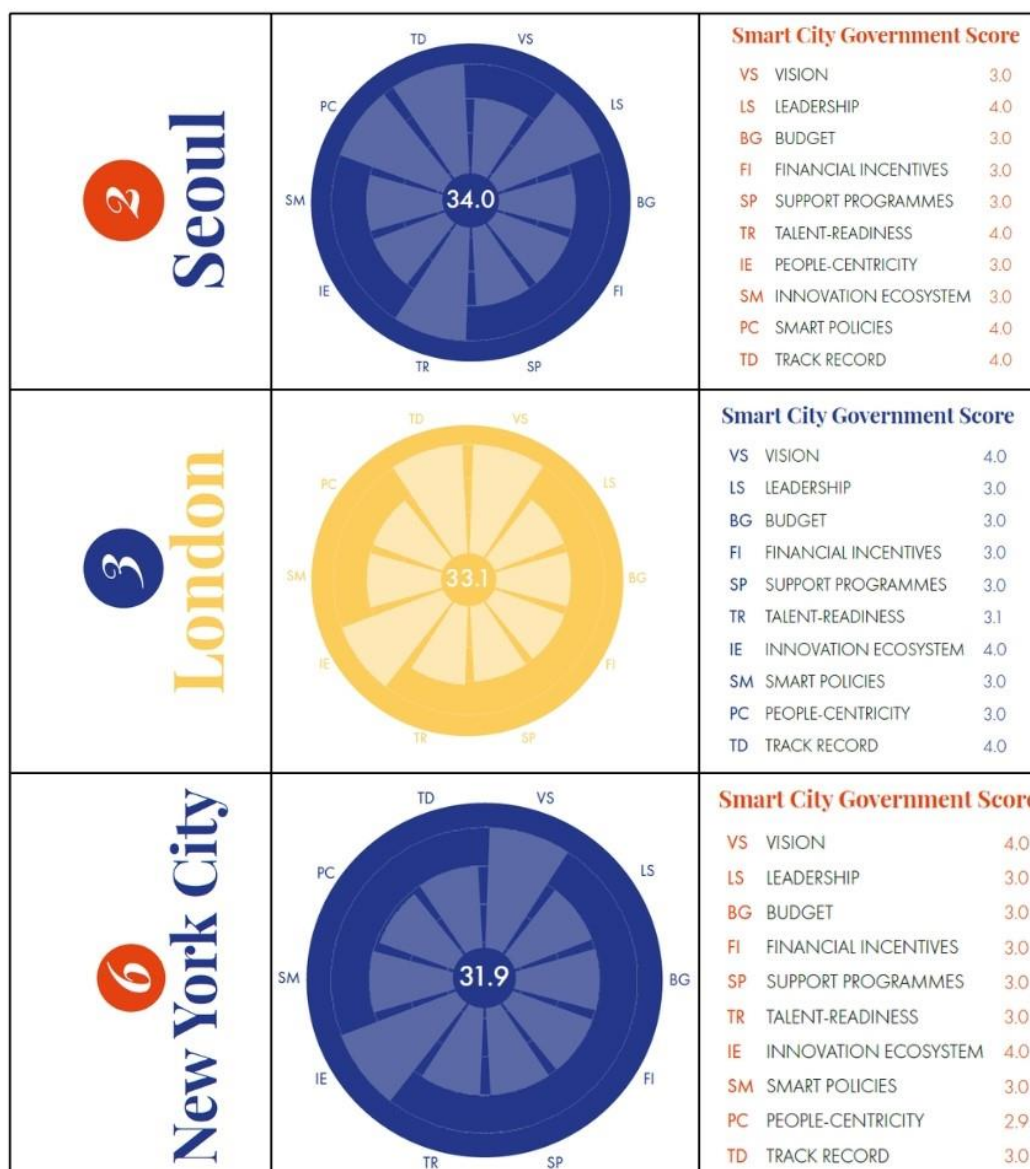
*Talent-readiness:* Cities in the top 50 are distributed between 1-4 points in the context of "*programmes to equip the city's talent with smart skills*" while the mean is 2.76 point. Among the cities examined, Seoul is the city with the best position in terms of this indicator with 4 points, while London (3.1 point) and New York City (3 point) also have high scores.

*People-centricity:* The cities in the top 50 are distributed between 2.1-4 points in the context of "*a sincere, people-first design of the future city*" while the mean is 3.02 point. Among the cities examined, Seoul and New York City are the best-positioned cities with 3 point in the context of this indicator, while London (2.9 point) also has a high score.

*Innovation ecosystems:* The cities in the top 50 are distributed between 1-4 points in the context of "*a comprehensive range of engaged stakeholders to sustain innovation and partnerships where the city government was instrumental in sustaining and catalysing them*" while the mean is 2.58 point. All the cities examined in the context of this indicator are above the average while London and New York City have the highest scores (4.0 point).

**Figure 1**

Rankings of Seoul, London and New York City in terms of 2020/21 top 10 Smart City Government



Source: Prepared by authors using Eden Strategy Institute, 2021.

*Smart Policies:* The cities in the top 50 are distributed on 1-4 points score scale in the context of “a conducive policy environment for SC development city” while the mean is 2.74 point. Among the cities examined, Seoul has the highest score (4.0 point) in this indicator, while London and New York City also have high scores (3 point) above the average.

*Track record:* The cities in the top 50 are distributed on a 2.8-4 points scale in the context of “the government’s experience in catalysing successful SC initiatives, with no systematic or widespread failure” while the mean is 3.28. Among the cities examined, Seoul and London have the highest score (4.0 points) in this indicator, while New York City has a lower score (3.0 point) at below average.

When the cities in the top 50 are considered holistically in the context of key SC factors, the average values of the cities are in the range of 2.47-3.28. The three indicators in which cities were most successful were *Track record* (3.28), *Vision* (3.02) and *People-centricity* (3.02), while the indicators in which they were less successful were *Financial incentives* (2.47), *Support programs* (2.56) and

Innovation Ecosystems (2.58). When the three cities examined are considered in terms of their average values for these factors (Figure 1, Figure 2);

The indicators that *Seoul* is best at are *Leadership*, *Talent-readiness*, *Smart policies* and *Track record* indicators. While *Vision* and *People-centricity* indicators in the city have values just below the average, *other indicators have values above the average*.

The indicators that *London* is best at are *Vision*, *Innovation ecosystems* and *Track record* indicators. In the city, only the *People-centricity* indicator has a value just below the average, while *other indicators have values above the average*.

The indicators that *New York City* is best at are *Vision*, *Leadership* and *Innovation ecosystems* indicators. While the *People-centricity* and *Track record* indicators in the city are almost at average values, *other indicators have above average values*.

**Figure 2**

*Comparison of Seoul, London and New York City in terms of Key Smart City Factors*



Source: Prepared by authors using Eden Strategy Institute, 2021.

## CONCLUSION

Evaluating SC government performance is thought to be an effective driver for learning, accountability and dialogue in the SC space (URL 3). In current study to reveal the contemporary SC applications and to understand the role of city governments for smart cities the Eden Strategy Institute's The Top 50 Smart City Government Rankings (2020/2021) focused specifically on the role of city governments as a key driver for SC development and assessed the cities based on ten indicators including vision, leadership, talent readiness and effective SC financing and policy models, has been adopted. According to Calvin Chu Yee Ming, Managing Partner at Eden Strategy Institute "Top smart city governments in the 2020/2021 rankings were able to collaborate and partner with public and private sector stakeholders, and use digital solutions and data to deliver services and make decisions" (URL 3). The findings of this study, which examines in detail the SC policies developed by local governments with a focus on the cities of Seoul, London and New York, in terms of strategic plans, programs and Eden Institute's 2020/2021 Smart City Ranking study are at the below:

When the cities in the Top 50 in the Eden Institute's (2021) Top Smart City rankings are considered holistically in the context of key SC factors, the three indicators in which the cities are most successful are *Track record* (3.28), *Vision* (3.02) and *People-centricity* (3.02) while the indicators where they were less successful were *Financial incentives* (2.47), *Support programs* (2.56) and *Innovation Ecosystems* (2.58).

When the three cities examined are considered in terms of the average values of these factors; in the context of *Track record* indicators *Seoul*, like all leading smart cities; in the context of the *Vision* and *Track record* indicators *London*; in terms of the *Vision* indicator *New York* is very successful. In addition, *Seoul* is very successful in the context of *Leadership*, *Talent-readiness* and *Smart Policies* indicators. *London*, on the other hand, performs very well in the context of the *Innovation Ecosystems* indicator, where the 50 leading smart cities perform less well than other indicators. *New York City*, like *London*, is very successful in terms of the *Innovation ecosystems* indicator. In addition, it is strong in the context of the *New York City Leadership* indicator.

SMG has developed e-government initiatives that incorporate advanced ICT to improve its administration's efficiency and quality when serving its citizens to achieve a citizen-led governance (Eden Strategy Institute, 2018). *Seoul* is recognised for programmes such as wide-scale deployment of IoT and public-private partnerships (URL 3). The collection, storage, analysis, and strategic use of data has been at the heart of the *Seoul* city's SC success (Eden Strategy Institute, 2021). Sharing public information thus strengthening the city-citizen relationship and developing apps to enhance the quality and efficiency of public services are considered important by SMG (Hwang, 2013). However, improvement policies should be adopted in the context of *Vision* and *People-centricity* indicators, which have values just below the average in *Seoul* city but have the highest values in leading smart cities. The continuity and development of studies on other indicators with above-average values is important for the continuity of the city's SC policies.

The city of *London* has based its SC initiative on four dimensions of technology innovation, open data and transparency, collaboration and engagement, efficiency and resource management (Greater London Authority, 2018). In this context city data, digital inclusion & connectivity, innovation and participation are accepted as key priorities for smart *London* (URL 2). *London's* SC initiatives include the Smarter *London Together* roadmap, a collaborative approach with local stakeholders and international cities, and the Mayor's Civic Innovation Challenge approach to spurring solutions to address social challenges (URL 3). Improvement policies should be adopted in the context of the *People-centricity* indicator in *London*, which has the highest values in leading SCs, but has values just below the average compared to other indicators.

*New York* city has a SC plan envisions a city with a dynamic, thriving economy that is also a responsible steward of the environment and is resilient against shocks both natural and manmade at five dimensions (NYC Mayor's Office of Tech and Innovation, 2015): In terms of Smart Buildings + Infrastructure aim *New York City* is committed to developing and maintaining world-class buildings and infrastructure that enhances the delivery of public services and supports the City's economic growth, sustainability, and resiliency. In terms of Smart Transport + Mobility aim *New York City* is committed to maintaining a reliable, safe, sustainable, and accessible transportation network that meets the needs of all *New Yorkers* and supports the city's growing economy. In terms of "Smart Energy + Environment" aim *New York City* is committed to being the most sustainable big city in the world and a global leader in the fight against climate change. In terms of "Smart Public Health + Safety" aim *New York City* is committed to being the safest large U.S. city and ensuring every *New Yorker* long live and healthy life. In terms of "Smart Government + Community" aim technology plays a critical role in improving service delivery and increasing civic engagement. *New York City* is committed to expanding

two-way digital communication and engagement with the public using tools like nyc.gov, as well as non-government platforms and products. Every New Yorker should have access to high quality, community-based City resources that enable residents to thrive. *People-centricity* and *Track record* indicators, which are almost average in the context of Eiden Institute's Smart City Rankings but have the highest values in leading smart cities, need to be improved in the city.

The results of the study clearly show that (1) the concept of SC is not limited to the spread of ICT, but also considers the needs of individuals and society. (2) the inter-sectoral impacts and socially connected aspects of SC initiatives in Seoul, London and New York cities are important. (3) The three leading SCs that are in the top of “Eden Strategy Institute's Top 50 Smart City Government Rankings” and examined & compared in the context of the ten key SC factors, consisting of Vision, Leadership, Budget, Financial, Support programmes, Policies, Ecosystems, People-centricity, Talent-readiness and Track record should, should strengthen their weaknesses while improving their strengths stated here title by title. Research findings not only provides guidance for planners, designers and politicians at these cities but also guides across the globe.

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This study does not require ethical approval. However, approval was received for the in-depth interview forms and survey sheet used in the field study of the master's thesis on which the study is based, with the Decision No.1 dated 12.11.2020 of the Necmettin Erbakan University Science and Engineering Sciences Scientific Research Ethics Committee.

### **Author Contributions**

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Writing the Article (CRediT 12-13) Author 1 (%30) – Author 2 (%70)

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There is no conflict of interest with Afina Sholihat, Fadim Yavuz.

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11 Sustainable Cities and Communities

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