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Sociotechnical Characteristics of Conceptually Related Smart Cities' Services from an International Perspective

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Abstract: Sustainable smart cities (SSCs) have developed various services and technologies with multi-stakeholderism under multiple names. The characteristics of SSCs are specified by implementing conceptually related smart cities (CRSCs), which are ICT-based transformative cities. Many scholars point out that in-depth empirical studies of CRSCs are necessary to clarify the nature of the sociotechnical transition of SSCs while avoiding the oversimplified narratives of techno-utopia. Utilizing a periodic matrix taxonomy, this study aims to examine empirical characteristics of CRSCs services' socio-technical transformation from international perspectives. The target cities were sampled using cluster sampling through three screening steps based on four representative documents reflecting the critical aspects of the operational definition of SSCs. The city-level data were collected using Preferred Reporting Items for Systematic Review and Meta-Analysis Protocol and preprocessed with coding and weighting to create a periodic matrix taxonomy. The outcomes are the commonalities and different services' sociotechnical transitions of sampled European cities from perspectives of multi-stakeholderism. The outcomes have managerial implications demonstrating empirically the sequences of service transformation of European megacities. Theoretical implications for the existing theories also arise through empirical analysis of historical real-city data and specification of stakeholders' partnerships in conceptually related smart cities.

Keywords: conceptually related smart cities; smart cities; smart services; sociotechnical transition; sustainability; sustainable smart cities

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1. Introduction

Sustainable smart cities have developed through technologies and services in a paradigm of a socio-technology transition, which is the co-development nature of society, technologies, and human innovation, under various names to achieve urban sustainability [1–7]. The sustainable smart cities' transformations have been influenced by miscellaneous stakeholders' participation and partnerships [3]. According to Komninos et al. (2019), the governance and investment from international public and global private sectors in the first circuit transform the first circuit of establishing core technologies such as backbone internet, virtual communities, and cyberspaces using Advanced Research Project Agency Network to a second circuit, which is also transformed by citizen behavior based on urban awareness of efficiently using urban infrastructure into third one that emphasizes the improved local government systems based on strong participation of local entities [3]. Subsequently, conceptually related smart cities are developed as an innovative platform to gather diverse stakeholders to transform society into sustainable smart cities.

The two concepts of sustainability and smart cities have distinctive characteristics that compensate for their counterparts' shortcomings [8]. Sustainability has distinct indicators of citizen participation, social inclusion, future diversity, and GDP, which are more related to the Sustainable Development Goals (SDGs). At the same time, smart cities are more oriented toward ICT to improve the efficiency of urban management and services, citizens'

quality of life, and urban competitiveness so as to satisfy the needs of present and future generations [9–13].

Conceptually related smart cities are subordinate to sustainable smart cities. Related studies have synthesized the two concepts to contribute to sustainable development in smart cities [14–19]. The definitions of sustainable smart cities have arisen from five academic disciplines as follows: (1) a combination of sustainability and smart cities, (2) a compound word emphasizing urban resource management, (3) a unified, innovative index, (4) a transformative process of urban services based on ICT, and (5) places of transformative sociotechnical innovative transitions to satisfy current and future local needs and improve urban ecosystems. The latter supports a multilevel perspective framework and the middle range of sustainable smart cities [5]. Diversely named smart cities are largely understood in the last concept of Sustainable smart cities when analyzed in the existing literature [8,20–23]. They emphasize the need for urban planning, data, and infrastructure to appropriately guide the direction of ICT and data analytic technologies for developing sustainable smart cities [8]. By following the last concept [5,8,24], this study conceives conceptually related smart cities as ICT-based transformative communities and cities, including cyber cities, virtual cities, Internet cities, wireless broadband cities, intelligent cities, digital cities, ubiquitous cities, and smart cities [8]. They have been introduced, advanced, and expired in the history of sustainable smart cities. Subsequently, conceptually related smart cities have been developed and implemented in the transformative sociotechnical framework of sustainable smart cities in cooperation with diverse players, based on the advancement history of ICT and applied urban services.

The qualitative literature review method was utilized to identify the characteristics of studies on smart cities in relation to other topics and unresearched fields within smart city studies. The related study adopts a scoping review [25] to extract the relevant data from each piece of literature as possible, including the methods, findings, and variables, because the method aims to provide an overview of what has been done [26]. A systematic literature review is largely utilized in the field of sustainable smart cities to provide the standards for applying the term "smart city" in the view of knowledge management since 2010 [27]. A systematic literature review has been utilized to identify key services or elements to understand the key notion of smart cities in relation to sustainability [14,28–31]. The Preferred Reporting Items for Systematic Review and Meta-Analysis Protocol (PRISMA) is utilized based on a systematic literature review to identify how disruptive technologies transform cities in relation to the fields of environment, health, and social services [32–38]. The data for conducting PRISMA are not limited to white literature, but they utilize data extracted from social network services, blogs, news, and other informal online written documents to analyze public opinion [39]. Theoretical research has been conducted on smart cities using meta-reviews to identify a holistic view of smart city development, which creates advanced ICT to promote sustainability and participatory urban governance [40,41]. Some studies have used bibliographic analysis to identify the effect of smart infrastructure on e-governance and e-participation [42]. This study adopts PRISMA to collect related data on three conceptually related smart cities based on white literature, grey literature, and unofficial written documents in line with existing literature on smart cities.

A lack of in-depth empirical studies of sociotechnical transitions in conceptually related smart cities affects the oversimplified narratives [43]. Since the new technologies have been emphasized in the development of conceptually related smart cities, it has resulted in the absence of in-depth empirical studies of the sociotechnical transition and oversimplified the narratives of techno-utopia by ignoring the urban sustainability, diverse urban systems, and stakeholders' capabilities [43]. The challenges of the recent development of conceptually related smart cities give rise to the necessity of empirical studies to identify the different characteristics of real cities' cases of sustainable smart cities in sociotechnical transformation. Based on the comprehensive research question "what are the sociotechnical characteristics of Conceptually Related Smart Cities services from an international perspective", this study aims to identify the empirical characteristics of conceptually related smart

cities services' socio-technical transformation led by different stakeholders' cooperation for service implementation from international perspectives.

Considering the study's aim illustrated in Figure 1, this paper is structured as follows. Section 2 reviews the concept of sustainable smart cities and establishes a theoretical background based on a literature review. Section 3 describes the framework of the proposed method. Section 4 describes the study process and explains its three outcomes. Section 5 discusses and expands our findings using existing theories, and the last section presents concluding remarks.

Figure 1. Schematic Section Framework.

2. Literature Review

2.1. Background of Conceptually Related Smart Cities

Empirical characteristics of conceptually related smart cities have yet to be thoroughly studied from a holistic perspective using several real-city cases. Scholars have conceptually typified names to identify the classified heterogeneities and features, as shown in Table 1. The term of conceptually related smart cities was first suggested by Kim and Yang (2021) to analyze the different names of smart cities in holistic manners [8]. It encompasses all the names of smart cities developed by the public, private, and public sectors, as illustrated in Table 1. Meanwhile, Research by Anthopoulos [23] has shortcomings in describing cities' characteristics as it unifies the concepts related to conceptually related smart cities based on the real cities' projects even if the research ushered in new approaches to smart city research based on real cities' transformation. Therefore, it is necessary to clarify the meaning of various terminologies using real-city cases by focusing on the local distinctiveness and sustainable implementation of ICT to deal with smart city challenges of developing local sustainability.

Table 1. The names of Conceptually Related Smart Cites in the existing literature.

Citation	Author (Year)	Title	Conceptually Related Smart Cites
[20]	Nam et al. (2011)	Conceptualizing smart city with dimensions of technology, people, and institutions	a technological dimension (the digital city, intelligent city, ubiquitous city, wired city, hybrid city, and information city), a people dimension (a creative city, learning city, a human city, and knowledge city), and a community dimension (smart community)
[21]	Guo et al. (2019)	A Bibliometric Diagnosis and Analysis of Smart Cities	smart city, digital city, information city, intelligent city, knowledge-based city, and ubiquitous city
[22]	D'Auria et al. (2018)	Modern Conceptions of Cities as Smart and Sustainable and Their Commonalities	technology-led digital city, human capital emphasized smart cities, cyber cities, and virtual cities
[8]	Kim&Yang (2021)	Characteristics of Conceptually Related Smart Cities (CRSCs) Services from the Perspective of Sustainability	cyber city, virtual city, internet city, wireless broadband city, intelligent city, digital city, ubiquitous city, and smart city
[23]	Anthopoulos et al. (2017)	The rise of the smart city	A cyber-based city, a web city, a virtual city, a knowledge base, a broadband city, a wireless/mobile city, a smart city, a digital city, a ubiquitous city, and an eco-city.

Conceptually related smart cities are regarded as innovative platforms in cooperation with diverse stakeholders' partnerships. Technology and society have developed through the formulation of correlated relationships. The technologies are influenced by economic, social, environmental, and political urban resources to satisfy different needs in each period while untethering a flood of social changes in modern society [44]. Those sociotechnical communities are the conceptually related smart cities developed in the five stages of IT transformative history, beginning from pre-telecommunications, telegraph, telephony, computing, and ICT [45–47]. In the history of transitions, ICTs have influenced better decisions and policymaking at the city level. It has empowered citizens' participation by opening up the data and training them to become intelligent citizens, encouraged multi-stakeholder partnerships by breaking down traditional silos, and enhanced city sustainability by managing social, economic, and environmental resources, even though the technologies seem to be emphasized in the initial implementation stages. Sociotechnical advancement based on different stakeholders' partnerships diversifies and evolves conceptually related smart cities in innovative trajectories. Their endogenous elements emphasize the role of stakeholders, geographical characteristics, and dynamic urban services [5,48–50]. The ICT-based transformative communities and cities are, aforementioned, cyber cities, virtual cities, Internet cities, wireless broadband cities, intelligent cities, digital cities, ubiquitous cities, and smart cities [8]. Through the interaction of these three factors, cities become innovative laboratories to develop place-based technologies [47,48] through exploration and exploitation activities immersed in the urban services' interaction, especially in cooperation with the public, private, people, academia, and NGO sectors [51].

Overall, the related literature insists on the importance of multi-stakeholder partnerships and place-based urban services to make conceptually related smart cities sustainable. However, few studies have examined the empirical development of sustainable smart cities according to different stakeholder partnerships [43]. This study typified sociotechnical service developments of conceptually related smart cities according to different stakeholders' cooperation by adopting the comprehensive concept of multi-stakeholderism. Meanwhile, this study differs from previous sustainable smart cities studies with respect to empirically clarifying three types of service sustainability by focusing on different stakeholders' partnerships.

2.2. Concept of Sustainable Smart Cities

The concept of sustainable smart cities is neither a general nor fixed term. It has been discussed disparately by combining two terms: smart cities and sustainability. The concept of sustainable smart cities is based on (1) the concept of sustainability or sustainable development goals (SDGs) as a vision in a government plan [52–55] which the United Nations' SDGs influence, 2030 Agenda, the New Urban Agenda to improve indiscreet urbanization,

and the rapid growth of urban populations [56–58]. (2) Some studies define it as a compound term for managing urban resources by mobilizing ICT [21,59,60]. (3) It is regarded as a complex and innovative index for achieving urban sustainability [53,61–64]. (4) Other studies consider sustainability as a transformative process of urban services sustainability based on the transformative concept of ICT and multi-stakeholder partnership [51,65–67]. (5) Established from the transformative concept of sustainable smart city services, others conceive it in transformative sociotechnical innovative transitions to improve urban ecosystems and meet local needs [3,11]. In particular, Mora et al. (2021) adopt a middle-range of sustainable smart city transitions, which bridge the theoretical preposition with subsequent empirical testing based on the multilevel perspective framework to bring new theoretical insights beyond techno-utopianism [5]. Kim and Yang (2021) defined sustainable smart cities as complex initiatives aiming to develop and implement sustainably and integratively diverse urban services from social, technological, governancial, environmental, and managemental aspects [8]. Tcholtchev and Schieferdecker (2021) describe sustainable smart cities as those that fulfill SDGs in a sustainable process based on ICT, including IT, to boast various fields sustainably based on their development history [24].

In this study, sustainable smart cities are defined as transformative initiatives for developing and implementing integrative social, technological, governance, economic, environmental, and management urban services sustainably by extending the ideas of Tcholtchev and Schieferdecker (2021) [24], Kim and Yang's (2021) concepts [28], and Mora et al.'s (2021) framework [5].

2.3. Literature Review of Socio-Technical Transition

The theory of a multilevel perspective of sociotechnical transitions was first framed by Geels [68] and influenced by various multilevel transition concepts. The field began its study by understanding technological changes and shifts by scholars in evolutionary economics. Nelson-Winter's model is a representative study for identifying technological transitions using technological regimes and organizational and cognitive routines [69]. The technological regime focuses on the attention of engineers to provide strong guidance on the tactics for probing in that direction [70]. The regime results from the organizational and cognitive routines that engineers and firms share. It results in technological trajectories through innovative activities and R&D towards incremental improvements based on the stability of the technological regime [68,69]. Rip and Kemp widened the concept of the technological regime by conceiving sociological and economic perspectives [71]. Having the foundation of these two concepts, Geels combines various concepts by adopting Hughes' large technological systems and the relationship between sociology, institutions, and rules [72]. This notion is supported by multilevel perspectives [73]. Malerga's sectoral systems of innovation [74] and Carlsson's technological systems [75] frame the sociotechnical transition from multilevel perspectives [68,76]. Rotmans et al. (2001) collaborated with Geels on different research levels of aggregation, including sociotechnical landscapes, regimes, and niches [77]. Geels was influenced by existing sociotechnical transition theories, including transformative economic, institutional economic, and middle-range frameworks, to conceptualize overall dynamic patterns in sociotechnical transitions [78].

The multilevel perspectives on sociotechnical transitions include three levels: niche innovations, sociotechnical regimes, and sociotechnical landscapes. Niche innovations are developed by small networks of various social groups and actors to build internal momentum based on visions, expectations, and the learning process. It is an expanded concept that embeds the concept of Dosi's (1982) technological trajectories [79] with social groups and engineering communities, such as a knowledge base, engineering practice, corporate governance structures, manufacturing processes, and product characteristics [68,79]. As an extended version of the technological regime in Nelson and Winter's theory, the sociotechnical regime acts as a window of opportunity for niche innovation by stabilizing the uncertainty of dominant design, which results in technological trajectories and cognitive routines. The socio-technical

landscape, which is an exogenous context, places pressure on the existing regime and opens up opportunities for novelty.

Multilevel perspectives become robust when more empirical studies with diverse cases in varied time-periods and sectors [68]. The perspectives have been supported by historical case studies and typological studies [68]. The real society has different phases from adopting emerging technologies. As there is a lack of research on conceptually related smart cities from a holistic multilevel perspective that considers technological trajectories, technological regimes, local contexts, and different stakeholders' characteristics and participation, it is not easy to conceptualize smart cities visions and definitions, and develop conceptually related smart cities sustainably [80,81]. Empirical research has been conducted in specific fields or areas, such as the Metaverse, which has recently been researched as socially constructed, politically driven, economically conditioned, and historically situated to overcome its problematic nature [82]. As the technologies have consistently been considered in the local context and the distinct characteristics of stakeholders, in-depth empirical studies of the sociotechnical transition are necessary to clarify diverse urban systems and stakeholders' capabilities to make cities sustainable by avoiding the oversimplified narratives of techno-utopia [2,43]. This study has a gap in terms of identifying the holistic development of technological trajectories, regimes, and participants from multilevel perspectives. Sophisticatedly, this study is different from other sociotechnical transition researchers adopting multilevel perspectives in terms of clarifying "which services are developed mainly by whom in which cities" by reflecting the different conditions of local context and historical trends in each period.

3. Materials and Methods

A periodic matrix taxonomy was utilized based on the literature-reviewed data after cluster sampling, as illustrated in Figure 2. The cluster sampling method is helpful when the frame of the study population is not fully available [83], especially in the case of ongoing projects in smart cities. Multi-stage cluster sampling is a probability sampling method in which researchers list the study population as Table 2, divide them into clusters, and randomly select data from among them. The selected clusters were listed to conduct stratified sampling to determine the final samples randomly [84]. This method is usually utilized to select cities or people in social sciences, medical research, and agricultural studies for interviews or surveys [85–90]. Some systematic literature review researches use adaptive cluster sampling by clustering sources into three overarching steps of sample selection [91,92]. In this study, sampled European cities were selected using cluster sampling from all lists of smart cities (population), combined with lists of sustainable smart cities (study population), while considering the concept's sectoral keywords, including social, technological, governance, economic, environmental, and management elements. The second step was to compile relevant conceptually related smart cities data through longitudinal PRISMA and sort them by criteria to create a dataset for further analysis. The next step was data preprocessing by coding the projects and providing weights to the services depending on the number of stakeholders. The fourth step was to create a periodic matrix taxonomy using coded services and years. It comprises the year category on the top of the x-axis and the category of services on the left side of the y-axis. The vision and names of cities are positioned below the y-axis services and are marked as identical to the services. The cells are shaded if there is a service in a corresponding year, even if identically categorized services are developed within a year. Periodic matrix taxonomy provides two results from an international perspective within the framework of sociotechnical transitions. The following paragraphs elaborate on methodologies and outcomes in a detailed manner.

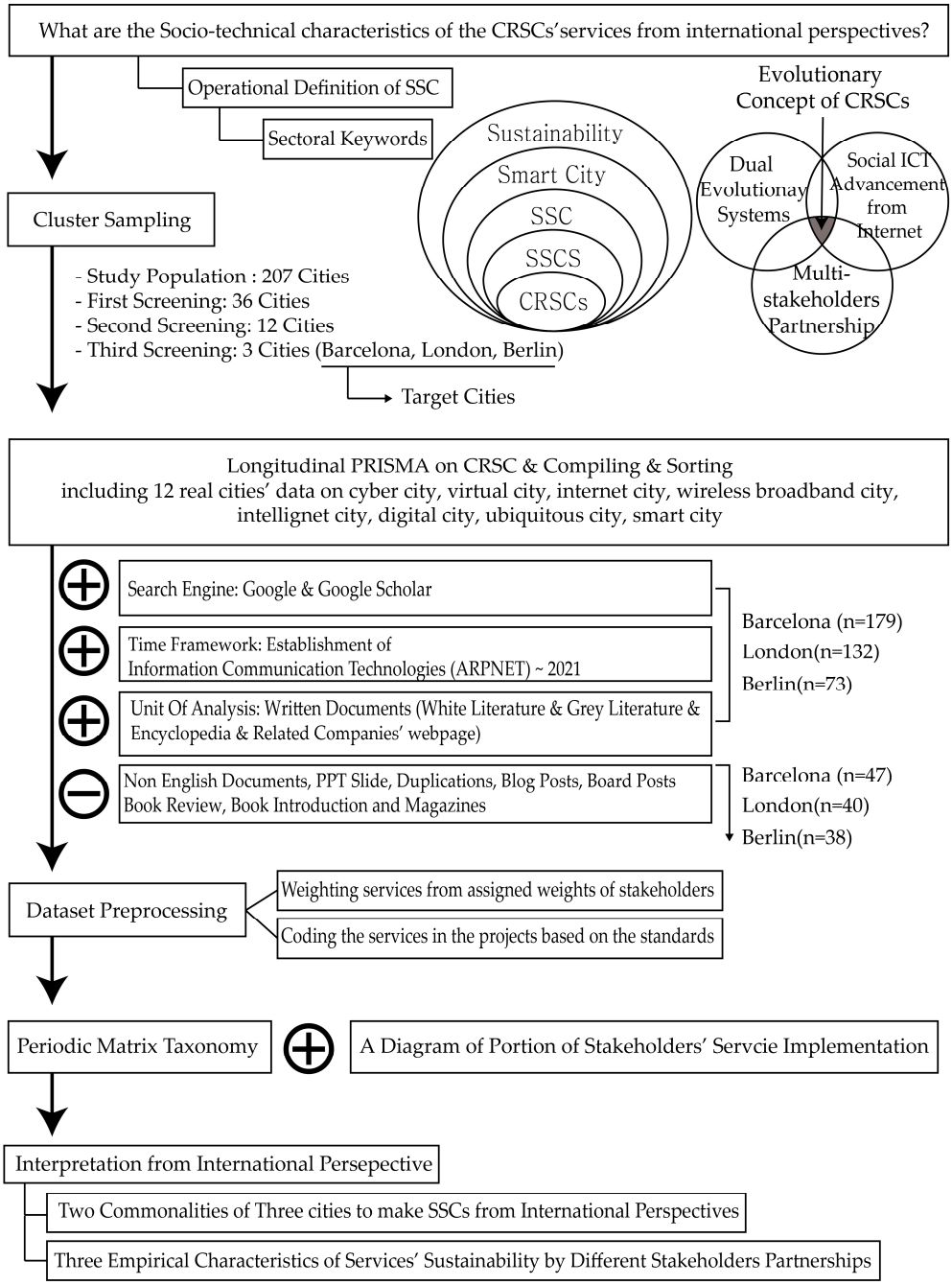

Figure 2. Study Framework.

The first step in framing the methods was started by casting the research question. The question is correlated with the study aim and concept of conceptually related smart cities in the concept of sustainable smart cities, which contain measurable indicators to establish the study frame, as illustrated in Figure 2. As mentioned above, in the concept of sustainable smart cities, the factors of six aspects and one keyword are narrowed down by adopting suitable research materials to sample sustainable smart cities to reflect the concept. The key concept in this study is the sustainability of urban services, and the six aspects are social, technological, governancial, economic, environmental, and managemental elements.

Table 2. A process of sampling cities.

Study Population	First Screening Result	Second Screening Result	European Cities
Singapore, Tokyo, New York, London, San Francisco (Oakland), Paris, Hong Kong, Osaka, Los Angeles-Long, Beach-Santa Ana, Chicago, Barcelona, Moscow, Stockholm, Seoul, Munich, Stuttgart, Boston, Madrid, Shenzhen, Frankfurt am Main, Philadelphia, Toronto, Taipei, Houston, Miami, Berlin, Melbourne, Rome, Shanghai, Seattle, Manchester, Atlanta, San Jose, Cleveland, Sydney, Hiroshima, Birmingham, Beijing, Milan, Montreal, Dallas-Fort Worth, Buenos Aires, Vienna, Tel Aviv-Yafo, Denver-Aurora, Hamburg, Zurich, Nagoya, Baltimore, Kitakyushu-Fukuoka, Copenhagen, Hannover, Salt Lake City, San Diego, Perth, Washington D.C., Incheon, Suzhou, Raleigh, Kuala Lumpur, Vancouver, Amsterdam, Astana, Geneva, Brussels, Detroit, Guangzhou, Austin, Orlando, West Yorkshire, Cologne, Helsinki, Daejeon, Istanbul, Ulsan, Richmond, Valencia, Jerusalem, Columbus, Sao Paulo, Bridgeport Stamford, Phoenix-Mesa, Nanjing, Doha, Haifa, Antwerp, Hartford, Riyadh, Sapporo, Gwangju, Busan, Naples, Xiamen, Milwaukee, Glasgow, Adelaide, Dubai, Daegu, Santiago de Chile, Malaga, Athens, Wuxi, Dortmund, Louisville, Pretoria, Essen, Tianjin, Foshan, Taichung, Brisbane, Auckland, Dresden, Saint Petersburg, Virginia Beach, Calgary, Las Vegas, Bogota, Medina, Dongguan, Wuhan, Lima, Kaohsiung, Dusseldorf, Tampa-St., Petersburg, Belfast, Jedda, Worcester, Hangzhou, Lyon, New Haven, Leipzig, Dublin, Hamilton, Hague, Buffalo, Charlette, Liege, Zaragoza, Torino, Colorado Springs, Chengdu, Qingdao, Nashville-Davidson, Macao, Rio de Janeiro, San Antonio, Zhongshan, Minneapolis-Saint Paul, Sendai, Lisbon, Silo, Ningbo, Lille, Liverpool, Provo-Orem, Changzhou, Zhengzhou, Amman, Venice, Dammam, Rotterdam, Tainan, Changsha, Leicester, Tehran, San Juan, Providence, Shizuoka-Hamamatsu M.M.A., Verona, Johannesburg, Baton Rouge, Bangkok, New Orleans, Gold Coast, Ottawa-Gatineau, Bologna, Leon, Solfa, Indianapolis, Shenyang, Pittsburgh, Ogden, Florence, Kansas City, Budapest, Montevideo, Zhuhai, Honolulu, Barcelona-Puerto La Cruz, Oklahoma City, Dallin, Minsk, Porto, Mecca, Xi'an, Ahvaz, Hefei, Marseille-Aix-en Provence, San Francisco, Tallinn, Roma, São Paulo, Mexico City, Warsaw, Prague, Almaty	Singapore, New York, Stockholm, Seoul, Shanghai, Amsterdam, Helsinki, San Francisco, Chicago, Copenhagen, Barcelona, Melbourne, London, Tokyo, Paris, Moscow, Madrid, Toronto, Berlin, Bogota, Buenos Aires, Istanbul, Brussels, Dubai, Mexico City, Sydney, Johannesburg, Lisbon, Athens, Kuala Lumpur, Seattle, Austin, Vienna, Beijing, Shenzhen	Singapore, New York, San Francisco, Chicago, Barcelona, Melbourne, London, Tokyo, Berlin, Dubai, Mexico City, Seoul	Barcelona, London, Berlin
207 cities	36 cities	12 cities	3 cities

The cluster sampling in this study proceeded through three filtering steps. The cluster sampling needs to list the population to cluster them, and the population for this study is 221 cities, according to Smart City Tracker 1Q18 [93]. The study population combines three rankings representing the sectoral aspects of the sustainable smart cities concept: the United Nations-Habitat Global Urban Competitiveness Report, McKinsey Company's Smart Cities: Digital Solutions for a More Livable Future, and the United Nations E-Government Survey 2020 [94–96]. The first report represents the social, economic, environmental, and managemental aspects. The second report indicates the aspect of technology, while the third one represents the aspects of governance. The first screening results came from the combination of three sustainable smart cities rankings, mentioned more than twice in the three groups of selected cities based on the Sustainable Smart Cities concept, which resulted in 36 cities. The second sampling is conducted to select high-performing sustainable smart cities by integrating the first screen result and the top 20 smart cities from the rank of smart cities performance published by Juniper Research, which included 12 cities. Among the result of the second screening, European cities were selected, and Berlin, London, and Barcelona are the sampled cities representing European samples of the operational concepts' keywords.

Longitudinal PRISMA is conducted to compile the year of occurrence, related events, stakeholders on duty, and related government plans from the written documents that describe events starting from 1968 to 2021, considering the emergence of social ICT from the Advanced Research Project Agency, a pioneer of the Internet. As illustrated in Table 3, the search keywords refer to the existing literature in Section 2 and Kim and Yang's study because they typify the elements of conceptually related smart cities by combining the indicator of sustainable smart cities and conceptually related smart cities based on

transformative concepts using a systematic literature review [8]. The search keywords were used to collect related data from Google and Google Scholars for each city.

Table 3. Search Keywords of Conceptually Related Smart Cities.

Conceptually Related Smart Cities	Search Keywords
Cyber City and Virtual City	Advanced Research Project Agency, file transfer protocol, packet switching, ethernet, telnet, e-mail, backbone networking, web-based community, video chat, audio chat, Bulletin Boards Systems, list server, news lists, Usenet, Bitnet, Computer Mediated Community, Internet Relay Chat, and Multiuser Dungeons.
Internet City	Transmission Control Program/Internet Protocol, modem, and World Wide Web.
Broadband City	digital subscriber, and fiber optic data communication.
Wireless Broadband City	packet radio, local area network, Packet Radio Network, Wave LAN, Wi-Fi, 1G, 2G, 3G, 4G, LTE, and 5G.
Intelligent City	Intelligent Cities are related with keywords of intelligent city, intelligent transport systems, artificial intelligence, intelligent government and intelligent building system.
Digital City	digital city, Geographic Information System, cloud computing, one-stop services, digital inclusion, digital education, digital economy, digital participation, crowd funding, crowdsourcing, digital plan, and data network.
Ubiquitous City	3A(anywhere, anyone, anytime), and manage city resources using ubiquitous, computing, sensors and microchips such as ubiquitous computing, operation center, clouding computer, Radio-Frequency Identification, Near Field Communication, Quick Response code, CCTV, ubiquitous city, ubiquitous plan and u-services.
Smart City	smart city, smart citizens, smart services, Internet of Things, Internet of Everything, robotics, 3D printing, neuro-technologies, quantum computing, solar desalination, zero-carbon natural gas, nanotechnology-cloud computing, energy storage, predicting future and proacting to the disasters and climate changes, cyber-physical system, digital twin, microdata, super connectivity, 5G, Big Data, data security, blockchain, Vehicle To Grid, autonomous vehicle, health passport, DNA computing and storage, carbon based transistors, and other emerging technologies.

Collecting relevant government, company, NGO, academic, and international organization publications is a fundamental step in constructing a dataset for further work. The data features for analysis are shown in Table 4. After searching for the documents with keywords in Table 3, it resulted in 182 documents concerning Barcelona, 110 documents regarding London, and 64 documents regarding Berlin. Non-English documents, PPT slides, duplications, blog posts, board posts, book reviews, book introductions, and magazines were excluded. As organized in Appendix A, the final data sources for analyzing three cities were 47 documents for Barcelona [97–143], 40 sources for London [65,106,144–181], and 38 sources for Berlin [161,182–218]. As Table 4, the 179 Barcelona projects were implemented with 182 participants over 34 years continuously and in an ad hoc manner. The 132 London projects are implemented with 110 players in London under the five names of the conceptually related smart cities for 44 years, mostly continuous plans. Berlin has implemented 73 projects with 64 participants under three names of conceptually related smart cities in 25 years in an ad hoc manner.

Table 4. Compiled Data Features.

Name of Cities	The Number of Participators	The Number of Conceptually Related Smart Cities	The Number of Implemented Years	Implemented Projects
Barcelona	182	3	34	179
London	110	5	44	132
Berlin	64	3	25	73

The compiled data were organized into the categories of the year of occurrence, related projects, stakeholders on duty, and related government plans. Since the compiled data are usually long sentences or paragraphs that are difficult to analyze systematically, it is challenging to identify the flow of conceptually related smart city services' sustainable

development. The data were divided into service, vision, naming, and reference categories by extracting relevant data from long sentences following the progress shown in Figure 3.

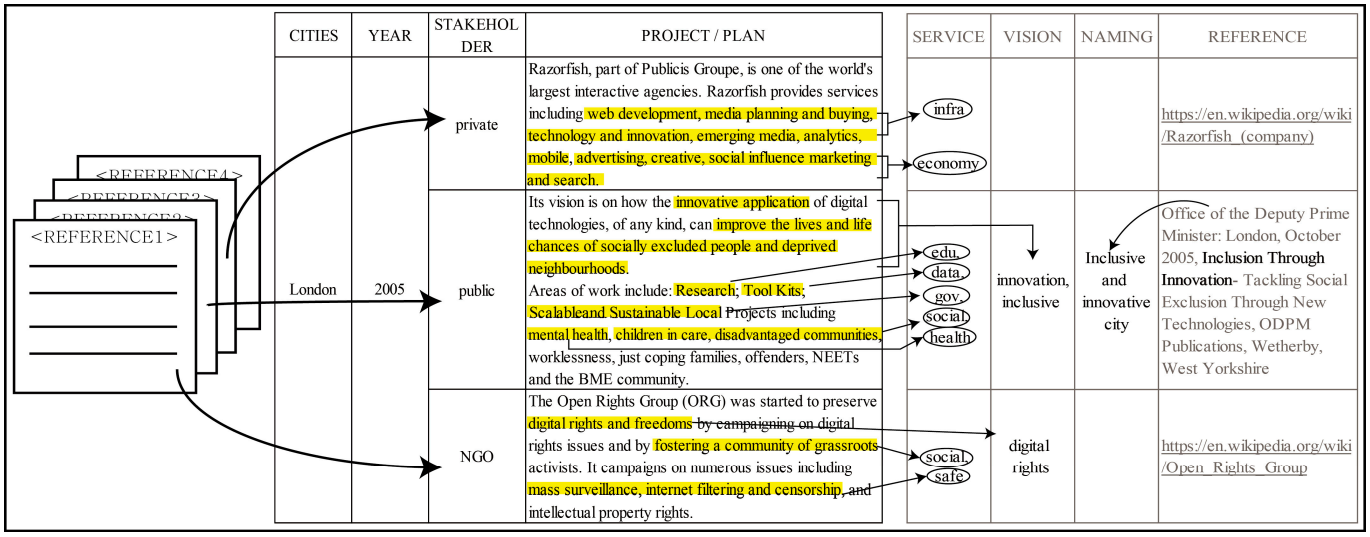

Figure 3. Compiling and Sorting Data.

The compiled text data were transformed into numeric data for the analysis as Appendix A. The first step for data preprocessing is to code them using sustainable smart cities service categories in Figure 4 by referring to Kim and Yang's study because of their similar study aims and concepts [8]. This study adopts 17 service indicators, including social, tour, safety, environment, economy, health, transport, government, waste, architecture, energy, education, history, media and art, standardization, data, and infrastructure, while excluding urban planning vision and including three subordinate elements of hard infrastructure from Kim and Yang's study [8]. The coding index of vision consists of extracting frequently mentioned words from the data documents of the three cities. Following the progress illustrated in Figure 5, the services are codified to create a periodic matrix taxonomy. The codes are marked on the top of the x-axis, referring to the year categories, and service categories are marked on the left side of the y-axis. The vision and names of the cities are marked below the y-axis services based on the government plan.

The second step for data preprocessing is to give weights to each service and stakeholder to count them equally if they correspond in the same years. The weighting process is a crucial step to identify which services are more developed by whom in individual cities. Some projects, which describe only the vision and absent action plans or activities, were excluded from making a weighted service table as this study purposed to identify the characteristics of implemented or planned activities. The services involved in each stakeholder are divided by services' number from the assigned weights of the individual stakeholders. As each year weights "1" equally, the weight is divided by the number of participating stakeholders in that year to distribute the weight to the participated stakeholders equally. The services get weights individually through dividing the assigned weights for stakeholders by the number of implemented services. The point is that the total weight of services in the same year needs to be "1", as shown in Appendix A. Each service is included in some stakeholders each year because this is counted equally, and stakeholders are vice versa in the same year.

The key players are illustrated distinctively in Table 5 and Figure 6. The number of individual stakeholders' driven services is deducted by adding weights corresponding to each city's stakeholders' services. The portion of services results from dividing the number of stakeholder services by the entire year of service implementation in individual cities. When the result is interpreted with the major service-leading stakeholders, the public and private sectors, separate from the others, it reveals that the private and people partnership

has developed in Berlin. By contrast, Barcelona's smart cities have comparatively more weight in the public and people sectors, and London's smart cities are relatively strong in public, academic, and NGO partnerships.

Sustainable Smart Cities (SSCs) Coding Standards			
Service Categories		Vision Categories	
IFR	Infrastructure	IC	Inclusive
Social	Social	Sus	Sustainability
E	Economy	opn	Open
GOV	Government	eff	Efficiency
EDU	Education	ptc	Participatory
SF	Safety	con	Convinient
Tour	Tour	col	Collaborative
DATA	Data	self	Self-sufficient
ENV	Environment	QoL	Quality of Life
H	Health	mea	Measurable
STD	Standardization	mng	Manageable
EG	Energy	DR	Digital Right
TSP	Transportation	IN	Innovation
WST	Waste		
ARC	Architecture		
MA	Media & Art		
HST	History		

Figure 4. The Sustainable Smart Cities Coding Standards.

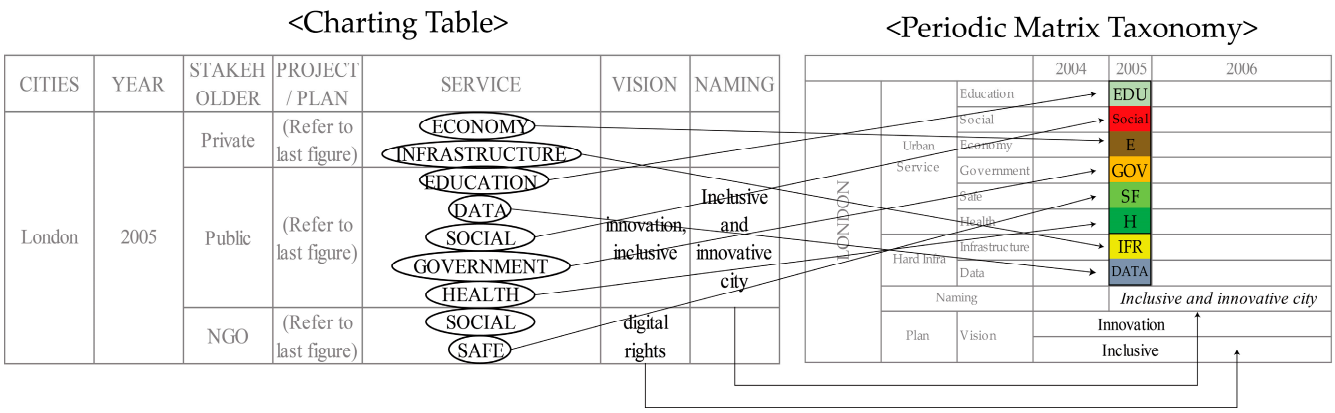

Figure 5. Coding Data.

Table 5. Three types of services' sustainability by different stakeholders' partnerships.

	Barcelona	London	Berlin
The weights of publicly driven services	26.82	23.64	9.58
The weights of privately driven services	4.3	12.99	13.47
The weights of people-driven services	1.92	0.33	1.95
The weights of academic-driven services	0.89	4.87	0
The weights of NGO-driven services	0.08	2.17	1
Total year of service implementation	34	44	25

Table 5. *Cont.*

	Barcelona	London	Berlin
The portion of public-driven services	0.79	0.54	0.34
The portion of private-driven services	0.13	0.3	0.54
The portion of people-driven services	0.06	0.01	0.08
The portion of academic-driven services	0.03	0.11	0
The portion of NGO-driven services	0	0.05	0.04
Total	1	1	1

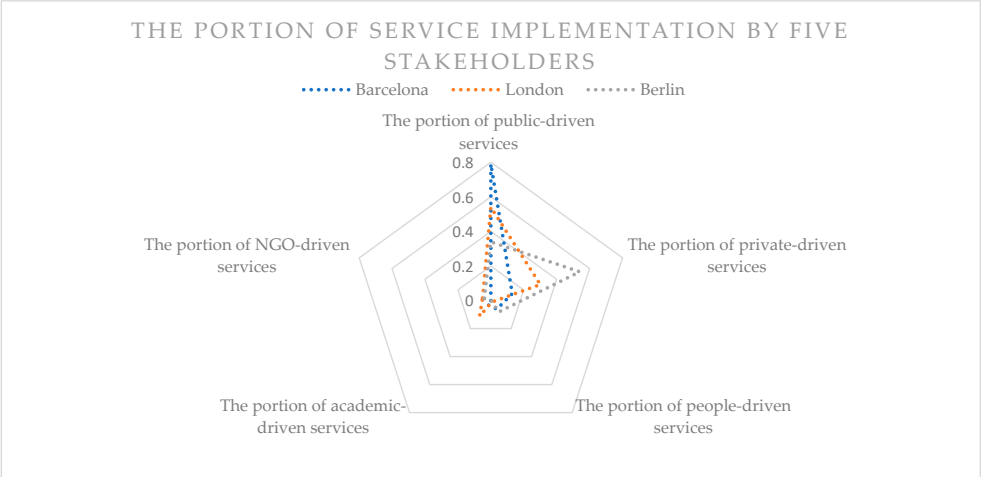

Figure 6. The portion of service implementation by five stakeholders.

4. Results

The periodic matrix taxonomy provided two important commonalities and three different empirical characteristics from an international perspective through cluster sampling, PRISMA, and data preprocessing of coding and weighting. The first commonality among the three cities is the comparatively higher weights for publicly and privately driven services. The two stakeholders have led the projects since the smart cities and their essential technologies were developed. After the public and international private sectors develop built environments, core technologies, and infrastructure with their large funds in the initial stage, the frontier and emerging technologies are publicized by national companies in support of small and medium companies. After spreading across nations and cities, innovation has emerged in cooperation with multiple stakeholders, such as public-academics-NGO, private-people, or public-people partnerships. In other words, the major players in the development of smart cities are the public and private sectors. The other commonality is sustaining the development and implementation of services after approximately 2015. This phase is influenced by the public sector's leadership at the national level and the launch of SDGs at the international level. Specifically, London launched a London Infrastructure in 2015 to advance supportive technologies after planning the Smart London Plan in 2013. Barcelona planned municipal action plans after the smart city project was launched after Mayor Trias' decided to enhance citizens' quality of life and reduce the cost of government operations in 2012 [101]. The Berlin government launched a "Smart city makes the people and citizens smarter" plan with ten goals. The plans correlate with the SDGs to make smart and existing cities sustainable. It deals with current challenges based on active participation in innovative ideas, advanced, resilient infrastructure to reduce resource consumption, and interactive, diverse urban services to encourage smart networks. Consequently, the three cities have commonalities in stakeholder cooperation and service sustainability.

The period matrix taxonomy discovers three different characteristics of service development in socio-technical transitions concerning different stakeholder partnerships, as illustrated in Figure 7. The primary focus of the public-people-driven city in Barcelona was used to

develop infrastructure, government, economic, and social services for the preparation of the Olympics by implementing the @BCN Plan beginning in 1985 with 500 km of communication infrastructure of fiber optic cables [98]. As an Internet city, they have mobilized Internet networks in cooperation with academia and citizens, such as the Guifi.net platform [105], to educate citizens to allow anyone to make anything. Additionally, it implemented transportation and environmental services in 2000 when the government launched programs such as electric motorcycle charging stations, water management facilities, and hybrid bus prototypes and regulated new buildings to install solar energy sources [100]. In 2013, Barcelona provided health and well-being services and ensured the availability and sustainable management of water and sanitation [102,105,107,112,219]. Other current services and related projects are sustainably developed and posted in the municipality website (e.g., 5G-related projects, eight Barcelona Open Data Challenge projects, the makers' fair Barcelona, innovative solutions for dependent senior citizens project led by I. Lab, the mobile youth festival, remote surgeons, and other public-people partnership projects). They generally focus on participatory urban planning led by public-people partnerships in developing conceptually related smart cities.

Berlin is a private-people-driven smart city. Its first computer networking was implemented in 1981 by networking with the Stanford Research Institute to produce the German Ministry for Research and Technology status report on computer networking in the intended federal project "German Research Network" [182]. The Internet network was publicized in cooperation with the government and private sectors until Deutsche Telekom was established in 1995. Although Deutsche Telekom became a government corporation, the required services for operating companies were still developed in an ad hoc manner until 2011, including transportation (e.g., Door2door and on-demand air taxi), health (e.g., farming tech and Plantix), and social (e.g., Internet café and Internet Relay Chat) services. However, cooperation between the public and private sectors began when Silicon Allee was implemented through urban planning in 2011 to build a start-up community using meetups, events, and an English-language blog [189]. The government and companies branded Silicon Allee in Berlin as a creative city through urban planning, which implied a vision of the future with urban planners. The plan aimed to instill an ideal future in the city by attracting new creative classes, ideas, investments, businesses, and money [220]. Public plans (e.g., "Smart City makes the people and citizens smarter," and "Digital Strategy 2025") led to other types of services, including social, public, energy, safety, and education services, which have been sustained with previously developed services.

Public-academic-NGO-driven services are provided in London. It has a long history of developing data transmission infrastructure in cooperation with governments and researchers since Donald Davies conceived the idea of packet switching for data communications chosen by the Advanced Research Project Agency Network to serve as an interface message processor [44]. The government and private companies have provided social services since the public view data service was opened by Prestel [175]. Health services were provided for research purposes in 1986 (e.g., NYSERNet) and were served within the government project by creating a set of locally sustainable and nationally scalable digital inclusion initiatives in 2005 [221]. As broadband technology was implemented, more people used the Internet [175], and commercial ISPs (e.g., Pipex) and nonprofit ISPs (e.g., GreenNet) were introduced. As an inclusive and innovative city, the government launched free services (e.g., Mapping service, Tool kits, and other Scalable and Sustainable Local Projects) and private sectors (e.g., TalkTalk and Sky TV) while NGOs raised their voices to secure digital rights (e.g., Open Rights Group). The digital city emphasizes the digital economy, cyberspace security, and digital content [156]. Other services, including energy, the environment, and transportation, have been implemented through the London Infrastructure 2050 Plan by supplying energy to homes and businesses and unlocking housing growth through transport infrastructure [148].

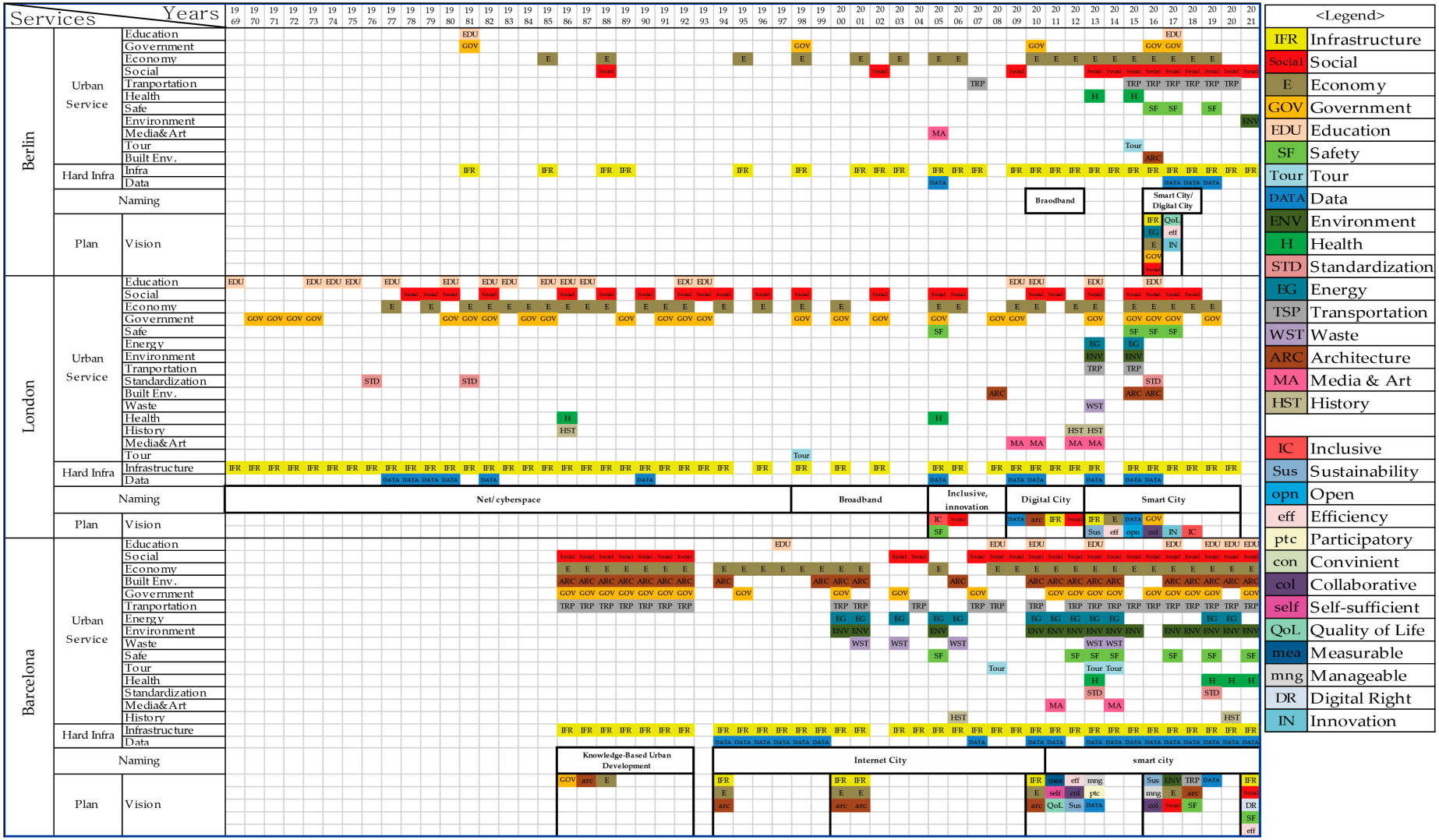

Figure 7. Periodic Matrix Taxonomy of Three European Smart Cities.

5. Discussion

Conceptually related smart cities have evolved in the history of sociotechnical transitions to realize SDGs for urban sustainability in cooperation with diverse stakeholders' partnerships. Some scholars point out that some service implementation standards are far from real-cities, because they lack a holistic strategic framework of service development and are drawn from related research, mostly on the conceptual characteristics of smart cities or the empirical characteristics of technological fields [81,222,223]. In this regard, this study identified the sociotechnical characteristics of conceptually related smart cities services from international perspectives by using the periodic matrix taxonomy under the research question of "What are the sociotechnical characteristics of conceptually related smart cities services from international perspectives?". The empirical characteristics are based on three sampled European sustainable smart cities using a periodic matrix taxonomy. This section elaborates on the findings and implications of their relations with the existing literature.

The first outcome concerns two commonalities of European conceptually related smart cities development in the history of sociotechnical transitions from an international perspective. The development process, from a macro perspective, analyzes the European empirical cases in correlation to the existing study, which uses city data from Manchester (UK) and Boston, Massachusetts, and San Diego (US) [224]. Subsequently, this study has implications in terms of providing a headstone for making a global consensus reflecting on the local sustainable smart cities context regarding Schiavoand Magalhães' research [81] for establishing the global sustainable smart cities' urban service standardization. Specifically, this study clarifies that initial services, including infrastructure, economy, government, society, and education, are fundamental to develop smart cities. The services are either shifted or diversified to meet needs in the current period, including safety, health, and transportation services. These transitions are based on an Extended Metabolism Model by Newman, demonstrating how livability is integrated with the flow of resources [225] and supports smart metabolism, which assesses cities with three critical approaches to increase livability involving the use of sensors, real-time data, and informing different stakeholders through the use of pervasive technologies [80,226]. The transitions of magnified services in each period have shifted smart metabolism to increase livability. Using the internal combustion engine automobile for e-mobility is an example of the smart metabolism of sustainable smart cities service development. The smart metabolism can be empirically identified, given that the sensor and big data analytic device analyze the related spatial-temporal and longitudinal data. The second commonality is that public or private stakeholders initialize and sustain them with various local services, in line with the SDG plan after 2015. It compensates for the issues raised by Parra-Domínguez et al. [18], who demonstrate the necessity of smart city development by incorporating the SDGs set by the 2030 Agenda with technology implementation. However, it would be challenging for the local indicators and themes to be used or reflected in conjunction with global smart city indicators and local context, and vice versa in a holistic and systemic view [81].

The other outcome is the development of three empirical characteristics of sustainable smart cities according to different stakeholder partnerships, which are divided into public-academic-NGO, public-people, and private-people partnerships. This study empirically demonstrates the multi-level perspectives in socio-technical transitions raised by Geel and expands the technological transitions by Nelson-Winter's model. It contributes to the discourse on multi-stakeholderism in conceptually related smart cities by specifying partnerships based on the development of services and local physical characteristics. The multi-stakeholderism for developing sustainable smart cities has been discussed in several previous studies empirically from the perspective of sociotechnical transitions by mobilizing ICT, which serves as a gluing component to interact with different services and engage stakeholders' partnerships by responding resiliently to upcoming challenges through technological advancement [24]. The quadruple-helix framework helps to understand the different characteristics of service implementation based on the local context in sociotechnical history and multi-stakeholderism [227]. It has been researched in several

models, such as strategic niche management [71], technological innovation system [228], and multilevel perspective models [2,68]. The middle range theory, based on multilevel perspective frameworks, provides a scientific foundation by empirically examining the patterns, regularities, and stylized mechanisms of diverse sustainable smart city transition processes and using general conceptual schemes [5]. However, related empirical studies have not yet been conducted using transformative city-level data. Therefore, this study expands the existing literature based on the middle-range theory framework to identify the empirical characteristics of sustainable smart cities development from the perspective of stakeholder roles, innovation, and sustainable smart city planning.

6. Conclusions

Sustainable smart cities have evolved through sociotechnical transitions in cooperation with diverse stakeholders to achieve future sustainability. In-depth empirical studies of the sociotechnical transition based on conceptual studies would prevent one-size-fits-all narratives [43] and provide a fundamental node for planning sustainable smart cities. This study aims to identify the empirical characteristics of the service developments of conceptually related smart cities services' socio-technical transitions from an international perspective. The empirical characteristics were identified based on the real-city data sources of three sampled cities, which are selected by cluster sampling using the representative ranks of keywords in the concept of sustainable smart cities. The outcomes were measured using periodic matrix taxonomy. It results in two outcomes: two commonalities from international perspectives and three empirical characteristics of the development of sustainable smart cities. The two commonalities of the conceptually related smart cities service development of the three cities resulted in the identification of leading stakeholders and the starting year of cooperation between the local level of sustainable smart cities implementation and the international level of sustainable smart cities development. The other outcome is the three empirical characteristics of sociotechnical transitions in sustainable smart cities development according to different stakeholders' partnerships, resulting in conceptually related smart cities services development in cooperation with public-academic-NGOs, public people, and private-people partnerships.

These results provide managerial contributions. The first outcome provides the entire sequence of developing smart cities services for achieving sustainability in correlation to existing studies. Specifically, the initial services such as infrastructure, economy, government, society, and education are fundamental to develop smart cities. At the same time, the services diversify other services satisfying the local context and the needs in the era including safety, health, and transportation services. This transformation in the history of developing smart city services could be considered as one of the socio-economic development processes [229] but also intelligent metaphoric approaches for upcoming challenges. In the current transformation, the local authorities and citizens' active participation would be the determinant factors in adjusting cities to the new environment mobilizing new technologies, digitalization, data, information, and vision. Meanwhile, cities could develop contextualized or advanced services based on geographical, cultural, political, economic, and environmental data drawn from measuring cities' status using sensors, data analytic technologies, and alerting devices. The second result empirically clarifies that smart cities' development emphasizes place-based development rather than the disappearance of time and space by extending Sassen [229]. The place-based traits, which are intrinsically inherited in the history of developing cities mobilizing ICTs, influence smart city services' development and stakeholders' cooperation characteristics.

Moreover, the outcome has theoretical contributions to smart metabolism that empirically clarify how urban resources and services have been transformed or evolved in the history of sustainable smart cities with the advancement of ICTs. It would be empirically identified given that the sensor and big data analytic device analyze the related spatial-temporal and longitudinal data. It could contribute to the conceptualization of establishing smart cities' history by analyzing the commonalities of several mega smart city

services' transformation so as to provide a fundamental principle to newly participated sectors and to deal with the development from the perspectives of the technological utopia. The second outcome contributes to the discourse on multi-stakeholderism in conceptually related smart cities by specifying partnerships based on the development of services and local characteristics. Empirical models of sustainable smart cities have been discussed from the middle-range theory based on multilevel perspective frameworks [2,68]. It thoroughly examines the sustainable smart city transition process and the general conceptual scheme using diverse empirical smart city-related concepts and models [5]. However, this field has not used data from transformative cities. Therefore, this study expands the middle-range theory framework to identify the empirical transformative characteristics of sustainable smart cities through the lens of stakeholders' roles, innovation, and smart city planning.

This study had some limitations. First, the unit of analysis, which is entirely related to documents describing conceptually related smart cities, could have the possibility to omit some relevant documents, even though the research result provides managerial and theoretical implications by explaining the priorities of developing conceptually related smart cities' services according to different stakeholders' partnerships and local contexts. Second, a lack of background knowledge makes it difficult to explain the development of different services based on multi-stakeholderism in a sophisticated manner. To deal with these issues, it updates and applies the theory and related research on multiple stakeholders to further studies.

Nevertheless, the outcomes have managerial implications of empirically demonstrating the different sequences of service transformation for European megacities depending on diverse stakeholders' partnerships, and theoretical implications to the existing theories, such as smart metabolism, multilevel perspectives, and the middle range theory, through the empirical analysis of historical real-city data and the specification of stakeholders' partnerships in conceptually related smart cities to identify the successful element of establishing sustainable smart cities from the urban sustainability perspective.

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Appendix A

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
1986		public	architecture	1	0	0	0	0	1	0.166666
		public	social						0	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
		public	infra						0	0.166666
		public	transport						0	0.166666

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
1987		public	architecture	1	0	0	0	0	1	0.166666
		public	social						0	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
		public	infra						0	0.166666
		public	transport						0	0.166666
1988		public	architecture	1	0	0	0	0	1	0.166666
		public	social						0	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
		public	infra						0	0.166666
		public	transport						0	0.166666
1989	[97,98,230]	public	architecture	1	0	0	0	0	1	0.166666
		public	social						0	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
		public	infra						0	0.166666
		public	transport						0	0.166666
1990		public	architecture	1	0	0	0	0	1	0.166666
		public	social						0	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
		public	infra						0	0.166666
		public	transport						0	0.166666
1991		public	architecture	1	0	0	0	0	1	0.166666
		public	social						0	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
		public	infra						0	0.166666
		public	transport						0	0.166666
1992		public	architecture	1	0	0	0	0	1	0.166666
		public	social						0	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
		public	infra						0	0.166666
		public	transport						0	0.166666
1994	[99]	public	infra	0.5	0	0	0	0	0.5	0.25
		public	architecture						0	0.25
	[98]	public	economy	0.5	0	0	0	0	0.5	0.1
		public	infra						0	0.1
		public	architecture						0	0.1
		public	economy						0	0.1
		public	data						0	0.1
1995		public	economy	0.5	0	0	0	0	0.5	0.166666
		public	infra						0	0.166666
		public	data						0	0.166666
	[231]	public	infra	0.5	0	0	0	0	0.5	0.25
		public	gov						0	0.25

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
1996	[98]	public	economy	1	0	0	0	0	1	0.333333
		public	infra						0	0.333333
		public	data						0	0.333333
1997		public	economy	0.5	0	0	0	0	0.5	0.166666
		public	infra						0	0.166666
		public	data						0	0.166666
	[100]	academia	infra	0	0	0	0.5	0	0.5	0.5
		academia	Edu						0	0
1998	[98]	public	economy	1	0	0	0	0	1	0.333333
		public	infra						0	0.333333
		public	data						0	0.333333
1999		public	economy	0.3333	0	0	0	0	0.3333	0.111111
		public	infra						0	0.111111
		public	data						0	0.111111
2000	[100]	public	infra	0.3333	0	0	0	0	0.3333	0.111111
		public	economy						0	0.111111
		public	architecture						0	0.111111
		public	infra	0.3333	0	0	0	0	0.3333	0.333333
		public	gov	0.25	0	0	0	0	0.25	0.0625
		public	economy						0	0.0625
		public	architecture						0	0.0625
		public	env						0	0.0625
		public	economy	0.25	0	0	0	0	0.25	0.25
		public	gov	0.25	0	0	0	0	0.25	0.05
		public	energy						0	0.05
		public	infra						0	0.05
		public	transport						0	0.05
		public	transport						0	0.05
2001		public	energy	0.25	0	0	0	0	0.25	0.25
		public	energy	0.5	0	0	0	0	0.5	0.166666
		public	infra						0	0.166666
		public	waste						0	0.166666
		public	infra	0.5	0	0	0	0	0.5	0.07142857
		public	transport						0	0.07142857
		public	env						0	0.07142857
		public	waste						0	0.07142857
		public	energy						0	0.07142857
		public	economy						0	0.07142857
		public	architecture						0	0.07142857
2003	[101]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	social						0	0.166666
		private	infra	0	0.3333	0	0	0	0.3333	0.08333333
		private	waste						0	0.08333333
		private	energy						0	0.08333333
		private	gov						0	0.08333333
		public	infra	0.3333	0	0	0	0	0.3333	0.08333333
		public	waste						0	0.08333333
		public	energy						0	0.08333333
		public	gov						0	0.08333333

Barcelona										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
2004	[100]	public	transport	0.5	0	0	0	0	0.5	0.5
	[105]	people	infra	0	0	0.5	0	0	0.5	0.25
		people	social						0	0.25
2005	[101]	private	infra	0	1	0	0	0	1	0.2
		private	energy						0	0.2
		private	env						0	0.2
		private	economy						0	0.2
		private	safe						0	0.2
2006	[100]	public	energy	0.3333	0	0	0	0	0.3333	0.333333
		public	architecture						0	0
	[101]	public	waste	0.3333	0	0	0	0	0.3333	0.333333
		public	infra						0	0
	[100]	public	history	0.3333	0	0	0	0	0.3333	0.333333
2007	[102]	public	infra	0.25	0	0	0	0	0.25	0.08333333
		public	gov						0	0.08333333
		public	social						0	0.08333333
	[101]	public	infra	0.25	0	0	0	0	0.25	0.08333333
		public	gov						0	0.08333333
		public	transport						0	0.08333333
	[103]	public	gov	0.25	0	0	0	0	0.25	0.08333333
		public	infra						0	0.08333333
		public	social						0	0.08333333
	[104]	public	data	0.25	0	0	0	0	0.25	0.125
		public	transport						0	0.125
2008		private	infra	0	0.25	0	0	0	0.25	0.0625
		private	transport						0	0.0625
		private	economy						0	0.0625
		private	tour						0	0.0625
		public	infra	0.25	0	0	0	0	0.25	0.0625
		public	transport						0	0.0625
		public	economy						0	0.0625
		public	tour						0	0.0625
	[105]	people	infra	0	0	0.25	0	0	0.25	0.125
		people	social						0	0.125
2009	[104]	people	social	0	0	0.25	0	0	0.25	0.0625
		people	infra						0	0.0625
		people	Edu						0	0.0625
		people	economy						0	0.0625
		public	infra	0.5	0	0	0	0	0.5	0.166666
		public	social						0	0.166666
		public	economy						0	0.166666
		private	infra	0	0.5	0	0	0	0.5	0.166666
		private	social						0	0.166666
		private	economy						0	0.166666
	[106]	private	architecture	0	0.142857	0	0	0	0.14286	0.07142857
		private	infra						0	0.07142857

Barcelona										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
2010	[101]	private	infra	0	0.142857	0	0	0	0.14286	0.03571429
		private	transport						0	0.03571429
		private	data						0	0.03571429
		private	economy						0	0.03571429
		public	infra	0.142857	0	0	0	0	0.14286	0.03571429
		public	transport						0	0.03571429
		public	data						0	0.03571429
		public	economy						0	0.03571429
	[107]	public	data	0.142857	0	0	0	0	0.14286	0.07142857
		public	social						0	0.07142857
	[108]	public	architecture	0.142857	0	0	0	0	0.14286	0.04761905
		public	env						0	0.04761905
		public	economy						0	0.04761905
	[101]	private	infra	0	0.142857	0	0	0	0.14286	0.02380952
		private	architecture						0	0.02380952
		private	economy						0	0.02380952
		private	Edu						0	0.02380952
		private	media and art						0	0.02380952
		private	env						0	0.02380952
	[109]	public	energy	0.142857	0	0	0	0	0.14286	0.04761905
		public	env						0	0.04761905
		public	transport						0	0.04761905
2011	[110]	people	social	0	0	0.076923	0	0	0.07692	0.02564103
		people	infra						0	0.02564103
		people	media and art						0	0.02564103
	[101]	public	infra	0.076923	0	0	0	0	0.07692	0.01923077
		public	energy						0	0.01923077
		public	env						0	0.01923077
		public	data						0	0.01923077
		NGO	infra	0	0	0	0	0.076923	0.07692	0.01923077
		NGO	energy						0	0.01923077
		NGO	env						0	0.01923077
		NGO	data						0	0.01923077
	[110]	public	gov	0.076923	0	0	0	0	0.07692	0.02564103
		public	infra						0	0.02564103
		public	social						0	0.02564103
		public	gov	0.076923	0	0	0	0	0.07692	0.01923077
		public	social						0	0.01923077
		public	economy						0	0.01923077
		public	infra						0	0.01923077
		public	infra	0.076923	0	0	0	0	0.07692	0.01538462
		public	gov						0	0.01538462
		public	data						0	0.01538462
		public	social						0	0.01538462
		public	standardization						0	0.01538462

Barcelona										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
		private	infra	0	0.076923	0	0	0	0.07692	0.01538462
		private	gov						0	0.01538462
		private	data						0	0.01538462
		private	social						0	0.01538462
		private	standardization						0	0.01538462
		private	infra	0	0.076923	0	0	0	0.07692	0.02564103
		private	architecture						0	0.02564103
		private	env						0	0.02564103
		public	infra	0.076923	0	0	0	0	0.07692	0.07692308
		private	infra	0	0.076923	0	0	0	0.07692	0.07692308
		public	infra	0.076923	0	0	0	0	0.07692	0.03846154
		public	gov						0	0.03846154
		public	infra	0.076923	0	0	0	0	0.07692	0.03846154
		public	data						0	0.03846154
	[112]	public	env	0.076923	0	0	0	0	0.07692	0.01538462
		public	social						0	0.01538462
		public	economy						0	0.01538462
		public	infra						0	0.01538462
		public	gov						0	0.01538462
	[113]	public	infra	0.25	0	0	0	0	0.25	0.0625
		public	energy						0	0.0625
		public	safe						0	0.0625
		public	architecture						0	0.0625
	[112]	public	env	0.25	0	0	0	0	0.25	0.05
		public	social						0	0.05
		public	economy						0	0.05
		public	infra						0	0.05
		public	gov						0	0.05
2012		public	gov	0.25	0	0	0	0	0.25	0.08333333
		public	economy						0	0.08333333
		public	architecture						0	0.08333333
		public	gov	0.25	0	0	0	0	0.25	0.03571429
		public	infra						0	0.03571429
		public	social						0	0.03571429
		public	architecture						0	0.03571429
		public	env						0	0.03571429
		public	energy						0	0.03571429
		public	transport						0	0.03571429
	[113]	public	infra	0.041667	0	0	0	0	0.04167	0.02083333
		public	social						0	0.02083333
	[112]	public	env	0.041667	0	0	0	0	0.04167	0.00833333
		public	social						0	0.00833333
		public	economy						0	0.00833333
2013		public	infra						0	0.00833333
		public	gov						0	0.00833333
	[102]	public	infra	0.041667	0	0	0	0	0.04167	0.04166667
	[107]	public	infra	0.041667	0	0	0	0	0.04167	0.01388889
		public	gov						0	0.01388889
		public	social						0	0.01388889

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
2014	[102,105,219]	public	data	0.041667	0	0	0	0	0.04167	0.04166667
		public	social	0.041667	0	0	0	0	0.04167	0.04166667
		public	energy	0.041667	0	0	0	0	0.04167	0.04166667
		public	env	0.041667	0	0	0	0	0.04167	0.04166667
		public	env	0.041667	0	0	0	0	0.04167	0.04166667
		public	architecture	0.041667	0	0	0	0	0.04167	0.02083333
		public	infra						0	0.02083333
		public	safe	0.041667	0	0	0	0	0.04167	0.04166667
		people	social	0	0	0.041667	0	0	0.04167	0.01041667
		people	infra						0	0.01041667
		people	data						0	0.01041667
		people	env						0	0.01041667
		public	gov	0.041667	0	0	0	0	0.04167	0.04166667
		public	infra	0.041667	0	0	0	0	0.04167	0.04166667
		public	waste	0.041667	0	0	0	0	0.04167	0.04166667
		public	economy	0.041667	0	0	0	0	0.04167	0.04166667
		public	health	0.041667	0	0	0	0	0.04167	0.02083333
		public	social						0	0.02083333
		public	Edu	0.041667	0	0	0	0	0.04167	0.01388889
		public	economy						0	0.01388889
		public	env						0	0.01388889
		public	tour	0.041667	0	0	0	0	0.04167	0.04166667
		public	infra	0.041667	0	0	0	0	0.04167	0.04166667
		public	infra	0.041667	0	0	0	0	0.04167	0.01388889
		public	data						0	0.01388889
		public	economy						0	0.01388889
	[113]	public	transport	0.041667	0	0	0	0	0.04167	0.01388889
		public	infra						0	0.01388889
		public	social						0	0.01388889
	[114]	public	infra	0.041667	0	0	0	0	0.04167	0.00595238
		public	data						0	0.00595238
		public	standardization						0	0.00595238
		public	social						0	0.00595238
		public	env						0	0.00595238
		public	energy						0	0.00595238
		public	gov						0	0.00595238
	[113]	public	transport	0.041667	0	0	0	0	0.04167	0.01388889
		public	infra						0	0.01388889
		public	data						0	0.01388889
		public	energy	0.076923	0	0	0	0	0.07692	0.01923077
		public	env						0	0.01923077
		public	social						0	0.01923077
		public	infra						0	0.01923077
	[112]	public	env	0.076923	0	0	0	0	0.07692	0.01538462
		public	social						0	0.01538462
		public	economy						0	0.01538462
		public	infra						0	0.01538462
		public	gov						0	0.01538462
	[102]	public	transport	0.076923	0	0	0	0	0.07692	0.07692308
	[115]	public	transport	0.076923	0	0	0	0	0.07692	0.07692308

Barcelona										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
	[102]	public	architecture	0.076923	0	0	0	0	0.07692	0.07692308
		public	gov	0.076923	0	0	0	0	0.07692	0.07692308
		public	safe	0.076923	0	0	0	0	0.07692	0.07692308
		public	waste	0.076923	0	0	0	0	0.07692	0.07692308
		private	economy	0	0.076923	0	0	0	0.07692	0.02564103
		private	social						0	0.02564103
		private	env						0	0.02564103
	[105]	people	media and art	0	0	0.076923	0	0	0.07692	0.07692308
	[102]	public	social	0.076923	0	0	0	0	0.07692	0.01098901
		public	data						0	0.01098901
		public	transport						0	0.01098901
		public	tour						0	0.01098901
		public	infra						0	0.01098901
		public	economy						0	0.01098901
		public	architecture						0	0.01098901
	[116]	private	data	0	0.076923	0	0	0	0.07692	0.03846154
		private	infra						0	0.03846154
	[104]	public	gov	0.076923	0	0	0	0	0.07692	0.01538462
		public	infra						0	0.01538462
		public	social						0	0.01538462
		public	economy						0	0.01538462
		public	standardization							0.01538462
2015	[112]	public	env	0.5	0	0	0	0	0.5	0.1
		public	social						0	0.1
		public	economy						0	0.1
		public	infra						0	0.1
		public	gov						0	0.1
		public	transport	0.5	0	0	0	0	0.5	0.125
		public	data						0	0.125
		public	env						0	0.125
		public	infra						0	0.125
		public	economy	0.25	0	0	0	0	0.25	0.125
		public	social						0	0.125
2016	[117]	public	transport	0.25	0	0	0	0	0.25	0.125
		public	env						0	0.125
		public	data	0.25	0	0	0	0	0.25	0.0625
		public	social						0	0.0625
		public	economy						0	0.0625
		public	infra						0	0.0625
		public	infra	0.25	0	0	0	0	0.25	0.25
	[118]	public	social	0.03125	0	0	0	0	0.03125	0.00446429
		public	data						0	0.00446429
		public	gov						0	0.00446429
		public	safe						0	0.00446429
		public	infra						0	0.00446429
		public	standardization							0.00446429
		public	data							0.00446429

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
2017	[100]	public	infra	0.03125	0	0	0	0	0.03125	0.015625
		public	gov						0	0.015625
		public	social	0.03125	0	0	0	0	0.03125	0.01041667
		public	infra						0	0.01041667
		public	data						0	0.01041667
		public	gov	0.03125	0	0	0	0	0.03125	0.01041667
		public	infra						0	0.01041667
		public	social						0	0.01041667
		people	gov	0	0	0.03125	0	0	0.03125	0.01041667
		people	infra						0	0.01041667
		people	social						0	0.01041667
		people	social	0	0	0.03125	0	0	0.03125	0.015625
		people	infra						0	0.015625
		public	social	0.03125	0	0	0	0	0.03125	0.015625
		public	infra						0	0.015625
		public	social	0.03125	0	0	0	0	0.03125	0.03125
		public	data	0.03125	0	0	0	0	0.03125	0.015625
		public	social						0	0.015625
		public	gov	0.03125	0	0	0	0	0.03125	0.01041667
		public	social						0	0.01041667
		public	infra						0	0.01041667
		public	data	0.03125	0	0	0	0	0.03125	0.015625
		public	social						0	0.015625
		private	gov	0	0.03125	0	0	0	0.03125	0.01041667
		private	data						0	0.01041667
		private	economy						0	0.01041667
		public	data	0.03125	0	0	0	0	0.03125	0.015625
		public	social						0	0.015625
		public	infra	0.03125	0	0	0	0	0.03125	0.03125
		public	infra	0.03125	0	0	0	0	0.03125	0.03125
		public	social	0.03125	0	0	0	0	0.03125	0.03125
		public	data	0.03125	0	0	0	0	0.03125	0.01041667
		public	gov						0	0.01041667
		public	social						0	0.01041667
		public	infra	0.03125	0	0	0	0	0.03125	0.015625
		public	data						0	0.015625
		public	data	0.03125	0	0	0	0	0.03125	0.01041667
		public	social						0	0.01041667
		public	architecture						0	0.01041667
	[111]	public	gov	0.03125	0	0	0	0	0.03125	0.0078125
		public	social						0	0.0078125
		public	infra						0	0.0078125
		public	economy						0	0.0078125
		people	infra	0	0	0.03125	0	0	0.03125	0.00625
		people	gov						0	0.00625
		people	social						0	0.00625
		people	media and art						0	0.00625
		people	economy						0	0.00625

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
2018	[103]	public	infra	0.03125	0	0	0	0	0.03125	0.00625
		public	gov						0	0.00625
		public	social						0	0.00625
		public	media and art						0	0.00625
		public	economy						0	0.00625
		public	data	0.03125	0	0	0	0	0.03125	0.015625
		public	social						0	0.015625
	[104]	people	architecture	0	0	0.03125	0	0	0.03125	0.01041667
		people	social						0	0.01041667
		people	transport						0	0.01041667
		public	social	0.03125	0	0	0	0	0.03125	0.03125
		public	infra	0.03125	0	0	0	0	0.03125	0.015625
		public	social						0	0.015625
		people	transport	0	0	0.03125	0	0	0.03125	0.01041667
		people	env						0	0.01041667
		people	infra						0	0.01041667
		public	architecture	0.03125	0	0	0	0	0.03125	0.01041667
		public	env						0	0.01041667
		public	social						0	0.01041667
		public	social	0.03125	0	0	0	0	0.03125	0.03125
		people	social	0	0	0.03125	0	0	0.03125	0.015625
		people	economy						0	0.015625
		people	Edu	0	0	0.03125	0	0	0.03125	0.00446429
		people	social						0	0.00446429
		people	economy						0	0.00446429
		people	gov						0	0.00446429
		people	architecture						0	0.00446429
		people	transport						0	0.00446429
		people	data						0	0.00446429
		academia	Edu	0	0	0	0.03125	0	0.03125	0.00446429
		academia	social						0	0.00446429
		academia	economy						0	0.00446429
		academia	gov						0	0.00446429
		academia	architecture						0	0.00446429
		academia	transport						0	0.00446429
		academia	data						0	0.00446429
		academia	Edu	0	0	0	0.090909	0	0.09091	0.01298701
		academia	social						0	0.01298701
		academia	economy						0	0.01298701
		academia	gov						0	0.01298701
		academia	architecture						0	0.01298701
		academia	transport						0	0.01298701
		academia	data						0	0.01298701
		people	Edu	0	0	0.090909	0	0	0.09091	0.01298701
		people	social						0	0.01298701
		people	economy						0	0.01298701
		people	gov						0	0.01298701
		people	architecture						0	0.01298701
		people	transport						0	0.01298701
		people	data						0	0.01298701

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
2019	[119]	public	economy	0.090909	0	0	0	0	0.09091	0.01298701
		public	social						0	0.01298701
		public	gov						0	0.01298701
		public	data						0	0.01298701
		public	infra						0	0.01298701
		public	env						0	0.01298701
		public	standardization						0	0.01298701
	[120]	public	gov	0.090909	0	0	0	0	0.09091	0.01818182
		public	infra						0	0.01818182
		public	data						0	0.01818182
		public	economy						0	0.01818182
		public	social						0	0.01818182
	[121]	public	gov	0.090909	0	0	0	0	0.09091	0.02272727
		public	transport						0	0.02272727
		public	data						0	0.02272727
		public	infra						0	0.02272727
	[122]	public	architecture	0.090909	0	0	0	0	0.09091	0.01515152
		public	economy						0	0.01515152
		public	infra						0	0.01515152
		public	data						0	0.01515152
		public	social						0	0.01515152
		public	env						0	0.01515152
	[123]	public	env	0.090909	0	0	0	0	0.09091	0.03030303
		public	energy						0	0.03030303
		public	gov						0	0.03030303
	[124]	public	architecture	0.090909	0	0	0	0	0.09091	0.01818182
		public	transport						0	0.01818182
		public	economy						0	0.01818182
		public	social						0	0.01818182
		public	gov						0	0.01818182
	[232]	public	infra	0.090909	0	0	0	0	0.09091	0.02272727
		public	env						0	0.02272727
		public	transport						0	0.02272727
		public	gov						0	0.02272727
	[104]	public	architecture	0.090909	0	0	0	0	0.09091	0.04545455
		public	infra						0	0.04545455
	[125]	public	infra	0.090909	0	0	0	0	0.09091	0.09090909
		private	infra	0	0.071429	0	0	0	0.07143	0.02380952
		private	transport						0	0.02380952
		private	safe						0	0.02380952
	[127]	private	infra	0	0.071429	0	0	0	0.07143	0.03571429
		private	economy						0	0.03571429
	[126]	private	infra	0	0.071429	0	0	0	0.07143	0.02380952
		private	transport						0	0.02380952
		private	health						0	0.02380952
		public	infra	0.071429	0	0	0	0	0.07143	0.02380952
		public	transport						0	0.02380952
		public	health						0	0.02380952
	[128]	public	infra	0.071429	0	0	0	0	0.07143	0.03571429
		public	Edu						0	0.03571429

Barcelona										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
2020	[129]	public	architecture	0.071429	0	0	0	0	0.07143	0.01428571
		public	economy						0	0.01428571
		public	health						0	0.01428571
		public	env						0	0.01428571
		public	energy						0	0.01428571
	[130]	people	infra	0	0	0.071429	0	0	0.07143	0.01190476
		people	Edu						0	0.01190476
		people	social						0	0.01190476
		people	health						0	0.01190476
		people	data						0	0.01190476
		people	architecture						0	0.01190476
	[131]	people	infra	0	0	0.071429	0	0	0.07143	0.02380952
		people	economy						0	0.02380952
		people	Edu						0	0.02380952
		private	infra	0	0.071429	0	0	0	0.07143	0.02380952
		private	economy						0	0.02380952
		private	Edu						0	0.02380952
		private	infra	0	0.071429	0	0	0	0.07143	0.03571429
		private	economy						0	0.03571429
		private	infra	0	0.071429	0	0	0	0.07143	0.01785714
		private	social						0	0.01785714
		private	economy						0	0.01785714
		private	Edu						0	0.01785714
	[132]	private	transport	0	0.071429	0	0	0	0.07143	0.01785714
		private	infra						0	0.01785714
		private	data						0	0.01785714
		private	safe						0	0.01785714
	[133]	private	health	0	0.071429	0	0	0	0.07143	0.03571429
		private	infra						0	0.03571429
	[104]	private	Edu	0	0.071429	0	0	0	0.07143	0.02380952
		private	social						0	0.02380952
		private	economy						0	0.02380952
	[134]	people	health	0	0	0.142857	0	0	0.14286	0.03571429
		people	Edu						0	0.03571429
		people	infra						0	0.03571429
		people	economy						0	0.03571429
	[110]	public	data	0.142857	0	0	0	0	0.14286	0.03571429
		public	infra						0	0.03571429
		public	social						0	0.03571429
		public	env						0	0.03571429
		academia	data	0	0	0	0.142857	0	0.14286	0.03571429
		academia	infra						0	0.03571429
		academia	social						0	0.03571429
		academia	env						0	0.03571429
	[135]	public	social	0.142857	0	0	0	0	0.14286	0.07142857
		public	infra						0	0.07142857
		private	social	0	0.142857	0	0	0	0.14286	0.07142857
		private	infra						0	0.07142857
	[136]	public	economy	0.142857	0	0	0	0	0.14286	0.04761905
		public	Edu						0	0.04761905
		public	infra						0	0.04761905

Barcelona										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
2021	[137]	public	economy	0.142857	0	0	0	0	0.14286	0.01428571
		public	Edu						0	0.01428571
		public	health						0	0.01428571
		public	history						0	0.01428571
		public	architecture						0	0.01428571
		public	energy						0	0.01428571
		public	env						0	0.01428571
		public	data						0	0.01428571
		public	health						0	0.01428571
		public	media and art						0	0.01428571
	[138]	public	economy	0.125	0	0	0	0	0.125	0.025
		public	env						0	0.025
		public	transport						0	0.025
		public	health						0	0.025
		public	tour						0	0.025
	[139]	private	data	0	0.125	0	0	0	0.125	0.0625
		private	economy						0	0.0625
	[140]	people	health	0	0	0.125	0	0	0.125	0.025
		people	infra						0	0.025
		people	data						0	0.025
		people	social						0	0.025
		people	env						0	0.025
	[137]	public	infra	0.125	0	0	0	0	0.125	0.025
		public	architecture						0	0.025
		public	social						0	0.025
		public	economy						0	0.025
		public	env						0	0.025
	[141]	public	infra	0.125	0	0	0	0	0.125	0.03125
		public	Edu						0	0.03125
		public	social						0	0.03125
		public	data						0	0.03125
	[142]	public	social	0.125	0	0	0	0	0.125	0.02083333
		public	gov						0	0.02083333
		public	infra						0	0.02083333
		public	safe						0	0.02083333
		public	transport						0	0.02083333
		public	data						0	0.02083333
	[143]	academia	infra	0	0	0	0.125	0	0.125	0.03125
		academia	health						0	0.03125
		academia	social						0	0.03125
		academia	Edu						0	0.03125
		private	infra	0	0.125	0	0	0	0.125	0.03125
		private	health						0	0.03125
		private	social						0	0.03125
		private	Edu						0	0.03125

London										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
1969	[177]	public	infra	0.3333	0	0	0	0	0.3333	0.166666
		public	Edu						0	0.166666
	[181]	academia	infra	0	0	0	0.3333	0	0.3333	0.166666
		academia	Edu						0	0.166666
	[233]	public	infra	0.3333	0	0	0	0	0.3333	0.166666
		public	Edu						0	0.166666
1970	[175]	public	infra	0.5	0	0	0	0	0.5	0.25
		public	gov						0	0.25
		public	infra	0.5	0	0	0	0	0.5	0.25
		public	gov						0	0.25
1971		public	infra	0.5	0	0	0	0	0.5	0.25
		public	gov						0	0.25
	[179]	public	infra	0.5	0	0	0	0	0.5	0.25
		public	gov						0	0.25
1972	[175]	public	infra	1	0	0	0	0	1	0.5
		public	gov						0	0.5
1973	[177]	public	infra	0.3333	0	0	0	0	0.3333	0.166666
		public	Edu						0	0.166666
	[175]	public	infra	0.3333	0	0	0	0	0.3333	0.166666
		public	gov						0	0.166666
		public	infra	0.3333	0	0	0	0	0.3333	0.166666
		public	gov						0	0.166666
1974	[177]	academia	infra	0	0	0	1	0	1	0.5
		academia	Edu						0	0.5
1975	[155]	academia	infra	0	0	0	0.5	0	0.5	0.25
		academia	Edu						0	0.25
	[178]	academia	infra	0	0	0	0.5	0	0.5	0.25
		academia	Edu						0	0.25
1976	[177]	academia	infra	0.5	0	0	0	0	0.5	0.5
	[176]	academia	infra	0	0	0	0.5	0	0.5	0.25
		academia	standardization						0	0.25
1977	[178]	public	infra	0.3333	0	0	0	0	0.3333	0.166666
		public	Edu						0	0.166666
		academia	infra	0	0	0	0.3333	0	0.3333	0.166666
		academia	Edu						0	0.166666
	[175]	private	data	0	0.3333	0	0	0	0.3333	0.111111
		private	economy						0	0.111111
		private	infra						0	0.111111
1978		public	infra	0.5	0	0	0	0	0.5	0.25
		public	social						0	0.25
		public	data	0.5	0	0	0	0	0.5	0.25
		public	infra						0	0.25
1979		private	data	0	0.5	0	0	0	0.5	0.166666
		private	infra						0	0.166666
		private	economy						0	0.166666
		private	data	0	0.5	0	0	0	0.5	0.166666
		private	infra						0	0.166666
		private	social						0	0.166666

London										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
1980	[171]	public	data	0.5	0	0	0	0	0.5	0.1
		public	infra						0	0.1
		public	gov						0	0.1
		public	social						0	0.1
		public	Edu						0	0.1
	[175]	public	data	0.5	0	0	0	0	0.5	0.166666
		public	infra						0	0.166666
		public	social						0	0.166666
1981		public	standardization	1	0	0	0	0	1	0.25
		public	economy						0	0.25
		public	gov						0	0.25
		public	infra						0	0.25
1982	[155]	academia	Edu	0	0	0	0.3333	0	0.3333	0.166666
		academia	infra						0	0.166666
		public	infra	0.3333	0	0	0	0	0.3333	0.111111
		public	gov						0	0.111111
		public	economy						0	0.111111
		private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	data						0	0.166666
1983	[175]	public	infra	1	0	0	0	0	1	0.333333
		public	Edu						0	0.333333
		public	economy						0	0.333333
1984		private	infra	0	0.5	0	0	0	0.5	0.166666
		private	gov						0	0.166666
		private	economy						0	0.166666
		public	infra	0.5	0	0	0	0	0.5	0.166666
		public	gov						0	0.166666
		public	economy						0	0.166666
1985	[155]	academia	infra	0	0	0	0.2	0	0.2	0.06666667
		academia	gov						0	0.06666667
		academia	Edu						0	0.06666667
		public	infra	0.2	0	0	0	0	0.2	0.06666667
		public	gov						0	0.06666667
		public	Edu						0	0.06666667
	[175]	public	infra	0.2	0	0	0	0	0.2	0.1
		public	economy						0	0.1
		private	infra	0	0.2	0	0	0	0.2	0.1
		private	economy						0	0.1
		private	infra	0	0.2	0	0	0	0.2	0.1
		private	economy						0	0.1
1986	[174]	NGO	social	0	0	0	0	0.5	0.5	0.1
		NGO	infra						0	0.1
		NGO	Edu						0	0.1
		NGO	history						0	0.1
		NGO	health						0	0.1
	[163]	public	social	0.5	0	0	0	0	0.5	0.25
		public	infra						0	0.25

London										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
1987	[173]	private	Edu	0	0.5	0	0	0	0.5	0.166666
		private	infra						0	0.166666
		private	economy						0	0.166666
		academia	Edu	0	0	0	0.5	0	0.5	0.166666
		academia	infra						0	0.166666
		academia	economy						0	0.166666
1988	[172]	private	infra	0	0.5	0	0	0	0.5	0.166666
		private	social						0	0.166666
		private	economy						0	0.166666
	[175]	public	economy	0.5	0	0	0	0	0.5	0.5
1989	[171]	public	infra	1	0	0	0	0	1	0.5
		public	gov						0	0.5
1990	[170]	NGO	social	0	0	0	0	0.3333	0.3333	0.166666
		NGO	infra						0	0.166666
	[168]	academia	social	0	0	0	0.3333	0	0.3333	0.111111
		academia	data						0	0.111111
		academia	infra						0	0.111111
		private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	economy						0	0.166666
1991	[171]	public	gov	0.3333	0	0	0	0	0.3333	0.166666
		public	infra						0	0.166666
		public	economy	0.3333	0	0	0	0	0.3333	0.166666
		public	infra						0	0.166666
		private	gov	0	0.3333	0	0	0	0.3333	0.166666
		private	infra						0	0.166666
1992	[167]	academia	social	0	0	0	0.3333	0	0.3333	0.08333333
		academia	Edu						0	0.08333333
		academia	infra						0	0.08333333
		academia	economy						0	0.08333333
		people	social	0	0	0.3333	0	0	0.3333	0.08333333
		people	Edu						0	0.08333333
		people	infra						0	0.08333333
		people	economy						0	0.08333333
	[171]	private	infra	0	0.3333	0	0	0	0.3333	0.111111
		private	gov						0	0.111111
		private	economy						0	0.111111
1993	[170]	NGO	gov	0	0	0	0	1	1	0.333333
		NGO	infra						0	0.333333
		NGO	social						0	0.333333
1994	[169]	Private	economy	0	0.3333	0	0	0	0.3333	0.111111
		Private	social						0	0.111111
		Private	infra						0	0.111111
	[168]	Private	infra	0	0.3333	0	0	0	0.3333	0.333333
	[167]	Private	infra	0	0.3333	0	0	0	0.3333	0.111111
		Private	social						0	0.111111
		Private	economy						0	0.111111
1996	[155]	Private	economy	0	1	0	0	0	1	0.333333
		Private	infra						0	0.333333
		Private	social						0	0.333333

London										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
1998	[166]	Private	economy	0	0.2	0	0	0	0.2	0.06666667
		Private	infra						0	0.06666667
		Private	social						0	0.06666667
	[165]	Private	tour	0	0.2	0	0	0	0.2	0.06666667
		Private	infra						0	0.06666667
		Private	economy						0	0.06666667
	[164]	Private	gov	0	0.2	0	0	0	0.2	0.1
		Private	social						0	0.1
	[163]	public	infra	0.2	0	0	0	0	0.2	0.2
	[162]	private	infra	0	0.2	0	0	0	0.2	0.06666667
		private	gov						0	0.06666667
		private	social						0	0.06666667
2000	[155]	private	gov	0	0.5	0	0	0	0.5	0.25
		private	infra						0	0.25
		private	economy	0	0.5	0	0	0	0.5	0.5
2002	[155]	public	infra	1	0	0	0	0	1	0.333333
		public	gov						0	0.333333
		public	social						0	0.333333
2005	[161]	private	economy	0	0.3333	0	0	0	0.3333	0.166666
		private	infra						0	0.166666
	[221]	public	Edu	0.3333	0	0	0	0	0.3333	0.06666667
		public	data						0	0.06666667
		public	social						0	0.06666667
		public	gov						0	0.06666667
		public	health						0	0.06666667
	[160]	NGO	social	0	0	0	0	0.3333	0.3333	0.166666
		NGO	safe						0	0.166666
2006	[155]	private	social	0	0.3333	0	0	0	0.3333	0.166666
		private	infra						0	0.166666
	[234]	private	social	0	0.3333	0	0	0	0.3333	0.166666
		private	infra						0	0.166666
	[158]	private	economy	0	0.3333	0	0	0	0.3333	0.111111
		private	social						0	0.111111
		private	infra						0	0.111111
2008	[159]	public	infra	1	0	0	0	0	1	0.333333
		public	architecture						0	0.333333
		public	gov						0	0.333333
2009	[158]	public	infra	0.5	0	0	0	0	0.5	0.25
		public	economy						0	0.25
	[156]	public	data	0.5	0	0	0	0	0.5	0.1
		public	infra						0	0.1
		public	gov						0	0.1
		public	Edu						0	0.1
		public	media and art						0	0.1

London										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
2010	[235]	public	economy	0.2	0	0	0	0	0.2	0.05
		public	infra						0	0.05
		public	media and art						0	0.05
		public	social						0	0.05
	[157]	public	infra	0.2	0	0	0	0	0.2	0.05
		public	social						0	0.05
		public	economy						0	0.05
		public	media and art						0	0.05
	[155]	private	infra	0	0.2	0	0	0	0.2	0.1
		private	economy						0	0.1
	[221]	public	social	0.2	0	0	0	0	0.2	0.1
		public	infra						0	0.1
		public	Edu	0.2	0	0	0	0	0.2	0.06666667
		public	social						0	0.06666667
		public	infra						0	0.06666667
2011	[155]	private	infra	0	1	0	0	0	1	1
2012	[154]	public	infra	1	0	0	0	0	1	0.2
		public	economy						0	0.2
		public	history						0	0.2
		public	media and art						0	0.2
		public	social						0	0.2
2013	[153]	private	infra	0	0.125	0	0	0	0.125	0.04166667
		private	social						0	0.04166667
		private	data						0	0.04166667
	[152]	private	infra	0	0.125	0	0	0	0.125	0.0625
		private	economy						0	0.0625
	[151]	public	infra	0.125	0	0	0	0	0.125	0.04166667
		public	social						0	0.04166667
		public	economy						0	0.04166667
	[150]	public	social	0.125	0	0	0	0	0.125	0.04166667
		public	infra						0	0.04166667
		public	economy						0	0.04166667
		public	data	0.125	0	0	0	0	0.125	0.025
		public	infra						0	0.025
		public	Edu						0	0.025
		public	economy						0	0.025
		public	gov						0	0.025
		public	energy	0.125	0	0	0	0	0.125	0.01785714
		public	env						0	0.01785714
		public	waste						0	0.01785714
		public	infra						0	0.01785714
		public	transport						0	0.01785714
		public	data						0	0.01785714
		public	economy						0	0.01785714

London										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
		public	social	0.125	0	0	0	0	0.125	0.01785714
		public	env						0	0.01785714
		public	infra						0	0.01785714
		public	history						0	0.01785714
		public	media and art						0	0.01785714
		public	gov						0	0.01785714
		public	economy						0	0.01785714
	[236]	public	social	0.125	0	0	0	0	0.125	0.0625
		public	infra	0	0	0	0	0	0	0.0625
	[149]	private	infra	0	0.090909	0	0	0	0.09091	0.04545455
		private	social						0	0.04545455
	[148]	public	infra	0.090909	0	0	0	0	0.09091	0.04545455
		public	gov						0	0.04545455
		public	architecture	0.090909	0	0	0	0	0.09091	0.04545455
		public	economy						0	0.04545455
		public	data	0.090909	0	0	0	0	0.09091	0.09090909
		public	architecture	0.090909	0	0	0	0	0.09091	0.09090909
		public	architecture	0.090909	0	0	0	0	0.09091	0.04545455
		public	transport						0	0.04545455
2015		public	economy	0.090909	0	0	0	0	0.09091	0.09090909
		public	env	0.090909	0	0	0	0	0.09091	0.09090909
		public	env	0.090909	0	0	0	0	0.09091	0.09090909
		public	energy	0.090909	0	0	0	0	0.09091	0.01818182
		public	env						0	0.01818182
		public	safe						0	0.01818182
		public	economy						0	0.01818182
		public	architecture						0	0.01818182
		public	infra	0.090909	0	0	0	0	0.09091	0.04545455
		public	economy						0	0.04545455
	[147]	public	infra	0.25	0	0	0	0	0.25	0.25
		private	infra	0	0.25	0	0	0	0.25	0.25
		public	gov	0.25	0	0	0	0	0.25	0.05
		public	social						0	0.05
		public	infra						0	0.05
		public	data						0	0.05
		public	safe						0	0.05
2016		public	infra	0.25	0	0	0	0	0.25	0.03571429
		public	social						0	0.03571429
		public	architecture						0	0.03571429
		public	economy						0	0.03571429
		public	standardization						0	0.03571429
		public	data						0	0.03571429
		public	Edu						0	0.03571429
	[237]	public	economy	1	0	0	0	0	1	0.2
		public	infra						0	0.2
2017		public	safe						0	0.2
		public	social						0	0.2
		public	gov						0	0.2

London										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
2018	[146]	private	economy		0.5	0	0	0	0.5	0.166666
		private	infra						0	0.166666
		private	social						0	0.166666
		public	economy	0.5	0	0	0	0	0.5	0.166666
		public	infra						0	0.166666
		public	social						0	0.166666
2019	[145]	public	economy	1	0	0	0	0	1	0.333333
		public	infra						0	0.333333
		public	gov						0	0.333333
2020	[144]	private	infra	0	1	0	0	0	1	1
2021				0	0	0	0	0	0	0

Berlin										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
1981	[182]	public	infra	1	0	0	0	0	1	0.333333
		public	Edu						0	0.333333
		public	gov						0	0.333333
1958	[183]	private	infra	0	1	0	0	0	1	0.5
		private	economy						0	0.5
1988	[184]	private	infra	0	1	0	0	0	1	0.333333
		private	social						0	0.333333
		private	economy						0	0.333333
1989	[182]	public	infra	1	0	0	0	0	1	0.5
		public	standardization						0	0.5
1995	[185]	public	infra	1	0	0	0	0	1	0.5
		public	economy						0	0.5
1998	[186]	private	infra	0	0.5	0	0	0	0.5	0.166666
		private	data						0	0.166666
		private	economy						0	0.166666
	[185]	public	infra	0.5	0	0	0	0	0.5	0.25
		public	gov						0	0.25
2001	[186]	private	infra	0	1	0	0	0	1	0.5
		private	economy						0	0.5
2002	[187]	NGO	infra	0	0	0	0	1	1	0.5
		NGO	social						0	0.5
2003	[188]	private	infra	0	1	0	0	0	1	0.5
		private	economy						0	0.5
2005	[161]	private	Infra	0	0.5	0	0	0	0.5	0.125
		private	media and art						0	0.125
		private	data						0	0.125
		private	economy						0	0.125
2006	[185]	public	infra	0.5	0	0	0	0	0.5	0.5
		private	infra	0	1	0	0	0	1	0.5
		private	economy						0	0.5
2007	[189]	public	infra	1	0	0	0	0	1	0.5
		public	transport						0	0.5
2009	[190]	public	infra	1	0	0	0	0	1	0.5
		public	social						0	0.5

Berlin										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
2010	[189]	public	infra	0.3333	0	0	0	0	0.3333	0.166666
		public	gov						0	0.166666
	[185]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	economy						0	0.166666
	[238]	private	infra	0	0.3333	0	0	0	0.3333	0.333333
2011	[185]	private	infra	0	0.3333	0	0	0	0.3333	0.333333
	[204]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	economy						0	0.166666
	[198]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	economy						0	0.166666
2012	[185]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	economy						0	0.166666
	[192]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	economy						0	0.166666
	[239]	private	infra	0	0.3333	0	0	0	0.3333	0.111111
		private	economy						0	0.111111
		private	transport						0	0.111111
2013	[169]	private	infra	0	0.25	0	0	0	0.25	0.08333333
		private	social						0	0.08333333
		private	economy						0	0.08333333
	[194]	private	infra	0	0.25	0	0	0	0.25	0.125
		private	economy						0	0.125
	[240]	private	infra	0	0.25	0	0	0	0.25	0.125
		private	economy						0	0.125
	[195]	private	infra	0	0.25	0	0	0	0.25	0.08333333
		private	economy						0	0.08333333
		private	health						0	0.08333333
2014	[185]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	economy						0	0.166666
	[196]	people	infra	0	0	0.3333	0	0	0.3333	0.166666
		people	social						0	0.166666
	[197]	people	infra	0	0	0.3333	0	0	0.3333	0.166666
		people	social						0	0.166666
2015	[202]	people	infra	0	0	0.111111	0	0	0.11111	0.05555556
		people	social						0	0.05555556
	[203]	people	infra	0	0	0.111111	0	0	0.11111	0.05555556
		people	social						0	0.05555556
	[198]	private	infra	0	0.111111	0	0	0	0.11111	0.05555556
		private	economy						0	0.05555556
	[199]	private	infra	0	0.111111	0	0	0	0.11111	0.05555556
		private	economy						0	0.05555556
	[200]	private	infra	0	0.111111	0	0	0	0.11111	0.03703704
		private	tour						0	0.03703704
		private	economy						0	0.03703704
	[201]	private	infra	0	0.111111	0	0	0	0.11111	0.02777778
		private	economy						0	0.02777778
		private	health						0	0.02777778
		private	social						0	0.02777778

Berlin										
Year	**Data Source**	**Stakeholder**	**Service**	**Converted Number of Stakeholders**					**Sum of CNS**	**Converted Weight of Services**
				Public	**Private**	**People**	**Academia**	**NGO**		
2016	[200]	private	infra	0	0.111111	0	0	0	0.11111	0.05555556
		private	economy						0	0.05555556
		private	infra	0	0.111111	0	0	0	0.11111	0.03703704
		private	economy						0	0.03703704
		private	transport						0	0.03703704
		private	infra	0	0.111111	0	0	0	0.11111	0.05555556
		private	social						0	0.05555556
	[198]	private	infra	0	0.166667	0	0	0	0.16667	0.08333333
		private	economy						0	0.08333333
	[205]	private	infra	0	0.166667	0	0	0	0.16667	0.08333333
		private	economy						0	0.08333333
	[204]	private	infra	0	0.166667	0	0	0	0.16667	0.05555556
		private	economy						0	0.05555556
		private	social						0	0.05555556
	[206]	public	gov	0.166667	0	0	0	0	0.16667	0.02777778
		public	economy						0	0.02777778
		public	social						0	0.02777778
		public	architecture						0	0.02777778
		public	infra						0	0.02777778
		public	safe						0	0.02777778
	[241]	people	infra	0	0	0.166667	0	0	0.16667	0.08333333
		people	social						0	0.08333333
	[207]	private	infra	0	0.166667	0	0	0	0.16667	0.05555556
		private	economy						0	0.05555556
		private	transport						0	0.05555556
2017	[204]	private	infra	0	0.25	0	0	0	0.25	0.125
		private	economy						0	0.125
	[208]	people	infra	0	0	0.25	0	0	0.25	0.08333333
		people	data						0	0.08333333
		people	social						0	0.08333333
	[209]	private	infra	0	0.25	0	0	0	0.25	0.08333333
		private	economy						0	0.08333333
		private	transport						0	0.08333333
	[191]	public	economy	0.25	0	0	0	0	0.25	0.04166667
		public	infra						0	0.04166667
		public	data						0	0.04166667
		public	safe						0	0.04166667
		public	Edu						0	0.04166667
		public	gov						0	0.04166667
2018	[210]	public	social	0.3333	0	0	0	0	0.3333	0.111111
		public	infra						0	0.111111
		public	economy						0	0.111111
	[211]	private	data	0	0.3333	0	0	0	0.3333	0.111111
		private	transport						0	0.111111
		private	infra						0	0.111111
	[212]	private	infra	0	0.3333	0	0	0	0.3333	0.166666
		private	people						0	0.166666

Berlin										
Year	Data Source	Stakeholder	Service	Converted Number of Stakeholders					Sum of CNS	Converted Weight of Services
				Public	Private	People	Academia	NGO		
2019	[213]	private	infra	0	0.142857	0	0	0	0.14286	0.03571429
		private	transport						0	0.03571429
		private	safe						0	0.03571429
		private	data						0	0.03571429
	[204]	private	economy	0	0.142857	0	0	0	0.14286	0.14285714
	[215]	people	infra	0	0	0.142857	0	0	0.14286	0.07142857
		people	social						0	0.07142857
	[194]	private	infra	0	0.142857	0	0	0	0.14286	0.07142857
		private	economy						0	0.07142857
	[214]	private	infra	0	0.142857	0	0	0	0.14286	0.07142857
		private	transport						0	0.07142857
	[200]	private	infra	0	0.142857	0	0	0	0.14286	0.07142857
		private	social						0	0.07142857
		private	infra	0	0.142857	0	0	0	0.14286	0.04761905
		private	social						0	0.04761905
		private	economy						0	0.04761905
2020	[216]	public	infra	1	0	0	0	0	1	0.333333
		public	economy						0	0.333333
		public	transport						0	0.333333
2021	[217]	public	infra	0.5	0	0	0	0	0.5	0.25
		public	env						0	0.25
	[197]	people	infra	0	0	0.5	0	0	0.5	0.25
		people	social						0	0.25

References

1. Carvalho, L. Smart Cities from Scratch? A Socio-Technical Perspective. *Camb. J. Reg. Econ. Soc.* **2015**, *8*, 43–60. [CrossRef]
2. Geels, F.W.; Schot, J. Typology of Sociotechnical Transition Pathways. *Res. Policy* **2007**, *36*, 399–417. [CrossRef]
3. Komninos, N.; Kakderi, C.; Panori, A.; Tsarchopoulos, P. Smart City Planning from an Evolutionary Perspective. *J. Urban Technol.* **2019**, *26*, 3–20. [CrossRef]
4. Leydesdorff, L.; Deakin, M. The Triple-Helix Model of Smart Cities: A Neo-Evolutionary Perspective. *J. Urban Technol.* **2011**, *18*, 53–63. [CrossRef]
5. Mora, L.; Deakin, M.; Zhang, X.; Batty, M.; de Jong, M.; Santi, P.; Appio, F.P. Assembling Sustainable Smart City Transitions: An Interdisciplinary Theoretical Perspective. *J. Urban Technol.* **2021**, *28*, 1–27. [CrossRef]
6. Murphy, J.T. Human Geography and Socio-Technical Transition Studies: Promising Intersections. *Environ. Innov. Soc. Transit.* **2015**, *17*, 73–91. [CrossRef]
7. Nochta, T.; Wan, L.; Schooling, J.M.; Parlikad, A.K. A Socio-Technical Perspective on Urban Analytics: The Case of City-Scale Digital Twins. *J. Urban Technol.* **2021**, *28*, 263–287. [CrossRef]
8. Kim, N.; Yang, S. Characteristics of Conceptually Related Smart Cities (CRSCs) Services from the Perspective of Sustainability. *Sustainability* **2021**, *13*, 3334. [CrossRef]
9. Albino, V.; Berardi, U.; Dangelico, R.M. Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *J. Urban Technol.* **2015**, *22*, 3–21. [CrossRef]
10. Elgazzar, R.F.; El-Gazzar, R. Smart Cities, Sustainable Cities, or Both. In Proceedings of the 6th International Conference on Smart Cities and Green ICT Systems (SMARTGREENS 2017), Porto, Portugal, 22–24 April 2017; pp. 22–24.
11. Höjer, M.; Wangel, J. Smart Sustainable Cities: Definition and Challenges. In *ICT Innovations for Sustainability*; Springer: Berlin/Heidelberg, Germany, 2015; pp. 333–349.
12. International Telecommunication Union. *Focus Group on Smart Sustainable Cities*; ITU: Geneva, Switzerland, 2015.
13. WeGO. The Statue for the World Smart Sustainable Cities Organization. 2017. Available online: http://we-gov.org/wp-content/uploads/2017/08/%E2%98%85WeGO-STATUTE-adopted-at-4th-GA_2017_Final.pdf (accessed on 9 August 2021).
14. Trindade, E.P.; Hinnig, M.P.F.; Moreira da Costa, E.; Marques, J.; Bastos, R.; Yigitcanlar, T. Sustainable Development of Smart Cities: A Systematic Review of the Literature. *J. Open Innov. Technol. Mark. Complex.* **2017**, *3*, 11. [CrossRef]
15. Girardi, P.; Temporelli, A. Smartainability: A Methodology for Assessing the Sustainability of the Smart City. *Energy Procedia* **2017**, *111*, 810–816. [CrossRef]

16. Marsal-Llacuna, M.-L. City Indicators on Social Sustainability as Standardization Technologies for Smarter (Citizen-Centered) Governance of Cities. *Soc. Indic. Res.* **2016**, *128*, 1193–1216. [CrossRef]
17. Khansari, N.; Mostashari, A.; Mansouri, M. Impacting Sustainable Behavior and Planning in Smart City. *Int. J. Sustain. Land Use Urban Plan.* **2014**, *1*, 46–61. [CrossRef]
18. Parra-Domínguez, J.; Gil-Egido, A.; Rodríguez-González, S. SDGs as One of the Drivers of Smart City Development: The Indicator Selection Process. *Smart Cities* **2022**, *5*, 51. [CrossRef]
19. United for Smart Sustainable Cities; United Nations Economic Commission for Europe. *A UN Initiative*; International Telecommunication Union: Geneva, Switzerland, 2020.
20. Nam, T.; Pardo, T.A. *Conceptualizing Smart City with Dimensions of Technology, People, and Institutions*; ACM: New York, NY, USA, 2011; pp. 282–291.
21. Guo, Y.-M.; Huang, Z.-L.; Guo, J.; Li, H.; Guo, X.-R.; Nkeli, M.J. Bibliometric Analysis on Smart Cities Research. *Sustainability* **2019**, *11*, 3606. [CrossRef]
22. D'Auria, A.; Tregua, M.; Vallejo-Martos, M.C. Modern Conceptions of Cities as Smart and Sustainable and Their Commonalities. *Sustainability* **2018**, *10*, 2642. [CrossRef]
23. Anthopoulos, L.G. The Rise of the Smart City. In *Understanding Smart Cities: A Tool for Smart Government or an Industrial Trick?*; Springer: Berlin/Heidelberg, Germany, 2017; pp. 5–45.
24. Tcholtchev, N.; Schieferdecker, I. Sustainable and Reliable Information and Communication Technology for Resilient Smart Cities. *Smart Cities* **2021**, *4*, 9. [CrossRef]
25. Arksey, H.; O'Malley, L. Scoping Studies: Towards a Methodological Framework. *Int. J. Soc. Res. Methodol.* **2005**, *8*, 19–32. [CrossRef]
26. Xiao, Y.; Watson, M. Guidance on Conducting a Systematic Literature Review. *J. Plan. Educ. Res.* **2019**, *39*, 93–112. [CrossRef]
27. Cocchia, A. Smart and Digital City: A Systematic Literature Review. In *Smart City*; Springer: Berlin/Heidelberg, Germany, 2014; pp. 13–43.
28. Yigitcanlar, T.; Kamruzzaman, M.; Buys, L.; Ioppolo, G.; Sabatini-Marques, J.; da Costa, E.M.; Yun, J.J. Understanding 'Smart Cities': Intertwining Development Drivers with Desired Outcomes in a Multidimensional Framework. *Cities* **2018**, *81*, 145–160. [CrossRef]
29. Yigitcanlar, T.; Kamruzzaman, M.; Foth, M.; Sabatini-Marques, J.; da Costa, E.; Ioppolo, G. Can Cities Become Smart without Being Sustainable? A Systematic Review of the Literature. *Sustain. Cities Soc.* **2019**, *45*, 348–365. [CrossRef]
30. Prasetyo, Y.A.; Lubis, M. Smart City Architecture Development Methodology (SCADM): A Meta-Analysis Using SOA-EA and SoS Approach. *SAGE Open* **2020**, *10*, 2158244020919528. [CrossRef]
31. Ahmed, S.; Shah, M.A.; Wakil, K. Blockchain as a Trust Builder in the Smart City Domain: A Systematic Literature Review. *IEEE Access* **2020**, *8*, 92977–92985. [CrossRef]
32. Sharifi, A.; Khavarian-Garmsir, A.R.; Kummitha, R.K.R. Contributions of Smart City Solutions and Technologies to Resilience against the COVID-19 Pandemic: A Literature Review. *Sustainability* **2021**, *13*, 8018. [CrossRef]
33. Dashkevych, O.; Portnov, B.A. Criteria for Smart City Identification: A Systematic Literature Review. *Sustainability* **2022**, *14*, 4448. [CrossRef]
34. Alzahrani, N.M.; Alfouzan, F.A. Augmented Reality (AR) and Cyber-Security for Smart Cities—A Systematic Literature Review. *Sensors* **2022**, *22*, 2792. [CrossRef]
35. Pacheco Rocha, N.; Dias, A.; Santinha, G.; Rodrigues, M.; Rodrigues, C.; Queirós, A.; Bastardo, R.; Pavão, J. Systematic Literature Review of Context-Awareness Applications Supported by Smart Cities' Infrastructures. *SN Appl. Sci.* **2022**, *4*, 90. [CrossRef]
36. Bellini, P.; Nesi, P.; Pantaleo, G. IoT-Enabled Smart Cities: A Review of Concepts, Frameworks and Key Technologies. *Appl. Sci.* **2022**, *12*, 1607. [CrossRef]
37. Sharif, R.A.; Pokharel, S. Smart City Dimensions and Associated Risks: Review of Literature. *Sustain. Cities Soc.* **2022**, *77*, 103542. [CrossRef]
38. Ramírez-Moreno, M.A.; Keshtkar, S.; Padilla-Reyes, D.A.; Ramos-López, E.; García-Martínez, M.; Hernández-Luna, M.C.; Mogro, A.E.; Mahlknecht, J.; Huertas, J.I.; Peimbert-García, R.E.; et al. Sensors for Sustainable Smart Cities: A Review. *Appl. Sci.* **2021**, *11*, 8198. [CrossRef]
39. Li, N.; Li, R.Y.M.; Yao, Q.; Song, L.; Deeprasert, J. Housing Safety and Health Academic and Public Opinion Mining from 1945 to 2021: PRISMA, Cluster Analysis, and Natural Language Processing Approaches. *Front. Public Health* **2022**, *10*, 902576. [CrossRef]
40. Reis, J.; Marques, P.A.; Marques, P.C. Where Are Smart Cities Heading? A Meta-Review and Guidelines for Future Research. *Appl. Sci.* **2022**, *12*, 8328. [CrossRef]
41. Esashika, D.; Masiero, G.; Mauger, Y. An Investigation into the Elusive Concept of Smart Cities: A Systematic Review and Meta-Synthesis. *Technol. Anal. Strateg. Manag.* **2021**, *33*, 957–969. [CrossRef]
42. Anthony Jnr, B. Managing Digital Transformation of Smart Cities through Enterprise Architecture—A Review and Research Agenda. *Enterp. Inf. Syst.* **2021**, *15*, 299–331. [CrossRef]
43. Kitchin, R. The Real-Time City? Big Data and Smart Urbanism. *GeoJournal* **2014**, *79*, 1–14. [CrossRef]
44. Ceruzzi, P.E. *Computing: A Concise History*; MIT Press: Cambridge, UK, 2012; ISBN 978-0-262-51767-6.
45. Go, E. *IT CookBook, Introduction to Information and Communication in the Era of the 4th Industrial Revolution*; Hanbit Academy: Seoul, Republic of Korea, 2020; ISBN 979-11-5664-476-7.

46. Kim, T.; Kim, K.; Heo, Y. *Introduction to Information and Communication*; Ohsung Media: Seoul, Republic of Korea, 2002; ISBN 978-89-89464-25-9.
47. Park, D.-C.; Bae, C.; Sin, J. *Introduction to Information and Communication (Revised)*; Ungbo Publishing House: Seoul, Republic of Korea, 2006; ISBN 978-89-8462-198-5.
48. Boudreau, M.-C.; Robey, D. Enacting Integrated Information Technology: A Human Agency Perspective. *Organ. Sci.* **2005**, *16*, 3–18. [CrossRef]
49. Pesch, U. Tracing Discursive Space: Agency and Change in Sustainability Transitions. *Technol. Forecast. Soc. Chang.* **2015**, *90*, 379–388. [CrossRef]
50. Rauschmayer, F.; Bauler, T.; Schäpke, N. Towards a Thick Understanding of Sustainability Transitions—Linking Transition Management, Capabilities and Social Practices. *Ecol. Econ.* **2015**, *109*, 211–221. [CrossRef]
51. Van den Buuse, D.; van Winden, W.; Schrama, W. Balancing Exploration and Exploitation in Sustainable Urban Innovation: An Ambidexterity Perspective toward Smart Cities. *J. Urban Technol.* **2021**, *28*, 175–197. [CrossRef]
52. Al-Nasrawi, S.; Adams, C.; El-Zaart, A. A conceptual multidimensional model for assessing smart sustainable cities. *J. Inf. Syst. Technol. Manag.* **2015**, *12*, 541–558. [CrossRef]
53. Bibri, S.E.; Krogstie, J. Smart Sustainable Cities of the Future: An Extensive Interdisciplinary Literature Review. *Sustain. Cities Soc.* **2017**, *31*, 183–212. [CrossRef]
54. Bouzguenda, I.; Alalouch, C.; Fava, N. Towards Smart Sustainable Cities: A Review of the Role Digital Citizen Participation Could Play in Advancing Social Sustainability. *Sustain. Cities Soc.* **2019**, *50*, 101627. [CrossRef]
55. Chang, D.L.; Sabatini-Marques, J.; Da Costa, E.M.; Selig, P.M.; Yigitcanlar, T. Knowledge-Based, Smart and Sustainable Cities: A Provocation for a Conceptual Framework. *J. Open Innov. Technol. Mark. Complex.* **2018**, *4*, 5. [CrossRef]
56. Keeble, B.R. The Brundtland Report: 'Our Common Future'. *Med. War* **1988**, *4*, 17–25. [CrossRef]
57. United Nations. *Report of the World Commission on Environment and Development—Our Common Future (A/42/251 82e Environment)*; Oxford University Press: Oxford, UK, 1987.
58. Washburn, D.; Sindhu, U.; Balaouras, S.; Dines, R.A.; Hayes, N.; Nelson, L.E. Helping CIOs Understand "Smart City" Initiatives. *Growth* **2009**, *17*, 1–17.
59. Ibrahim, M.; El-Zaart, A.; Adams, C. Smart Sustainable Cities Roadmap: Readiness for Transformation towards Urban Sustainability. *Sustain. Cities Soc.* **2018**, *37*, 530–540. [CrossRef]
60. Mora, L.; Deakin, M. *Untangling Smart Cities: From Utopian Dreams to Innovation Systems for a Technology-Enabled Urban Sustainability*; Elsevier: Amsterdam, The Netherlands, 2019.
61. Bibri, S.E.; Krogstie, J. On the Social Shaping Dimensions of Smart Sustainable Cities: A Study in Science, Technology, and Society. *Sustain. Cities Soc.* **2017**, *29*, 219–246. [CrossRef]
62. Haarstad, H. Constructing the Sustainable City: Examining the Role of Sustainability in the 'Smart City' Discourse. *J. Environ. Policy Plann.* **2017**, *19*, 423–437. [CrossRef]
63. De Souza, J.T.; de Francisco, A.C.; Piekarski, C.M.; Prado, G.F. Do Data Mining and Machine Learning to Promote Smart Cities: A Systematic Review from 2000 to 2018. *Sustainability* **2019**, *11*, 1077. [CrossRef]
64. Wang, J.; Shen, L.; Ren, Y.; Ochoa, J.J.; Guo, Z.; Yan, H.; Wu, Z. A Lessons Mining System for Searching References to Support Decision Making towards Sustainable Urbanization. *J. Clean. Prod.* **2019**, *209*, 451–460. [CrossRef]
65. Mayer, M.; Martino, L. International Politics in the Digital Age. In Proceedings of the XXVIth SISP Conference, Florence, Italy, 12–14 September 2013.
66. Tampouridou, A.; Pozoukidou, G. Smart Cities and Urban Sustainability: Two Complementary and Inter-Related Concepts. *RELAND Int. J. Real Estate Land Plan.* **2018**, *1*, 393–401. [CrossRef]
67. Winden, W.V.; Buuse, D.V.D. Smart City Pilot Projects: Exploring the Dimensions and Conditions of Scaling Up. *J. Urban Technol.* **2017**, *24*, 51–72. [CrossRef]
68. Geels, F.W. Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case-Study. *Res. Policy* **2002**, *31*, 1257–1274. [CrossRef]
69. Winter, S.G.; Nelson, R.R. *An Evolutionary Theory of Economic Change*; University of Pennsylvania: Philadelphia, PA, USA, 1982.
70. Nelson, R.R.; Winter, S.G. In Search of a Useful Theory of Innovation. In *Innovation, Economic Change and Technology Policies: Proceedings of the Innovation, Economic Change and Technology Policies, Bonn, Germany, 5–9 April 1976*; Stroetmann, K.A., Ed.; Birkhäuser: Basel, Switzerland, 1977; pp. 215–245.
71. Rip, A.; Kemp, R. Technological Change. *Hum. Choice Clim. Chang.* **1998**, *2*, 327–399.
72. Bijker, W.E.; Hughes, T.P.; Pinch, T. *The Social Construction of Technological Systems, Anniversary Edition: New Directions in the Sociology and History of Technology*; MIT Press: Cambridge, UK, 2012; ISBN 978-0-262-30087-2.
73. Genus, A.; Coles, A.-M. Rethinking the Multi-Level Perspective of Technological Transitions. *Res. Policy* **2008**, *37*, 1436–1445. [CrossRef]
74. Malerba, F. Sectoral Systems of Innovation: A Framework for Linking Innovation to the Knowledge Base, Structure and Dynamics of Sectors. *Econ. Innov. New Technol.* **2005**, *14*, 63–82. [CrossRef]
75. Carlsson, B.; Stankiewicz, R. On the Nature, Function and Composition of Technological Systems. *J. Evol. Econ.* **1991**, *1*, 93–118. [CrossRef]

76. Park, S.-O. Environment, Drivers and Dynamics of Socio-Technical System Transition and STI Policy for the Transition Management. *J. Sci. Technol. Stud.* **2011**, *11*, 61–88.
77. Rotmans, J.; Kemp, R.; van Asselt, M. More Evolution than Revolution: Transition Management in Public Policy. *Foresight* **2001**, *3*, 15–31. [CrossRef]
78. Geels, F.W. The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms. *Environ. Innov. Soc. Transit.* **2011**, *1*, 24–40. [CrossRef]
79. Dosi, G. Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants and Directions of Technical Change. *Res. Policy* **1982**, *11*, 147–162. [CrossRef]
80. Allam, Z.; Newman, P. Redefining the Smart City: Culture, Metabolism and Governance. *Smart Cities* **2018**, *1*, 2. [CrossRef]
81. Schiavo, F.T.; de Magalhães, C.F. Smart Sustainable Cities: The Essentials for Managers' and Leaders' Initiatives within the Complex Context of Differing Definitions and Assessments. *Smart Cities* **2022**, *5*, 50. [CrossRef]
82. Bibri, S.E. The Social Shaping of the Metaverse as an Alternative to the Imaginaries of Data-Driven Smart Cities: A Study in Science, Technology, and Society. *Smart Cities* **2022**, *5*, 43. [CrossRef]
83. Ly, T.T. Cluster Sample Type Case-Control Study Designs. Ph.D. Thesis, University of Southern California, Los Angeles, CA, USA, 2013.
84. Babbie, E.R. *The Practice of Social Research*; Cengage Learning: Belmont, CA, USA, 2020.
85. Al-Lawati, J.A.; Mohammed, A.J.; Al-Hinai, H.Q.; Jousilahti, P. Prevalence of the Metabolic Syndrome among Omani Adults. *Diabetes Care* **2003**, *26*, 1781–1785. [CrossRef] [PubMed]
86. Al-Nozha, M.; Al-Khadra, A.; Arafah, M.R.; Al-Maatouq, M.A.; Khalil, M.Z.; Khan, N.B.; Al-Mazrou, Y.Y.; Al-Marzouki, K.; Al-Harthi, S.S.; Abdullah, M.; et al. Metabolic Syndrome in Saudi Arabia. *Saudi. Med. J.* **2005**, *26*, 1918–1925. [PubMed]
87. Alam, M.F.; Nasreen, S.; Ullah, E.; Hussain, A. The Awareness and Prevalence of Metabolic Syndrome in Medical Community of Bahawalpur. *Oman Med. J.* **2011**, *26*, 26–28. [CrossRef]
88. Sibai, A.-M.; Obeid, O.; Batal, M.; Adra, N.; Khoury, D.E.; Hwalla, N. Prevalence and Correlates of Metabolic Syndrome in an Adult Lebanese Population. *CVD Prev. Control.* **2008**, *3*, 83–90. [CrossRef]
89. Madow, W.G.; Madow, L.H. On the Theory of Systematic Sampling, I. *Ann. Math. Stat.* **1944**, *15*, 1–24. [CrossRef]
90. Jensen, A. Report on the Representative Method in Statistics. *Bull. Int. Stat. Inst.* **1926**, *22*, 381–439.
91. Hiebl, M.R.W. Sample Selection in Systematic Literature Reviews of Management Research. *Organ. Res. Methods* **2021**, 86851. [CrossRef]
92. Felizardo, K.R.; MacDonell, S.G.; Mendes, E.; Maldonado, J.C. A Systematic Mapping on the Use of Visual Data Mining to Support the Conduct of Systematic Literature Reviews. *JSW* **2012**, *7*, 450–461. [CrossRef]
93. Ryan, C.; Woods, E. *Smart City Tracker 1q18: Global Smart City Projects by World Region, Market Segment, Technology, and Application*; Navigant Consulting, Incorporated: Chicago, IL, USA, 2018.
94. Kamiya, M.; Ni, P.; Guo, J.; Li, B.; Ma, H.; Xu, H.; Gauntner, L.P.; Allou, S.; Aldon, L.; Eguino, H.; et al. *Global Urban Competitiveness Report (2019–2020)*; UN HABITAT: Nairobi, Kenya, 2020.
95. McKinsey Global Institute. *Smart Cities: Digital Solutions for a More Livable Future*; McKinsey Global Institute: San Francisco, CA, USA, 2018.
96. United Nations. *UN E-Government Survey 2020*; United Nations: New York, NY, USA, 2020.
97. Cities Territories Governance. Barcelona Activa, The Economic Development Agency of Barcelona City Council. Available online: http://www.citego.org/bdf_fiche-document-1156_en.html (accessed on 9 August 2021).
98. Clua, A.; Albet, A. 22@bcn Plan: Bringing Barcelona Forward in the Information Era. In *Knowledge-Based Urban Development: Planning and Applications in the Information Era*; IGI Global: Hershey, PA, USA, 2008; pp. 132–147.
99. Bakıcı, T.; Almirall, E.; Wareham, J. A Smart City Initiative: The Case of Barcelona. *J. Knowl. Econ.* **2013**, *4*, 135–148. [CrossRef]
100. Team INNOVA and Research Group CRIT. *22@Barcelona 2000~2015*; Barcelona City Council: Barcelona, Spain, 2016.
101. Ajuntament de Barcelona. *Barcelona Smart City Tour*; Ajuntament de Barcelona: Barcelona, Spain, 2012.
102. Mila Gasco-hernandez Building a Smart City. Lessons from Barcelona. *Commun. ACM* **2018**, *61*, 50–57. [CrossRef]
103. Madakam, S. Ramaswamy Ramachandran Barcelona Smart City: The Heaven on Earth. *ZTE Commun.* **2015**, *13*, 3–9.
104. Francesca, B. *Barcelona Digital City Plan—Putting Technology at the Service of People*; Ajuntament de Barcelona: Barcelona, Spain, 2015; p. 61.
105. Capdevila, I.; Zarlenga, M.I. Smart City or Smart Citizens? The Barcelona Case. *J. Strategy Manag.* **2015**, *8*, 266–282. [CrossRef]
106. Hire Fiber Internet, Mobile and Landline at the Best Price. Available online: https://adamo.es/es/sobre-adamo/historia (accessed on 9 August 2021).
107. Rahyaputra, V.; Muna, N.K.; Rizal, N.S. *Barcelona's Smart City: The Frontrunner in Digital Transfromation*; 04 Case Studies Series; Center from Digital Society: Atlanta, GA, USA, 2016; pp. 1–13.
108. Tech & Mobility. Barcelona's Innovation District—22@Barcelona. Available online: https://safesmart.city/en/district-22-barcelona/ (accessed on 9 August 2021).
109. Martínez, I. *Hybrid Bus Prototype Created with the Participation of the IREC Joins TMB Fleet*; IREC—Institut de Recerca en Energia de Catalunya: Barcelona, Spain, 2010.
110. Ajuntament de Barcelona. *User Manual Barcelona Wifi*; Ajuntament de Barcelona: Barcelona, Spain, 2012.
111. Ajuntament de Barcelona. *Government Measure a Boost to 22@*; Ajuntament de Barcelona: Barcelona, Spain, 2020.
112. Mora, L.; Bolici, R. The Development Process of Smart City Strategies: The Case of Barcelona. In *Re-City: Future City-Combining Disciplines*; Rajaniemi, J., Ed.; Tampere University of Technology: Tampere, Finland, 2016; pp. 155–181. ISBN 978-952-15-3624-3.

113. How Smart City Barcelona Brought the Internet of Things to Life. Available online: https://datasmart.ash.harvard.edu/news/article/how-smart-city-barcelona-brought-the-internet-of-things-to-life-789 (accessed on 9 August 2021).
114. C40. Available online: https://www.c40.org/profiles/2014-barcelona (accessed on 9 August 2021).
115. Zygiaris, S. Smart City Reference Model: Assisting Planners to Conceptualize the Building of Smart City Innovation Ecosystems. *J. Knowl. Econ.* **2013**, *4*, 217–231. [CrossRef]
116. Cisco DevNet. Available online: https://developer.cisco.com/site/cmx-mobility-services/ (accessed on 9 August 2021).
117. Kuyper, T. Smart City Strategy & Upscaling: Comparing Barcelona and Amsterdam. Master's Thesis, University Pompeu Fabra, Barcelona, Spain, 2016.
118. Barcelona Ciutat Digital. *Barcelona City Council Digital Plan*; Barcelona Ciutat Digital: Barcelona, Spain, 2017.
119. Info Barcelona. Sharing Cities Agreement to Regulate Collaborative Digital Platforms. Available online: https://www.barcelona.cat/infobarcelona/en/tema/commerce-and-markets/agreement-between-cities-to-regulate-collaborative-digital-platforms_732358.html (accessed on 9 August 2021).
120. Info Barcelona. Common Front to Negotiate with Large Digital Platforms. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/common-front-to-negotiate-with-large-digital-platforms_735144.html (accessed on 9 August 2021).
121. Info Barcelona. Barcelona to Lead the Way for Future Mobility. Available online: https://www.barcelona.cat/infobarcelona/en/tema/mobility-and-transport/barcelona-to-lead-the-way-for-future-mobility-2_745843.html (accessed on 9 August 2021).
122. Info Barcelona. Common Housing Solutions for a Global Challenge. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/common-housing-solutions-for-a-global-challenge_735663.html (accessed on 9 August 2021).
123. Info Barcelona. Barcelona, Athens, Milan and Berlin Unite against Climate Change. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/barcelona-athens-milan-and-berlin-unite-against-climate-change_735174.html (accessed on 9 August 2021).
124. Info Barcelona. Promoting Municipal Innovation at the Smart City World Congress. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/promoting-municipal-innovation-at-the-smart-city-world-congress_735048.html (accessed on 9 August 2021).
125. 5G Barcelona, 5G Hub for Southern Europe. What Is 5G Barcelona? *2018.* Available online: https://5gbarcelona.org/what-is-5g-barcelona/ (accessed on 9 August 2021).
126. 5G Barcelona, 5G Hub for Southern Europe. 5G Connected Ambulance. 2019. Available online: https://5gbarcelona.org/pilots/5g-connected-ambulance/ (accessed on 9 August 2021).
127. 5G Barcelona, 5G Hub for Southern Europe. Telemanaged Robotic Platform with 5G. 2019. Available online: https://5gbarcelona.org/pilots/piloto-telemanaged-robotic-platform/ (accessed on 9 August 2021).
128. Info Barcelona. Students from Eight Schools Reach the Final of the Barcelona Open Data Challenge. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/students-from-eight-schools-reach-the-final-of-the-barcelona-open-data-challenge_799897.html (accessed on 9 August 2021).
129. Home—Maker Faire Barcelona. Available online: https://barcelona.makerfaire.com/en/home/ (accessed on 9 August 2021).
130. Info Barcelona. Innovative Solutions for Dependent Senior Citizens. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/innovative-solutions-for-dependent-senior-citizens_822913.html (accessed on 9 August 2021).
131. Info Barcelona. Women and Young People Play a Bigger Part at the Mobile World Congress. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/women-and-young-people-play-a-bigger-part-at-the-mobile-world-congress_776516.html (accessed on 9 August 2021).
132. 5G Barcelona, 5G Hub for Southern Europe. Gestión de Emergencias Con Drones. 2019. Available online: https://5gbarcelona.org/pilots/emergency-management-with-drones/ (accessed on 9 August 2021).
133. 5G Barcelona, 5G Hub for Southern Europe. Remote Surgeon. 2019. Available online: https://5gbarcelona.org/pilots/remote-surgeon-pilot/ (accessed on 9 August 2021).
134. Info Barcelona. Fab Labs and the Maker Community Team up to Combat COVID-19. Available online: https://www.barcelona.cat/infobarcelona/en/tema/information-about-covid-19/fab-labs-and-the-maker-community-team-up-to-combat-covid-19_932584.html (accessed on 9 August 2021).
135. Info Barcelona. Smart City Week Returns with a New Edition Focusing on Digital Inclusion. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/smart-city-week-returns-with-a-new-edition-focusing-on-digital-inclusion_1003575.html (accessed on 9 August 2021).
136. Info Barcelona. 42 Barcelona Is Here, the Most Innovative Programming Campus. Available online: https://www.barcelona.cat/infobarcelona/en/tema/city-council/42-barcelona-is-here-the-most-innovative-programming-campus_1020113.html (accessed on 9 August 2021).
137. Info Barcelona. Seven Local Initiatives for a Proactive City. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/seven-local-initiatives-for-a-proactive-city_1001024.html (accessed on 9 August 2021).
138. Info Barcelona. Barcelona ReAct: Dialogue to Reactivate a More Competitive and Resilient City. Available online: https://www.barcelona.cat/infobarcelona/en/tema/city-council/barcelona-react-dialogue-to-reactivate-a-more-competitive-and-resilient-city_1049847.html (accessed on 9 August 2021).
139. Info Barcelona. How Can Open Data Help Small Commerce? Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/how-can-open-data-help-small-commerce_1047525.html (accessed on 9 August 2021).

140. Info Barcelona. Food and Energy Production through a New Project by Local People. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/food-and-energy-production-through-a-new-project-by-local-people_1048764.html (accessed on 9 August 2021).
141. Info Barcelona. More Women in Tech Sectors, Less of a Digital Gender Divide. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/more-women-in-tech-sectors-less-of-a-digital-gender-divide_1044801.html (accessed on 9 August 2021).
142. Info Barcelona. Boosting the Development of AI in Municipal Services. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/boosting-the-development-of-ai-in-municipal-services_1060962.html (accessed on 9 August 2021).
143. Info Barcelona. Innovative Proposals to Improve Hospital Stays for Teenagers. Available online: https://www.barcelona.cat/infobarcelona/en/tema/smart-city/innovative-proposals-to-improve-hospital-stays-for-teenagers_1067133.html (accessed on 9 August 2021).
144. thinkbroadband. Check UK Broadband Performance and Coverage Statistics. Available online: https://labs.thinkbroadband.com/local/ (accessed on 9 August 2021).
145. Government Dodges "Full Fibre for All by 2025" Pledge. BBC News, 14 October 2019. Available online: https://www.bbc.com/news/technology-50042720 (accessed on 9 August 2021).
146. Fibre Broadband Options—City of London. Available online: https://www.cityoflondon.gov.uk/supporting-businesses/commercial-property/telecommunications-and-utilities-infrastructure/fibre-broadband-options (accessed on 9 August 2021).
147. Greater London Authority. *Smarter London Together*; Greater London Authority City Hall: London, UK, 2018.
148. Mayor of London. *London Infrastructure 2050*; Mayor of London: London, UK, 2015.
149. UPDATE3 BT Unveil Universal 5–10 Mb Broadband and 500 Mb G.fast Rollout. ISP News, 22 September 2015. Available online: https://www.ispreview.co.uk/index.php/2015/09/bt-sets-plan-for-universal-5-10mbps-uk-broadband-and-500mbps-g-fast-rollout.html (accessed on 9 August 2021).
150. London City Hall. *Smart London Plan*; London City Hall: London, UK, 2021.
151. £25m Campaign to Protect Child Safety on the Internet. Available online: https://www.itv.com/news/update/2013-11-16/25m-campaign-to-protect-child-safety-on-the-internet/ (accessed on 9 August 2021).
152. Nine out of Ten Homes to Have Porn Filters within Two Months. Available online: https://www.telegraph.co.uk/technology/internet/10482171/Nine-out-of-ten-homes-to-have-porn-filters-within-two-months.html (accessed on 9 August 2021).
153. Wikipedia. Cambridge Analytica. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Cambridge_Analytica&oldid=1037622346 (accessed on 9 August 2021).
154. Department for Culture, Media and Sport. *Super-Connected Cities Programme*; Department for Culture, Media and Sport: London, UK, 2012.
155. Wikipedia. Internet in the United Kingdom. Available online: https://en.wikipedia.org/wiki/Internet_in_the_United_Kingdom (accessed on 9 August 2021).
156. Department for Business Innovation & Skills. *Digital Britain Report, Proposed New Duties for Ofrcom on Resilience: Secondary Information*; Department for Business Innovation & Skills: London, UK, 2009.
157. Department for Business Innovation & Skills. *Digital Economy Act 2010*; Department for Business Innovation & Skills: London, UK, 2010.
158. A History of UK Broadband | Computerworld. Available online: https://www.computerworld.com/article/3412338/a-history-of-uk-broadband-roll-out--bt--openreach-and-other-major-milestones.html#slide2 (accessed on 9 August 2021).
159. The Olympic Delivery Authority (ODA). *Progress*; The National Lottery, the London Development Agency, the Department for Culture, Media and Sport and the Greater London Authority: London, UK, 2007.
160. Wikipedia. Open Rights Group. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Open_Rights_Group&oldid=1000971221 (accessed on 9 August 2021).
161. Wikipedia. Razorfish (Company). 2021. Available online: https://en.wikipedia.org/w/index.php?title=Razorfish_(company)&oldid=1021988746 (accessed on 9 August 2021).
162. Klug, F.; Starmer, K.; Weir, S. *The Three Pillars of Liberty: Political Rights and Freedoms in the United Kingdom*, 1st ed.; Routledge: London, UK, 1996; ISBN 978-0-415-09641-6.
163. BT Plc. 1984—Onwards—The History of Telecommunications—Our History—About BT. Available online: https://www.bt.com/about/bt/our-history/history-of-telecommunications/1984-onwards (accessed on 9 August 2021).
164. Wikipedia. Internet Censorship in the United Kingdom. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Internet_censorship_in_the_United_Kingdom&oldid=1033431882 (accessed on 9 August 2021).
165. Wikipedia.com. Lastminute. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Lastminute.com&oldid=1037571776 (accessed on 9 August 2021).
166. Chaffey, D.; Ellis-Chadwick, F. *Digital Marketing*, 6th ed.; Pearson: London, UK, 2015; ISBN 978-1-292-07761-1.
167. IRC.org. Available online: http://www.irc.org/history_docs/m_lawrie.html (accessed on 10 August 2021).
168. Slevin, J. *The Internet and Society*, 1st ed.; Polity: Malden, MA, USA, 2000; ISBN 978-0-7456-2087-9.
169. Wikipedia. Internet Café. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Internet_caf%C3%A9&oldid=1035703041 (accessed on 9 August 2021).

170. Internet Hall of Fame. Karen Banks. Available online: https://www.internethalloffame.org/inductees/karen-banks (accessed on 9 August 2021).
171. Wikipedia. JANET. 2021. Available online: https://en.wikipedia.org/w/index.php?title=JANET&oldid=1034343901 (accessed on 9 August 2021).
172. CIX. About Us. Available online: https://www.cix.uk/contact/about (accessed on 9 August 2021).
173. Rutter, D.J. From Diversity to Convergence: British Computer Networks and the Internet, 1970–1995. Ph.D. Thesis, University of Warwick, Warwich, UK, 2005.
174. Wikipedia. NYSERNet. 2021. Available online: https://en.wikipedia.org/w/index.php?title=NYSERNet&oldid=1037626811 (accessed on 9 August 2021).
175. About, B.T. Available online: https://www.bt.com/about/bt/our-history/history-of-telecommunications/1969-to-1980 (accessed on 9 August 2021).
176. Schwartz, M.X. 25 Virtual Circuits—TRANSPAC IN France—Pre-Internet Data Networking [History of Communications]. *IEEE Commun. Mag.* **2010**, *48*, 40–46. [CrossRef]
177. Wikipedia. NPL Network. 2021. Available online: https://en.wikipedia.org/w/index.php?title=NPL_network&oldid=1028198611 (accessed on 9 August 2021).
178. History of Information. Available online: https://www.historyofinformation.com/index.php?cat=59#entry_918 (accessed on 10 August 2021).
179. Computer History Museum Networking & The Web, Timeline of Computer History. Available online: https://www.computerhistory.org/timeline/networking-the-web/ (accessed on 4 August 2021).
180. Leiner, B.M.; Cerf, V.G.; Clark, D.D.; Kahn, R.E.; Kleinrock, L.; Lynch, D.C.; Postel, J.; Roberts, L.G.; Wolff, S. A Brief History of the Internet. *ACM SIGCOMM Comput. Commun. Rev.* **2009**, *39*, 22–31. [CrossRef]
181. Wikipedia. ARPANET. Available online: https://en.wikipedia.org/wiki/ARPANET (accessed on 9 August 2021).
182. Internet Hall of Fame. Historic First Email from U.S. to Germany Arrives in 1984. Available online: https://www.internethalloffame.org/blog/2013/07/29/historic-first-email-us-germany-arrives-1984 (accessed on 10 August 2021).
183. Wikipedia. Tele Columbus. Available online: https://de.wikipedia.org/wiki/Tele_Columbus (accessed on 10 August 2021).
184. IONOS by 1&1. About Us—The Company at a Glance. Available online: https://www.ionos.com/about (accessed on 10 August 2021).
185. Wikipedia. Internet in Germany. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Internet_in_Germany&oldid=1026147483 (accessed on 10 August 2021).
186. FundingUniverse. History of Deutsche Telekom AG. Available online: http://www.fundinguniverse.com/company-histories/deutsche-telekom-ag-history/ (accessed on 10 August 2021).
187. Wikipedia. Freifunk. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Freifunk&oldid=1032941394 (accessed on 10 August 2021).
188. Wikipedia. Vodafone Kabel Deutschland. 2021. Available online: https://de.wikipedia.org/w/index.php?title=Vodafone_Kabel_Deutschland&oldid=213993953 (accessed on 10 August 2021).
189. Endter, C. *The Implementation of Free WIFI Service in the German Public Transport System: E.g., The Berlin Public Transport Company—BVG*; GRIN Publishing: Munich, Germany, 2012; ISBN 978-3-656-29842-7.
190. Maerker Brandenburg. Available online: https://www.de.digital/DIGITAL/Redaktion/DE/Smart-City-Navigator/Projekte/maerker-brandenburg.html (accessed on 10 August 2021).
191. Federal Ministry for Economic Affairs and Energy. *Digital Strategy 2025*; Federal Ministry for Economic Affairs and Energy: Berlin, Germany, 2016.
192. Wiki | Golden. Raisin (Company). Available online: https://golden.com/wiki/Raisin_(company)-YX3X9Y9 (accessed on 10 August 2021).
193. Wikipedia. Spätkauf. 2021. Available online: https://de.wikipedia.org/w/index.php?title=Sp%C3%A4tkauf&oldid=214132728 (accessed on 10 August 2021).
194. Wikipedia. N26. 2021. Available online: https://en.wikipedia.org/w/index.php?title=N26&oldid=1037572749 (accessed on 10 August 2021).
195. Faraguna, C.; Rexha, E.; Holm, A.; Ogolla, H.; Nisay, A.A. Infarm—Wiki. Available online: https://golden.com/wiki/Infarm-VWWWMM4 (accessed on 10 August 2021).
196. Ubuntu Berlin/HOME. Available online: http://www.ubuntu-berlin.de/ (accessed on 10 August 2021).
197. Emacs Berlin. Available online: https://emacs-berlin.org/ (accessed on 10 August 2021).
198. Wikipedia. EyeEm. 2021. Available online: https://en.wikipedia.org/w/index.php?title=EyeEm&oldid=1015458543 (accessed on 10 August 2021).
199. Wiki | Golden. Grover (Company). Available online: https://golden.com/wiki/Grover_(company)-ZXEPY3Z (accessed on 10 August 2021).
200. The Most Innovative Berlin Startups to Watch This Year. Available online: https://tms-outsource.com/blog/posts/berlin-startups/ (accessed on 10 August 2021).
201. Wikipedia. Plantix. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Plantix&oldid=1010009593 (accessed on 10 August 2021).

202. HTW Berlin—Hochschule Für Technik Und Wirtschaft Berlin. Available online: https://www.htw-berlin.de/ (accessed on 10 August 2021).
203. #Berlin DALnet—IRC Chat—Berlin, Germany. Available online: https://netsplit.de/channels/details.php?room=%23Berlin&net=DALnet (accessed on 10 August 2021).
204. Silicon Allee. Available online: https://www.siliconallee.com/who-we-are/ (accessed on 10 August 2021).
205. Debian Wiki. BSP/2019/02/de/Berlin. Available online: https://wiki.debian.org/BSP/2019/02/de/Berlin (accessed on 10 August 2021).
206. Senate Department for Urban Development and the Environment. *Smart City Strategy Berlin*; Senate Department for Urban Development and the Environment: Berlin, Germany, 2015.
207. Frumkin, D.; Smith, B.; Goyal, R.; Maniago, B.; Jhaveri, N.; Suter, W.; Gehlot, A. German Autolabs—Wiki. Available online: https://golden.com/wiki/German_Autolabs-5K96MRM (accessed on 10 August 2021).
208. Berlin—The Things Network Community. Available online: https://www.thethingsnetwork.org/community/berlin/ (accessed on 10 August 2021).
209. Manipula, M.; Sewell, D.; Nisay, A.A. Auto1 Group—Wiki. Available online: https://golden.com/wiki/Auto1_Group-PBW9P4Z (accessed on 10 August 2021).
210. DE.DIGITAL—ELEVATE Delta. Available online: https://www.de.digital/DIGITAL/Redaktion/DE/Smart-City-Navigator/Projekte/elevate-delta.html (accessed on 10 August 2021).
211. Rexha, E.; Kawka, K.; Sewell, D. Teraki—Wiki. Available online: https://golden.com/wiki/Teraki-EAAKE5M (accessed on 10 August 2021).
212. Pitch. Collaborative Presentation Software for Modern Teams. Available online: https://pitch.com/ (accessed on 10 August 2021).
213. SENSARE—Warnung und Resilienzverbesserung der Verkehrsinfrastruktur. Available online: https://www.de.digital/DIGITAL/Redaktion/DE/Smart-City-Navigator/Projekte/sensare-warnung-und-resilienzverbesserung-der-verkehrsinfrastruktur.html (accessed on 10 August 2021).
214. TIER—Change Mobility for Good. Available online: https://www.tier.app/ (accessed on 10 August 2021).
215. #debconf-Germany OFTC—IRC Chat—Germany, Europe. Available online: https://netsplit.de/channels/details.php?room=%23debconf-germany&net=OFTC (accessed on 10 August 2021).
216. Jelbi App. Available online: https://www.de.digital/DIGITAL/Redaktion/DE/Smart-City-Navigator/Projekte/jelbi-app.html (accessed on 10 August 2021).
217. Gieß Den Kiez. Available online: https://www.de.digital/DIGITAL/Redaktion/DE/Smart-City-Navigator/Projekte/giess-den-kiez.html (accessed on 10 August 2021).
218. Informationsplattform Digital Vereint. Available online: https://www.de.digital/DIGITAL/Redaktion/DE/Smart-City-Navigator/Projekte/informationsplattform-digital-vereint.html (accessed on 10 August 2021).
219. Somayya, M.; Ramaswamy, R. Amsterdam Smart City (ASC): Fishing Village to Sustainable City. *WIT Trans. Ecol. Environ.* **2016**, *204*, 831–842.
220. Phillips, L. Maker Made: Creating a Silicon Place in Berlin, Germany. Ph.D. Thesis, University of Minnesota, Minneapolis, MN, USA, 2016.
221. Department for Business Innovation & Skills. *National Plan for Digital Participation*; Department for Business Innovation & Skills: London, UK, 2010.
222. Almihat, M.G.M.; Kahn, M.T.E.; Aboalez, K.; Almaktoof, A.M. Energy and Sustainable Development in Smart Cities: An Overview. *Smart Cities* **2022**, *5*, 71. [CrossRef]
223. El Hendy, M.; Atalla, S.; Miniaoui, S.; Daradkeh, M.; Mansoor, W.; Bin Hashim, K.F. Hybrid Approach for Developing Strategic ICT Framework for Smart Cities—A Case Study of Dubai's Toll Gates (Salik). *Smart Cities* **2022**, *5*, 79. [CrossRef]
224. Agbali, M.; Trillo, C.; Ibrahim, I.A.; Arayici, Y.; Fernando, T. Are Smart Innovation Ecosystems Really Seeking to Meet Citizens' Needs? Insights from the Stakeholders' Vision on Smart City Strategy Implementation. *Smart Cities* **2019**, *2*, 19. [CrossRef]
225. Newman, P.W.G. Sustainability and Cities: Extending the Metabolism Model. *Landsc. Urban Plan.* **1999**, *44*, 219–226. [CrossRef]
226. Helal, S. IT Footprinting—Groundwork for Future Smart Cities. *Computer* **2011**, *44*, 30–31. [CrossRef]
227. Calzada, I. Democratising Smart Cities? Penta-Helix Multistakeholder Social Innovation Framework. *Smart Cities* **2020**, *3*, 57. [CrossRef]
228. Markard, J.; Hekkert, M.; Jacobsson, S. The Technological Innovation Systems Framework: Response to Six Criticisms. *Environ. Innov. Soc. Transit.* **2015**, *16*, 76–86. [CrossRef]
229. Sassen, S.; Kourtit, K. A Post-Corona Perspective for Smart Cities: 'Should I Stay or Should I Go?'. *Sustainability* **2021**, *13*, 9988. [CrossRef]
230. De Lima, E.L.V. The Fallacies of Strategic Urban Planning: Urban Marketing, Barcelona Model, and Mega-Events. *Bol. Goiano Geogr.* **2015**, *35*, 217–235.
231. The Barcelona Website | Barcelona City Council. Available online: https://www.barcelona.cat/en/home (accessed on 25 December 2022).
232. Ortega-Fernández, A.; Martín-Rojas, R.; García-Morales, V.J. Artificial Intelligence in the Urban Environment: Smart Cities as Models for Developing Innovation and Sustainability. *Sustainability* **2020**, *12*, 7860. [CrossRef]
233. History of Computer Communication. Available online: https://historyofcomputercommunications.info/ (accessed on 9 August 2021).

234. Business | Phone Firm "Plans Free Broadband". BBC News. Available online: http://news.bbc.co.uk/2/hi/business/4893194.stm (accessed on 9 August 2021).
235. Department for Business Innovation & Skills. *Britain's Superfast Broadband Future*; Department for Business Innovation & Skills: London, UK, 2010.
236. Wikipedia. Internet Filter. 2021. Available online: https://en.wikipedia.org/w/index.php?title=Internet_filter&oldid=1036474984 (accessed on 10 August 2021).
237. The National Archives. The Digital Economy Act 2017 (Commencement No. 4) Regulations. 2018. Available online: https://www.legislation.gov.uk/uksi/2018/382/contents/made (accessed on 9 August 2021).
238. Federal Ministry of Education and Research. *ICT 2020-Research for Innovations*; Federal Ministry of Education and Research: Bonn, Germany, 2020.
239. Door2door | The Future of Mobility. Available online: https://door2door.io/en/ (accessed on 10 August 2021).
240. Sewell, D.; Shah, U.; Suter, W.; Davies, R.; Ogolla, H. Contentful—Wiki. Available online: https://golden.com/wiki/Contentful-ZXXYJN4 (accessed on 10 August 2021).
241. Berlin 2017—Reproducible-Builds. Available online: https://reproducible-builds.org/events/berlin2017/ (accessed on 22 August 2021).