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Institutionalising smart city research and innovation: from fuzzy definitions to real-life experiments

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ABSTRACT

By exploring and defining characteristics of a smart city research and innovation centre, we contribute to the discussion on smart city development capacity. To do so, using a qualitative method, we review definitions of the concept and map international groups and institutes affiliated with this domain. Our main result is an overview of global research centres dealing with smart cities. One of the key implications of this paper is that instead of a strict definition, the important aspect appears in the framing provided by the complex real-life challenges that require and enable cross-disciplinary research, even though the concept keeps evolving.

KEYWORDS

smart city; centres of excellence; urban research and innovation; multidisciplinary; experiments

1. Introduction

Smart city (SC), a constantly evolving thematic domain, appears as an umbrella term that hosts multidisciplinary research on specific domains such as mobility, energy, built environment, data, and governance. As the term implies, the essence of the theme lays in real-life phenomena and artefacts in the actively changing life surroundings for a constantly increasing number of people all over the world. Cities, as such, consist of vast amount of people and human interaction, technologies that enable constantly advancing abilities for people to perform in improved ways, as well as practices and processes for groups and communities to collaborate and coordinate mutually important activities. Conceptually, and in more precise terms, Batty et al. (2012) have described the theme addressing 'constellations of instruments across many scales that are connected through multiple networks which provide continuous data regarding the movements of people and materials in terms of the flow of decisions about the physical and social form of the city'. A more general formulation is that most smart cities' research is about how digital processes can inform physical processes or are substituting for these (Batty 2020). One may argue that the concept encapsulates a huge variety of issues to consider extending towards being fuzzy and fluid.

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At the same time as the SC concept requires constant elaboration, it offers multiple opportunities and a conceptual umbrella for researchers and innovators to connect their ideation and development efforts. This research is interested in this from different viewpoints: geographical (east–west, culturally grounded approaches), time (how has it evolved, future research), science of cities (multidisciplinarily, wicked problems, surprising researcher combinations for new innovative ideas), and lively multistakeholder–research–innovation–nexus (city–industry–academia) collaboration.

The main research question is interested in understanding the operational part of smart city research, that is, which are the actual research groups globally dealing with the concept and what are their disciplinary focus areas. The academic literature so far has focused too much on defining smart city as a phenomenon, resulting in quite a fuzzy outcome without any robust consensus on the concept. On the other hand, the literature lacks a systematic overview of who are the actual smart city research actors. Understanding these actors can help to reason the smart city as a concept and therefore contribute to the smart city literature. That is, smart city research can be conceptualised by understanding what smart city researchers actually do. As a sub research question, this paper addresses the general definition of a smart city: What is the concept and definition of a smart city? We acknowledge that such an overarching question is a broad and bold endeavour, particularly as our interest goes beyond keyword-specific research based on papers that label themselves under the domain of smart cities.

The aim of this study is to review the smart city as an evolving and broadening theme and map it with smart city-related research groups in different urban data and technologies centres globally. There are different approaches to smart and sustainable cities in different regions ranging from planned cities in Asia to co-creative ones in Europe. This paper identifies conceptual and operational characteristics for a smart city centre with combined international and regional impact. To do so, first, we perform a literature review of smart city as a keyword domain; second, we map this with established academic centres that work on SC. Thus, one contribution of the paper is an updated list of smart city research groups globally, including identification of respective themes and approaches (i.e. overview of academic centres and research groups). Furthermore, this paper provides an overview of what kind of research relates to smart city research, independent from the thematic label, and introduces a research and innovation agenda for a novel smart city centre. The practical aim of the paper is to use the learnings in the forming of a recently founded smart city centre of excellence with a significant grant funding from the European Union, not to mention the considerations of the future orientation of the centre.

The rest of this paper is structured as follows. The next section presents a review of the relevant literature on smart cities, bringing some definitions, approaches, and models. Afterwards, how this study was performed is explained. The results section shows the centres dealing with smart city-related themes. Furthermore, the in-depth case study of the FinEst Centre for Smart Cities, a rather recently established centre, is presented. The last section brings theoretical and practical implications and final considerations.

2. Literature review: smart city concept and its models

Since the origin of the explicit smart city literature, several conceptions of smart city have emerged, varying according to the main 'smart' characteristics (Caragliu and Del Bo 2020). A smart city strategy involves application of technology in order to

- improve environmental quality in urban space, reducing CO_2 emissions, traffic, and waste;
- optimise energy consumption, by building efficiency and renewable energy production; and
- increase quality of life, delivering better public and private services, such as local public transport, health services, and so on (Dameri and Cocchia 2013).

From that perspective it is no wonder that a strong critique of this technology-centric vision emerged with the publication by Hollands (2008) 'Will the real smart city please stand up?'. The heavily business-driven and deterministic approach to city making was also refuted by several other academics (Neirotti et al. 2014; Söderström, Paasche, and Klauser 2014).

The first smart city definitions were focused on the technology perspective. Technology can be seen as an enabling force for the development of new forms of intelligence and collaboration to advance the problem-solving aptitude of the city (Angelidou et al., 2018). However, recent definitions are no longer limited to information and communication technology (ICT) diffusion, being shifted more towards people and community needs (Albino, Berardi, and Dangelico 2015). Table 1 shows smart city definitions from highly cited references from different years, based on a keyword search ('smart cit*') on Web of Science and Scopus. In addition, it coupled with the back and forward method (Webster and Watson 2002) to select other relevant literature.

As seen in the examples in Table 1, a new league of smart city definitions has surfaced over the last decade (c. 2010–2020) with an emphasis on creativity, human capital, education and learning, social inclusion, and governance. In addition, it highlights the need of multiple actors and partnerships for innovation (Ferraris, Santoro, and Pellicelli 2020). With the diversification of the underlying foundations of the smart city concept, the meaning of the label itself has become fuzzy and is used in ways that are inconsistent (Praharaj and Han 2019). Likewise, there are different approaches related to the smart cities discourse (Komninos and Mora 2018). For instance, on one hand, the technology-driven approach indicates that the deployment of digital technology improves the quality of life, whereas on the other hand the human-driven approach endorses the key role of human capital and citizen skills (Kummitha and Crutzen 2017). Moreover, the planning of a smart city initiative can be top-down or bottom-up (Komninos and Mora 2018). This could be simplified by organising the definitions in Table 1 based on their emphasis on top-down (Top-down) or bottom-up (Bot-up) approaches, and technology (Tech) vs. human emphasis (Hum) – keeping in mind that human emphasis means here a mere notion of human capital or citizen skills (Komninos and Mora 2018). It can be seen that a technology-oriented bottom-up approach is missing or at least weaker than the other three. This observation has

Table 1. Smart city definitions and approaches.

Smart city definition	Reference	Approach			
		Top-down + Tech	Top-down + Hum	Bot-up + Tech	Bot-up + Hum
The vision of 'Smart Cities' is the urban centre of the future, made safe, secure environmentally green, and efficient because all structures – whether for power, water, transportation, etc., are designed, constructed, and maintained making use of advanced, integrated materials, sensors, electronics, and networks which are interfaced with computerised systems comprised of databases, tracking, and decision-making algorithms.	(Hall et al. 2000, 1)	x			
A smart city is a city well performing in a forward-looking way in these six characteristics [economy, people, governance, mobility, environment, and living], built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens.	(Giffinger et al. 2007, 11)				x
A city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.	(Caragliu, Del Bo, and Nijkamp 2011)				x
A city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies.	(M. Batty et al. 2012)	x			
A smart city is defined with the meaning of smartness penetrating the urban context, the role of technologies in making a city smarter, and focal domain (infrastructures and services) that need to be smarter.	(Nam and Pardo 2014, p. S2)	x			
As a concept, SC is described in various ways, but a general definition involves the implementation and deployment of information and communication technology (ICT) infrastructures to support social and urban growth through improving the economy, citizens' involvement and government efficiency.	(Yeh 2017, 556)		x		
Smart cities stand for an idea of where the city wants to be in the future and how it imagines itself transformed by taking advantage of the capabilities of digital technology and innovation networks.	(Angelidou et al., 2018)	x			
A smart city not only includes the application of ICT in its infrastructure but also has the capacity to integrate people, information, and technology in building an efficient, sustainable, and resilient infrastructure that provides high-quality services and promotes the quality of life of its residents.	(Wu and Chen 2019, 2)		x		

something to do with the general requirement of *people first* in smart city discussions that started around 2005.

There is also a strong consensus of the fact that smart city discussion is very scattered and the work of defining and conceptualising it is still in progress (Albino, Berardi, and Dangelico 2015; Cocchia and Dameri 2016; Dameri and Cocchia 2013; Fernandez-Anez 2016; Mora, Bolici, and Deakin 2017; Ojo, Dzhusupova, and Curry 2016). There is a plethora of very different academic formulations of the smart city concept. Actually, the style of those formulations could be called more description than definition.

The language game of smart city (Praharaj and Han 2019), or to be more precise, *labelling* games and fuzziness of the definitions, can also be interpreted to arise partly from the belief that technical solutions would be all we need to mitigate urban problems

in a smart city. However, when the later smart city discussions have enlarged from technical niches to fields such as social capital, everyday-life and governance, settings to be solved and needed toolboxes have of course become more complicated.

Instead of trying to formulate one more definition of the concept of smart city, the discomfort could be alleviated by the statement of Giffinger and Lü (2015, 12) that actually all corresponding strategic discussions and efforts are more or less focusing on three core dimensions, introduced by Nam and Pardo (2011):

(1) *Technology* and its mediated services making infrastructure more efficient;
(2) *People* in the context of social learning for strengthening human infrastructure and collective decision-making;
(3) *Institutions* in the modified context of governance for institutional improvements and the citizens' engagement.

To put it even more concise, ' . . . the concept of "Smart City" is evolving as a specific approach to mitigate and remedy current urban problems between urban competitiveness and sustainability' (Giffinger and Lü 2015).

When shifting from conceptualisation challenges to academic spread, Mora, Bolici, and Deakin (2017) have collected bibliographical statistics from over 1000 English publications and so-called grey literature, published 1992–2012 and having words *smart city* or *smart cities* in title, abstract, or in a keyword list. They also calculated the shares of citations the collected publications got during the period. Until 2002 writings done by American universities – typically in collaboration with corporates and consultant companies, especially IBM and Forrester Research, ruled the statistics of publications – and citations (IBM got 9% of total amount of citations). The subjects of their writings were dominated by technical solutions with rather narrow scope. Also, publications or citations from Asia, mostly Japan (Hitachi) and India (Tata group), were rather corporate-driven, although being not very influential among smart city literature (0.82% of total amount of citations). From 2002 onwards, especially from 2008 to 2010 on, European universities and more holistic scopes of smart cities really took off. Their study showed Europe as the main contributor to the smart city research as 52% of source documents were produced by organisations located in Europe and they had the greatest impact; then North America also had a great contribution (16.6% of production and 24.4 of citations), whereas Asia had a good contribution (23.3%) but smaller (10.3%) impact (Mora, Bolici, and Deakin 2017).

The amount of the academic European activity, from the end of the first decade of the twenty-first century, also made the whole smart city discussion to grow more than 10 times bigger than it was a couple of decades earlier. Respectively, the amount of smart city researchers grew during the same period from less than 200 people to a community ten times larger (Mora, Bolici, and Deakin 2017). The community is probably even bigger than that, since the environmental reasons. Around 2010, there was a rise in popularity of the smart city concept (or its near equivalents) also as a top-level political initiative. During 2009, in addition to smart cities, the need to build the actual ecologically healthy cities (Eco-Cities) got general top-level political awareness in France and in the UK. Even more effective eco-city projects started in Abu Dhabi and in China (Joss 2010). Consequently, since 2010 the European Union has used 'smart' to

qualify sustainability projects and actions in the urban space (Dameri and Cocchia 2013), as for example, the programme *Smart Cities and Communities* from 2012. This has enormously expanded the usage of 'smart' among the academics and the urban developers who use European English as their professional language.

2.1 *Two smart city models*

The fuzziness between how smart city is defined in the literature versus what researchers are doing has a mutual share of two models: 'planned tech-oriented cities' versus 'improving the existing ones'. Whichever way the smart city concept is understood and implemented in different parts of the globe, it is always heavily connected to local political, cultural, and living condition, as is noted in the following two main models.

2.1.1 *Model 1: planned pop-up techno-cities*

While the idea of a city is rather mature in the US and European Union, there are not many opportunities for total technology-driven cities (techno-cities) in the Western countries. An enforcing exception to the rule is PlanIT valley that was about to be built in Portugal during the early 2010s but ceased because of funding problems. The most recent cases also show that the privatisation of cities is happening in very focused topics and in very small-scale pilots, for example, Volkswagen electrifying the transport modes of the little Greek Island, Astypalean.[1]

Due to global urbanization, a demand for creating smart cities has emerged, including in populated countries like India and China. The volume of people moving to cities is huge, and urban administrations cannot handle all social and infrastructural problems arising from this, partly semi-legal, intra-national migrancy. Furthermore, the rapid economic growth in China has caused environmental disasters, hence the term eco-city instead of smart city. The national solution for these problems has been to give cities greater independence from the national government (Caprotti and Romanowicz 2013).

Globally, it seems that Asian (and Arabian) countries are using a variety of smart city concepts as an accelerated possibility to modernise their cities. In practice that means how to cope with very rapid urbanisation, environmental and especially urban air and water quality problems. The implementation of these aims is heading quite precisely towards the way the existing Western cities are organised. These kinds of 'pop-up techno-cities' are not just trying to reach European basic-level conditions, they are also utilising Western urban planning ideologies such as modernism and even futurism, more precisely, Howardian Garden city, Le Corbusian/Futuristic and modernist techno-city, panoptic control rooms, and city dashboards. Conceptually, they are combinations of futuristic technocratic solutions and mid-twentieth-century idea of a city that all functionalities can be planned. It is no wonder that the general *ideals and models* of pop-up techno-cities in Asia and Arabia are rooted in Western urban ideals since typically the Western companies and even public administrations are strongly involved in those projects. Although some of the most challenging projects have failed because of high-level political and funding issues, many of them really are finalising – probably faster than any Western infrastructural large-scale project. However, the amount of people and companies is lagging far behind from the originally planned

figures. For example, the national flagship development Tianjin has – 10 years after the beginning of the project – a gross 100,000 residents, although the plan was 350,000. More successful case, technically, was South Korean Songdo, located near Incheon airport and 60 km from the capital city Seoul. From the European perspective, the above-described model of a smart city raises several questions. First, what is actually a city? Can it be simply the physical buildings, streets, and other technical infrastructure? Furthermore, a smaller version of the Asian pop-up techno-cities, Masdar city in the United Arab Emirates, near Abu Dhabi, already has urban structure, sun and wind power heavily utilised in air conditioning and electricity systems, and in the electric bus system, etc. However, the number of residents and companies is lagging heavily behind the planned figures – some thousand residents combined, only.

One bundle of reasons is the strong emphasis on supply-based technology and city-level efficiency, instead of the actual liveability and sociability among human beings. Tianjin was built on formerly toxic wasteland – not a very enticing fact for those who can choose where to live. More concretely, the newly constructed residential buildings in these – supposedly – apolitical eco-cities are so expensive that only upper-middle-class people can afford them. That is quite challenging in countries with high percentage of poor, some amount of elite, but very thin middle classes.

2.1.2 *Model 2: improving the smartness and governance of existing cities*

When demographical, cultural, and social issues are not solved, but their types and volumes are more or less matured, there is also a smart city concept related to those conditions. Smartness is only added and developed to existing infrastructural and social structure. This kind of exchange happens between Europe and Northern America. The concept of smart city can be seen boosted by the American academics' admiration of the European type of urban planning that takes the development of existing – European – cities and their social structure as a starting point.

The development process is typically such that public authorities of a city, perhaps supported by some national resources, are enabling, encouraging, or even procuring new services or functions to be created by private sector. Instead of providing covering public funding, the public resources are used to reformulate regulations, technical platforms, data hubs, Research & Innovation (R&I) programmes, or a combination of those. Thus, existing cities are only improved by the new, say, ICT services and governance practices.

The most important urban subsystems in the European smart city discussions, and, rankings, have been sustainability in energy and carbon savings, and especially in the transport system, for example, innovations in public transport, or in car-sharing and bicycling. This ranking interest is actually an important activity in European and North American smart city discussions. It promotes the cities, that is, shows that these cities are worth investments, in other words willing to have new jobs, new taxpayers, and new tourists. However, on a more abstract level we could also say that the phenomenon of these lists is a way of pondering the real, or at least most successful concept of the smart city.

According to Manville et al. (2014) who surveyed all European cities having population more than 100,000, virtually all Nordic Member State cities can be characterised as smart cities, as can most cities in Italy, Austria and the Netherlands, and approximately

half of British, Spanish and French cities. Germany and Poland have relatively few smart cities. Eastern European countries generally have a lower incidence of smart cities than the rest of EU-28' (Manville et al. 2014, 38). National or international smart city initiatives, having typically some kind of an environmental angle, are heavily funded by the European Commission (Manville et al. 2014).

In Europe, also big IT companies, such as IBM, Cisco, and Siemens, offer their remarkable legacy, resources, and practical products for the public planning, to an extent even *pro bono* in early phase planning. However, in Europe there are planning traditions and laws demanding local people to be invited into the societal, or local, discussions, especially so in the Nordic countries. A growing topic in European smart city discussions is the inclusion of citizens. One emerging example of that is the way personal data is supposed to be handled in the West. Compared to Asia this really makes a difference, having a dramatically different idea of individual rights and personal data. However, European democracy makes the decision-making process much slower than in Asia or Arabian countries. We can safely assume that it is precisely this cultural difference that pushes Western companies to offer their planning and implementation services for grateful governments in Asia, India, and Arabian countries.

3. Understanding smart cities through the lenses of research

Previous projects have shown that some public governments lack capacities to accelerate development of smart cities (Ardito et al. 2019; Ferraris, Santoro, and Pellicelli 2020), and for this to happen, it is important to involve different stakeholders. As a part of the 2010s' social and human intervention to formerly very techno-oriented smart city discussions, management studies and multistakeholder approach are offering a perspective that is relevant when positioning academic units related to the concept.

The concept of triple helix (e.g. Etzkowitz and Leydesdorff 1997) emphasises the collaboration between state, company, and university. Especially thinking of tech-oriented smart city projects, usually the initiative is 'driven and guided by public governments or Multinational Enterprises (MNEs), while the coordination is often multistakeholder driven and followed by university team's engagement' (Ferraris, Belyaeva, and Bresciani 2020, 165).

According to Ferraris, Belyaeva, and Bresciani (2020), the recent trend of smart innovation should be seen also from the multistakeholder dimension. It is important to understand the 'cause and consequence of stakeholder relationships and interactions in a network, as a stakeholders' causal scope' (Shams 2016, 676) to be able to generate sustainable innovations (Ferraris, Belyaeva, and Bresciani 2020). Thus, university can play an enhanced role in innovation in smart cities and in increasingly knowledge-based societies, acting not only as technology and knowledge transfer favouring the economic development but also operating as an intermediary and facilitator between the other components of the ecosystem in multi- and interdisciplinary ways (Del Giudice, Carayannis, and Maggioni 2017).

Since it is hard to capture the volume and certain vagueness of academic research on smart cities, and the actual implications in cities, one way to understand the smart city movement is to look at the most important sources of smart city research, the research groups, and centres around the world. Using a qualitative method based on expert

analysis of secondary data, first we mapped global research groups that work within the research domain of smart cities and identified the main academic centres dealing with urban informatics, smart cities, big data, and related fields. Since we are interested in more consolidated research units, we involved centres that have been in place over 5 years with minimum amount of around half-dozen researchers involved. The initial list of the centres derived from a report to the UK Economic and Social Research Council Cities Expert Group (Batty 2013), slightly updated by Townsend (2015). In our approach, we mapped and introduced these research groups, focusing on the ones that were active as of May 2021. Thus, this part of our study is based on the authors' internal evaluation with involvement of a global key expert in this field (Michael Batty from UCL-CASA) and detailed analysis of secondary data such as web pages.

The second part is an in-depth case study of the FinEst Centre for Smart Cities, a rather recently established centre that has been selected as it has a substantial research agenda and is one of the rare ones which is actually labelled as a smart city research centre. In this part, we studied the research and innovation agenda of this centre. In total, more than 40% smart city publications (out of a pool of over 100) were analysed with an overview of how large-scale research-based smart city pilots are planned and implemented. The aim of the FinEst Centre is to initiate long-term smart city research and innovation activities in collaboration with technology universities in Estonia and Finland, Estonian Ministry of Economic Affairs and Communications and Forum Virium Helsinki. The FinEst Centre is organised around five streams – Smart Mobility, Smart Energy, and the Built Environment – tied together by streams of Urban Analytics and Data, and Smart City Governance (Soe 2017). The FinEst Centre was initiated in December 2019 when it received 32 million euros 8-year start-up grant from the European Commission and Estonian Government to set up an independent smart city research and innovation centre.

4. Results: centres dealing with smart city-related themes

The first part of this section introduces and discusses the mapping of smart city-related centres. The second part is devoted to the in-depth case study of the FinEst Centre for Smart Cities.

4.1 *Overview of centres dealing with smart city-related themes*

By 2010, a small number of smart cities centres (in need of a better term) had been established to pursue an agenda related, first and foremost, to big data, real-time sensing, new forms of automation, as well as informing much of the science that had been developed for cities so far. As an example, the Centre for Advanced Spatial Analysis (CASA) has slowly moved towards this area as it began as a GIS centre, set up in UCL in 1995, as a group that could research geographic information systems and spatial analysis, but always with a strong city focus, their vision is to play a central role in the approach they call *science of cities*. CASA is less geared to computer science and more to urban applications. In contrast, the Senseable Cities Lab was set up in 2004 in the Department of Urban Studies and Planning (DUSP) at MIT, and its focus has been on networks and big data pertaining to streets and transport systems as well as

extending into a variety of simulations of mobility. The Media Lab, also at MIT, has to some extent been at the forefront of smart cities research since it was founded, in 1985, with several groups dealing with cities in terms of media, energy, visualisation, and design.

In 2005 and 2006, two other significant centres were founded, showing the range of interest in smart cities at this point: the Urban Scaling group at the Santa Fe Institute (SFI) and the Urban Informatics research lab at the Queensland University of Technology (QUT). The Santa Fe Institute, which was founded in 1984 as the first research institute dedicated to the study of complex adaptive systems, created in 2005 the *Cities, Scaling and Sustainability* research group with an interdisciplinary approach and quantitative synthesis of organisational and dynamical aspects of human social organisations, with an emphasis on cities. The work at Santa Fe continues, and there are strong links there to several areas of the social and policy sciences that take complexity theory and apply it to urban questions. While the QUT Urban Informatics group was created in 2006 and is more involved in the study, design, and practice of urban experiences across different urban contexts.

Since roughly 2010, the focus on smart cities has emerged; once smartphones became the dominant way in which individuals began to capture and manipulate their personal data, many centres have been set up to progress research on the types we have alluded to in the above discussion. Chief amongst the centres in terms of size are those in Chicago and in New York. The Urban Center for Computation and Data (Urban CCD), created in 2012 in Chicago, came from computer science and is strongly concerned with big data, sensing, and the development of projects involved in real-time streaming. Recently the urban science initiative at the University of Chicago, which is based on the Mansueto Institute for Urban Innovation, has joined Urban CCD while the Center for Spatial Data Science is also linked. Thus, the centre has also been getting involved in wider urban science issues. This seems to be a feature of all the centres. Although they may begin in one area, they tend to expand their focus, or at least be sympathetic to other disciplinary domains. This is important to provide a good context to smart city research and many centres appear to recognise it.

In fact, we can date the genesis of what we are calling here smart cities research centres with the Bloomberg Challenge which was set up in 2010–2011 to attract science centres to New York City, two of which subsequently became smart cities foci, namely the Center for Urban Science and Progress (CUSP) in NYU which begun in 2012, and Cornell Tech, which took longer to become established and opened in 2017. CUSP has also been limited by the fact that in NYU there are other programmes, in particular the Wagner School of Public Policy and at the Marron Institute which is much more focussed on the growth of cities. On the other hand, CUSP has also clones in England at Kings College and Warwick University.

There are three other groups that are significant in size. In the UK, there is the Urban Big Data Centre in the University of Glasgow (UBDC), jointly funded by the Economic and Social Research Council (ESRC) in 2014. UBDC is based at the University of Glasgow, but the centre has associates at University of Illinois at Chicago, University of Bristol, University of Edinburgh, University of Reading, University of Sheffield, and University of Cambridge. Their focus is primarily on assembling and integrating big data that pertains to cities, but there are a variety of projects involving urban science,

transportation, and the wider issues of privacy in data for smart cities. UBDC's key research strands are urban impacts of COVID-19; education and skills; housing and neighbourhoods; transport and infrastructure; and urban governance. In the University of Edinburgh, the Edinburgh Futures Institute is based more on digital humanities than on digital cities, but there are several important themes that relate to innovative uses of computers in cities.

There are a few significant centres funded from scratch which focus on urban science, the governance of smart cities, questions of big data, and issues such as mobility. The National University of Ireland's Programmable City Group at Maynooth has perhaps the strongest links from smart cities technologies to urban social and spatial structure and how this map into governance. This is a centre set up from scratch with European Research Council funding, and it runs alongside the National Centre for Geocomputation at Maynooth. Nevertheless, the groups are working with the City of Dublin on various technical problems involving dashboards and control systems.

A centre founded in 2015 is the Imperial College's Urban Systems Lab (USL) which has grown out of various initiatives devoted to urban transportation planning and energy studies. This centre has eight thematic research areas including low carbon operation and resource efficiency; resilience and adaptability; systemic quality of service; sensing, simulation, and modelling; economic performance; advanced materials and processes; health, well-being and quality of life; and business models and innovation. Another one is the ETH Zurich Future Cities Lab located at the National University of Singapore (note that the Senseable Cities also have a presence in the same location as part of the SMART Programme). The ETH Future Cities Lab has moved into a new phase (Future Cities II) with more emphasis on building, energy, sustainability, and regeneration with more focus on mobility.

Noting other initiatives in academia that not only cover smart cities but extend to spatial analysis, modelling, and other features of urban research, in Australia, there are two significant initiatives besides the previously mentioned QUT Group. These are at the University of New South Wales (UNSW) City Futures Research Centre, created in 2005, and there is the longer-standing group at the University of Wollongong, the SMART Infrastructure Facility, which brings together experts from fields such as rail, infrastructure systems, transport, water, energy, economics, modelling, and simulation, providing 30 state-of-the-art laboratories to facilitate this important research.

In continental Europe, several groups have emerged a little more slowly than those in the Anglo-American countries. In particular, the effort begun in Amsterdam in 2015. The AMS Amsterdam Institute for Advanced Metropolitan Solutions was cloned from and is linked to the Senseable Cities Lab at MIT and has fairly similar projects involving mobility, autonomous vehicles, as well as being developed on a background of geospatial and building technologies. The centre involves a partnership with Universities of Delft, Wageningen, Amsterdam, and Eindhoven. Eindhoven and Delft have substantial presence in the built environment, digital governance, and transport areas. A related development is at the Open University of the Netherlands that seems to build on various regional science initiatives. In Switzerland at ETH and Lausanne, there are various groups.

In Spain, there are several new approaches to urban planning based on smart cities. The municipality of Barcelona is iconic in that not only is the city labelled as being smart – it also provides resources to research itself. There are also a set of groups in urban science, such as those in Palma de Majorca, and there are some groups in transport modelling. In Austria, there is the Institute of Spatial Planning in Vienna at TU Wien. In Italy, there are some groups in Rome, Bologna, Torino, Milano, and Brindisi. What this overview shows is that there is a vast array of groups who deal with cities and are sympathetic to smart cities technologies, big data, and modelling, but do not specifically see themselves as smart cities centres per se. Furthermore, several e-government research groups working in the cross-field between public administration and Computer Science research have entered the field of smart cities. For example, the United Nations University's Operation Unit on Policy-Driven Electronic Governance (UNU-EGOV) based in Guimarães, Portugal.

In Germany, there do not seem to be any distinctive centres as such because the focus on cities is more social and policy-driven and what effort there is on smart cities is related to tech and business models for automating cities. There is a large German effort in this area which is ongoing but does not seem to be linked to academia.[2] In France, there are some powerful urban science groups centred around the Cities group at the Sorbonne and Barthelemy's group at Institut de Physique Theorique (CEA) and Centre d'Analyse et de Mathematique Sociales (EHESS). In addition, UrbanAI group is in the vanguard of a dedicated initiative dealing with big data and AI.

In East Asia, there are a variety of initiatives in China and Japan, but these are harder to identify as they do not seem to be very focal centres. There are many initiatives and centres for smart cities research in China, and all the key universities have a presence. If we begin with Hong Kong, at the Chinese University there is the GIS centre which is university wide and ranges from remote sensing to transportation, while this is also an Institute for the Future Cities which draws together a range of technologies and applications wider than smart cities *per se* but include them. A new Smart Cities Institute has been formed during the last two years in the Hong Kong Polytechnic University with strong focus on big data, visualisation, urban informatics, and various kinds of sensing. In mainland China, there are almost too many smart cities initiatives to define, but the academic centres that stand out are the Beijing City Lab which is attached to Tsinghua University and the spatial mobility group in Peking University. In Japan, there is a country-wide GIS network which is based on the Centre for Spatial Information Science in the University of Tokyo, and this has been in existence since the late 1980s. This embraces urban informatics and well as GIS and now big data and various types of analytics. It is in fact quite strongly orientated towards urban planning and policy.

In North America, we have already mentioned research groups at NYU, and in Chicago, but there is a cluster of groups in Boston based on the strong focus there on media and networks. In addition, in New York, there is a presence of sorts at Columbia University centred around Urban Planning and Computer Science although these appear to be somewhat separate, and the urban lab has changed its focus to a Center for Spatial Research. The data science focus is within a programme dealing with big data, and it is badged as smart cities, but it is important to see the effort in perspective. There are other institutes in Columbia such as the Earth Institute which have significant

links to smart cities research, in particular, and cities research, more generally. The City University of New York has a transportation centre while the Geography Department at Hunter College in CUNY has a long-standing interest in GIS and urban modelling. In addition, there is a Smart Cities Smart Government Research – Practice Consortium as a part of the Center for Technology in Government (CTG) – University at Albany, State University of New York. There do not seem to be strong groups in Los Angeles, but there are various research centres such as that at Oak Ridge on Urban Dynamics that are beginning to populate the smart cities space. At Harvard too, there are several initiatives in cities, and it is worth noting that in the US there is extensive interest and research into the digital economy, its organisation, questions of data and copyright, and IPR all of which are key to thinking about the implications of data streaming and sensing in smart cities. There are many other initiatives in the US, but most of these are focussed on transportation centres that are quite well developed and in geospatial centres that are associated more directly with spatial analysis, spatial statistics, GIS, and quantitative geography, all loosely defined as geospatial analysis. In South America, there is interest from GIS and transportation groups, but so far we have not identified any major centres. Of course, this survey is very impressionistic and, in this sense, nowhere near complete. It merely provides a glance but not a definitive summary in any sense.

As we have argued throughout this paper, this is inevitably an incomplete snapshot in time with respect to the evolution of research centres involving smart cities. How a smart cities centre is developed depends on the local context, cognate areas in other departments, and of course funding. Very few centres have been set up directly, but those that have appear to have worked better than looser associations of already established interests. A more comprehensive table of academic centres and institutes dealing with smart cities-related themes is available in Appendix A, including the location of the centre, brief description, and website links. Some of them are more like research institutes, a few of them are labelled as centre of excellence.

We argue here that what is needed as a next step is a more detailed worldwide review of larger initiatives. Last but not least, we need to consider how the ideas might impact on the grand challenges noted above, in terms of the way climate change, ageing, inclusion, energy, housing, health, mobility, the future of work, and education and learning all impinge on the ways in which we can make our cities smart. These in themselves pose challenges that any new centre needs to address as it develops, especially how to make interconnections between different disciplines in facing these actual challenges of cities globally.

4.2 *A case of FinEst Centre for Smart Cities*

One of the core ideas of mapping other smart city centres globally in the previous section is to learn how to set up new ones. This is the case of FinEst Centre that has been established in December of 2019, enabling rather multi-topic academic activities combined with versatile innovation projects with cities, companies, and other stakeholders. The centre has been initiated under the substantial European Unions's strategic H2020 program's *Spreading Excellence and Widening Participation* call for *Teaming* projects. Thus, the FinEst Centre draws from knowledge transfer from the more

developed Finnish R&I culture to the rapidly developing Estonian R&I culture. As a joint effort, the FinEst Centre involves approximately 40 researchers from the two technology universities in Estonia and Finland.

The FinEst Centre has five academic domains (Governance, Data, Built Environment, Mobility, and Energy) that are covering the identified and timely smart city topics. Each domain (stream) involves researchers from two technology universities in Estonia and Finland, some working directly at the FinEst Centre whereas most of them being affiliated to the centre via affiliation structure.

4.2.1 *Overview of FinEst Centre research performed*

Academic research and publishing is often done in siloed disciplines. However, within smart city studies, even paradigmatically different academic domains can find common ground and lots of explicit synergies through discipline-agnostic challenges from real-life surroundings. The FinEst Centre researchers have published over 100 publications during the first and half operative year. This indicates good opportunities for multi-disciplinary research. For instance, urban lightning is studied in the Built Environment stream (BE) as a source of urban light pollution. In Smart Governance (Gov), the lightning of public places in cities is a matter of public procurement. Furthermore, urban public lightning is also a technical platform for local WLAN connections, data, and electric power, which makes the public urban lightning not just a Smart Energy issue but also an Internet of Things (IoT) matter for the Urban Analytics & Data stream (Data). The potential content, paradigmatic orientation, and potential data types of those five domains are depicted in Table 2.

The IoT topics are handled in the published papers so far by Data from the perspectives of fault-tolerant frameworks, thinking especially of their security and resilience issues. One of the main concerns of the IoT-related studies is the interoperability and standards for different systems. Methodological focus has been in software engineering addressing agile software development methods in conjunction with Development-Operations (DevOps).

IoT is utilised in Mobility context as different communication relations between (physical and informative) infrastructure, vehicle, and (energy) grid. In the published papers, the studied relations are mostly that of Vehicle-to-Infrastructure, Vehicle-to-Grid, and Infrastructure-to-Infrastructure, not to mention human understandings of them. Data and IoT perspectives are central also in machine learning, in the papers related to self-driving vehicles – and the human understandings of the Self-driving Vehicles (e.g. Soe and Müür 2020).

Potential threats of Mobility-as-as Service (MaaS) concept are strongly Governance issues, in Mobility critics of MaaS, since this concept simply requires national laws, priorities of public authorities, and capitalistic business logics to be changed, to make it successful. Mobility is also referring to a democratic knowledge transfer when handling the relation of urban planning and transport issues. This public participation is in the strong interest of BE that has developed a data collection method called Public Participation Geographic Information System (PPGIS) to enable to collect systematically experiences of people in certain geographical spots and areas. BE studies not just humans (such as how social media is affecting urban planning) but also larger biodiversity.

Table 2. Main tasks and aims of the five research streams of the FinEst Centre.

Stream	Smart City Governance		
Expected to do	Study and develop holistic theories and models of urban governance, new data frames for the substance streams (Smart Mobility, Smart Energy, Built Environment)		
Paradigmatic orientation	From narrow techno-orientation to broader holism		
Potential sources and subjects of data	Theories/models of city-led innovations, sustainable transitions, citizen-government co-production, cross-border frameworks		
Stream	**Smart Mobility**	**Smart Energy**	**Built Environment**
Expected to do	Domain-specific data production, based on substantial understanding of public policies, value networks and business models, etc., that would enable the actual data streams		
Paradigmatic orientation	From modes of transport to urban mobility system(s)	From centralised energy supply to smart grids and local demand management	From human-oriented to life-oriented urban planning
Potential sources and subjects of data	*Humans in cars, transit, last mile, cross-border *Cargo in different vehicles *Self-driving vehicles in interactions with infrastructure, other vehicles, etc.	*District heating/cooling *Energy flows in nearly Zero-Energy Buildings *Local energy production *Market prices	*Lightning and outdoor conditions *Experienced quality of built environment *Co-created scenarios *Biodiversity and green infra *Collaborative urban planning processes
Stream	**Urban Analytics & Data**		
Expected to do	System of Systems (different stakeholders' systems can interchange data through standardised APIs so that both ends understands data similarly)		
Paradigmatic orientation	Enabling working Internet of Things systems through standardisation, harmonisation, and realistic business models		
Potential sources and subjects of data	Data harmonisation [semantic and syntactic interoperability, visualisations of data flows, APIs, widgets, security, authentication and billing function, new revelations of IoT functions and processes, and cross-border urban data platform (shared between Helsinki and Tallinn)]		

Energy papers are rather focused, but more broadly taken they can be divided into consumption and production of energy. Their main idea is to study (and support) new flexible and dispersed ways of energy production that would react smoothly to changing demand, instead of the traditional model of monolithic energy production that is all then consumed. The consumption side deals mostly with metering 'buildings', especially 'nearly zero emission buildings' heating, geothermal aspects, and ventilation. Production-side emphasis is in demand-based, smaller-scale, microgrid production. However, they also note that currently renewable energy sources still need nuclear power production as a levelling function.

Former and current research topics are of course the background of deep academic research also in smart city studies. However, in over 50 grant proposals FinEst Centre researchers have done during their first and half year, one can see several extensions. One extension is that of geographical. From the European smart city, the current smart city knowledge is planned to be transfered to Africa, rural European areas, or to Southeastern Asia. Another extension is topical, towards healthiness in cities. Third is mostly within the mobility, including the governance of urban airspace (drones), experience of urban tourists, climate change, last mile issues, and artificial intelligence. The last one is common also with Energy that proposes AI to be used also when studying digital twins. Climate change, energy consumption, and carbon neutrality are

also connected to master's degree education that would then concentrate on smart cities. Last but not least, digital resilience of smart cities is one new topic in the proposals.

4.2.2 *Urban challenge-based experiential pilots*

On one hand, efficient academic research is conducted within silos, as seen above where the five academic domains were organised into five respective research streams. On the other hand, these silos should be able to collaborate, especially when approaching practical problems of cities. An example of how the FinEst Centre is approaching the problems arising from cities is handled in Figure 1.

The FinEst Centre conducts a significant part of its research via large-scale experimental pilots, whereas a pilot is defined as the process of developing a new knowledge-based solution to an urban challenge. Pilots are focused on finding solutions in one of the streams or combining different streams. This approach goes beyond academic specialisations as pilots are exclusively urban challenges triggered based on the input received from local governments in Estonia. The aim of the large-scale pilots is to prototype research-based solutions especially for small- and medium-size cities around the world. The promotion of demonstration projects as pilots and living labs are recommended as a way to help reducing stakeholder issues concerning the implementation of innovative smart city projects (Ferraris, Santoro, and Pellicelli 2020).

The first phase of the realisation of the Experimental Piloting Programme was the mapping of the future urban challenges. For this, 35 Estonian local governments were surveyed and interviewed in the summer of 2020 with a goal to identify and rank top 10 urban challenges that the municipalities are facing in 5–10 years within the domains of the FinEst Centre. These 10 challenges were decided upon in a consensus meeting with local government representatives in fall 2020.[3] The second phase of the pilot realisation was an open call for R&I ideas to the challenges determined and selected in the first phase. In total, 71 ideas were submitted out of which four were selected as large-scale pilots[4] in December 2020. It is important that the pilots have to face broadly agreed-upon future challenges of local governments and the idea proposal process of pilots is fully

Figure 1. Smart city piloting programme phases.

open and participatory to everybody globally. The selected R&I pilots are coordinated by a joint team of researchers and cities with each pilot implemented in at least two cities. Thus, the cities serve as experimental testbeds for research and innovation ideas.

5. Theoretical, practical implications, and final considerations

In this analytic review of existing smart city research, a mismatch between conceptualisation of smart city and actual smart city research is pointed out. Our literature review shows that there is no rigid research domain as 'smart city', there is only a broad discussion on how smart city could be defined without any clear consensus on that. The definition of smart city ranges from smart city seen as software-driven (e.g. Washburn and Sindhu For 2010), people-and-community needs driven (Albino, Berardi, and Dangelico 2015), to very broad integrative frameworks combining a variety of domains like economy, people, governance, mobility, environment, and living (e.g. Giffinger 2007). More recently, a concept has developed a wider idea, involving also climate-related goals (Caragliu and Del Bo 2020). Everything combined makes smart city now a multi-interdisciplinary concept involving close to everything related to city environment, from spatial technologies (e.g. GPS) and agriculture (vegetable-friendly cities).

A different picture can be drawn when analysing what kind of research smart city-related centres actually do (even when neglecting what kind of actual implications cities have: geographical and cultural, not to mention political issues lead to hugely different solutions in Western vs. Asian-Arabian cities). Thus, if it is difficult to define smart city research via concept itself, it can be achieved via analysing the research groups and centres labelled under the domain of smart cities. When grouping the centres in the fields of urban informatics, smart cities, big data, and related urban science, only half-dozen centres are focused on smart cities by their name. All other examples mapped, over 50 centres, do not pop up when using the keyword of smart city, although they make a significant contribution to the field. For example, the UCL-CASA that began as a GIS centre and was set up in 1995 as a group that focuses on geographic information systems and spatial analysis has a strong smart city focus. Similarly, the Senseable Cities Lab at MIT, the Urban Scaling group at the Santa Fe Institute, and the Urban Informatics research lab at the Queensland Institute of Technology clearly contribute to the field of smart cities research. Interestingly, few established centres have future cities in their name instead of using 'smart' (Future Cities Lab University of Strathclyde; Future Cities Lab: ETH Zurich Singapore Centre; Institute for Future Cities CUHK). Thus, smart city studies are not yet institutionalised, although they certainly form a movement, as Batty puts it (Batty 2020). In practice, according to a few follow-up meetings to this research project with selected smart city research units, research groups contributing smart city discussions only seldomly study smart city topics as their full-time job.

When zooming into one smart-city focused recently set up centre as a case study (FinEst Centre), we indicated that the centre conducts basic research and pilots that are usually not labelled under the smart city directly, at least not using the keywords. Our analysis of approximately 40 research papers claimed to be in the field of smart cities, indicating that these are mainly contributing to the smart city-relevant fields, such as transport, ICT, public administration, civil engineering, robotics, architecture,

environment, energy, etc. Similarly, none of the selected smart city large-scale research-based pilot ideas have smart city in their name. In many cases, the only smart city label comes from the affiliation, not by title nor abstract nor content. Interestingly, in the case of innovation-closer activities, performed via experimental smart city pilots, the research disciplines are in continuous mix. The FinEst Centre addresses its large-scale smart city pilots to the actual challenges of local governments that often are not interdisciplinary. In research and innovation centres, it is important to enable fruitful collaboration between rather steady academic discipline-silos and more rapidly changing urban challenges.

However, as the case of FinEst Centre shows, the research-driven university unit can also be the actual driver in smart city projects. In the context of triple helix model, it can initiate and provide projects that invite (even by making them to compete with each other) cities, companies, and people to participate. Especially small cities and companies having not much urban developing resources of their own are happy to participate. Bigger cities with multi-siloed urban development sectors are of course more complicated to collaborate with. Thus, even the mere facilitation from university is still needed. An interesting question is, what is the role of multinational companies in this kind of setting? Are they willing to participate even if they perhaps cannot convert the focus of the project as they wish but simply adopt it?

One of the limitations of this study is related to the dependence on the expert judgements (e.g. Michael Batty from UCL-CASA) and secondary data such as web-pages and internal documents of FinEst Centre. As a follow-up study, it would make sense to collect primary data from the selected centres listed in annex either in form of questionnaire and or interviews.

For future research, there is a need to dig further in understanding what kind of research is performed by researchers in the interplay of technology and urban environment, instead of applying mere keywords-basedanalysis. In the case of scientific research, the term 'smart' could be used as merely one alternative of many concepts dealing with technological dsevelopment of cities. The concept of smart city has not become more rigid from the scientific perspective over the past decade, rather the opposite. Cities have faced a significant digitalisation over the past years, and thus smart cities are not the future concept anymore but are slowly becoming a *de facto* reality. Thus, the borders between advanced cities and smart cities are getting blurrier – this is a somewhat similar but slower process than how landline phones and then analogue mobile phones have transferred into smartphones over the past three decades, making smartphones *de facto* standard.

Although the amount of research on the hype term *smart city* has been increased substantially, the literature still lacks an introduction to the core research and innovation agenda of the phenomena which was proposed in this paper. If critically analysed, most of the papers state that the concept of smart city is vague and there is no agreement on definition among scholars. This is fundamentally true – there is no absolute shift towards a theory as smart city. More than that, smart city is a movement that connects several urban technology researchers and practitioners. From the academic perspective, smart city is more like a glue that can combine different ideas from different disciplines under one very broad umbrella. Although the number of separate disciplines under the umbrella is big, the emphasis of them tends to be in

technology-oriented ones. This could be one of the reasons for the general public indifference against the concept of smart cities. Thus, more emphasis on severe societal, cultural, and economic approaches, especially which of critical consumer and critical technology studies, might improve the acceptance of smart city movement. Our findings also implicate that larger-scale smart city studies should not be organised as separate academic disciplines. Instead, they should be built on real-life problems, even the wicked ones. In practice, this means more interdisciplinary and more experimental approach to the development of smart cities.

Notes

1. https://www.volkswagenag.com/en/sustainability/engagement/smart-sustainable-island.html
2. https://www.kfw.de/stories/economy/innovation/smart-cities/
3. www.taltech.ee/en/smartcity
4. http://www.finesttwins.eu/projects

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Appendix A: a list of academic centres that have some focus on smart cities research

Centre	Web address	Location	Brief description	Established date
Urban Informatics Centre – Queensland University of Technology (QUT) Design Lab	https://research.qut.edu.au/designlab/groups/urban-informatics/	Australia – Brisbane	The Urban Informatics group in the QUT Design Lab examines, communicates, and designs responses to how people, place, and technology come together to create urban experiences. Urban informatics is the study, design, and practice of urban experiences across different urban contexts that are created by new opportunities of real-time, ubiquitous technology and the augmentation that mediates the physical and digital layers of people networks and urban infrastructures. The group was founded in 2006 by Professor Marcus Foth. Since then, we have rapidly evolved into an internationally leading research and development team.	2006
AURIN Program, University of Melbourne	http://aurin.org.au/	Australia – Melbourne	Established in June 2010, the Australian Urban Research Infrastructure Network (AURIN) is an initiative of the Australian Government under the National Collaborative Research Infrastructure Strategy (NCRIS) and associated programmes. We provide the data and tools to allow you to make evidence-based decisions quickly and confidently, and we can help you get in touch with world-leading urban experts right here in Australia. Themes: spatial data infrastructure and analytical methods for urban and regional research and planning, urban intelligence	2010

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Centre	Web address	Location	Brief description	Established date
City Futures Research Centre – University New South Wales (UNSW)	https://cityfutures.be.unsw.edu.au	Australia – Sydney	Based in the Faculty of the Built Environment at UNSW since 2005, the City Futures Research Centre has developed into a national leader in scholarly applied urban research. In 2012, the centre was assessed by the Australian Research Council as the only Australian university research concentration in urban planning and related research rated at level 5 – 'well above world standard'. Focus: urban analytics, housing, urban well being, urban data, decision support: They have the CityBlog, VityViz, CityDash, CidyData	2004
Smart Cities and Infrastructure Research Cluster (SCIC) – UNSW	https://www.be.unsw.edu.au/research-centres-and-clusters/smart-cities/about-us	Australia – Sydney	The Smart Cities and Infrastructure Cluster (SCIC) seeks to promote and advance the efficient design, planning, and delivery of urban environments, infrastructure, and properties through the use of spatially integrated information and smart technologies.	2014
SMART Infrastructure Facility – University of Wollongong Australia	http://smart.uow.edu.au/	Australia – Wollongong	Smart cities focus with respect to energy, transport, infrastructure, demography, social simulation, geomatics, but wider than cities. One of the largest research institutions in the world dedicated to helping governments and businesses better plan for the future, SMART brings together experts from fields such as rail, infrastructure systems, transport, water, energy, economics, and modelling and simulation, providing 30 state-of-the-art laboratories to facilitate this important research.	2009
Institute of Spatial Planning Vienna University of Technology	https://www.srf.tuwien.ac.at/start/EN/	Austria – Vienna	As part of the Institute for Spatial Planning at TU Wien, this research unit considers its responsibilities in two main areas: (1) theoretically and methodologically sound spatial research and corresponding approaches to solutions to political and planning challenges as well as (2) offering didactically clearly structured learning offers on theories and methods as well as on the assessment of planning strategies within an evidence-based understanding of planning.	2000

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Centre	Web address	Location	Brief description	Established date
Geneva UN Charter Centre of Excellence on Smart and Sustainable Cities in Vienna	https://www.oier.pro/global-programs/excellence-center/	Austria – Vienna	The UN Geneva Charter Centre of Excellence on Smart and Sustainable Cities, managed by the Organization for International Economic Relations (OiER), was established in 2018 as a global framework serving as a multistakeholder city/industry platform for active collaboration of the private, public, and finance sector, as well as cities and civil society, to co-act and implement innovative smart and sustainable urban solutions.	2018
Beijing City Lab (BCL)	http://www.beijingcitylab.com/members/	China – Beijing	The Beijing City Lab (BCL) is dedicating to studying, but not limited to, China's capital Beijing. The Lab focuses on employing interdisciplinary methods to quantify urban dynamics, generating new insights for urban planning and governance, and ultimately producing the science of cities required for sustainable urban development. The lab's current mix of planners, architects, geographers, economists, and policy analysts lends unique research strength.	2012
Institute of Space & Earth Information Science (IEIES) – The Chinese University of Hong Kong	www.iseis.cuhk.edu.hk/eng/	China – Hong Kong, Shatin	Institute of Space & Earth Information Science (ISEIS) was established in 2005. It was developed on the base of the Joint Laboratory for GeoInformation Science (JLGIS) of Chinese Academy of Sciences & The Chinese University of Hong Kong. ISEIS consists of three major units: research, education and training, and technology development.	2005
Institute of Future Cities CUHK – The Chinese University of Hong Kong	http://www.iofc.cuhk.edu.hk	China – Hong Kong, Shatin	Institute of excellence, a leading multi-disciplinary research Institute in Asia with significant impacts on academic research and urban theories and practices including policy, plans and design especially in Hong Kong, mainland China and Asia. Themes: Sustainability, smart cities, digital applications, urban design	2014

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Centre	Web address	Location	Brief description	Established date
State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing (LIESMARS)	http://www.lmars.whu.edu.cn/en/	China – Wuhan	In 1989, the laboratory began construction on the basis of the National Key Disciplines of Photogrammetry and Remote Sensing and Geodetic of Wuhan Technology University of Surveying and Mapping. The State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University (LIESMARS) is the first state key laboratory in the field of surveying and mapping in China. The current research institutes are: Research Institute of Aerial and Space Photography; Research Institute of Remote Sensing Information Processing; Research Institute of Geospatial Information Systems and Services; Research Institute of 3S Integration and Network Communication; Research Institute of Navigation and Location-based Services.	1989
FinEst Centre for Smart Cities (FinEst Centre)	www.finesttwins.eu	Estonia and Finland	The FinEst Centre focuses on mobility, energy and built environment glued together by governance and urban analytics & data. The FinEst Centre develops the cross-border knowledge transfer infrastructure through real-life pilots.	2019
Spiekermann & Wegener (S&W) Urban and Regional Research – University of Dortmund	www.spiekermann-wegener.de/	Germany – Dortmund	Spiekermann & Wegener City and Regional Research (S&W) was founded as a research-oriented planning office in 2001. It is a long-standing urban modelling group affiliated to University of Dortmund.	2001
Ubineum – Living the future	https://ubineum.de/netzwerk.html	Germany – Zwickau	The ubineum is the successful and interdisciplinary specialist centre for everything to do with future living in Zwickau and serves as a milestone on the way to the 'All Electric Society' – the emergence of electricity, mobility, and digitality. The fusion of the real and information technology world and the implementation of innovative energetic sector couplings result in intelligent infrastructure systems, cost-efficient energy systems, and sustainable mobility concepts in the ubineum.	2017

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Centre	Web address	Location	Brief description	Established date
Center for Collaborative Research (CCR) for Scientific Modeling, Application, Research, and Training for City-centered Innovation and Technology	https://www.smartcity.ui.ac.id/	Indonesia	The Center for Collaborative Research (CCR) for Scientific Modeling, Application, Research, and Training for City-centered Innovation and Technology (abbreviated as SMART CITY) is led by University of Indonesia. CCR SMART CITY encourages the use of interdisciplinary approaches in its work, collaborates on a global scale, and creates scientific and technological innovations as response to facing urban challenges, including the adoption of green technology; information technology in urban administration, services, and governance; reliability of urban infrastructure; and the rapidly declining quality of life, health, and general well-being.	2017?
Information Technology Development Center of Iran (MAGFA)	https://www.oier.pro/news/iranian-smart-cities-center-of-excellence-development-opportunity-for-next-generation-smart-cities-in-iran-94/	Iran	Information Technology Development Center of Iran (MAGFA) in partnership with the Presidential Center for Progress and Development of Iran has established Iranian Smart City Excellence Center. The Center is Iran's official representative in the global network of Excellence Centres set up around the world for Sustainable Smart Cities implementation.	2019
National Centre for Geocomputation (NCG) – National University of Ireland Marynooth	http://ncg.nuim.ie/	Ireland – Maynooth	Since its inception in 2004 with the support of Science Foundation Ireland and centred in Maynooth University, the NCG has become firmly established as a leading centre for research in the field of Geocomputation, applying computational methods to large spatial data sets from acquisition to analysis, modelling, and visualisation.	2004
Geosimulation and Spatial Analysis Lab – Tel Aviv Uni	https://www.geosimlab.org/	Israel – Tel Aviv	Based on high-resolution GIS and big data on human and institutions' spatial behaviour, we model the complex geographic system as collectives of decision-makers who define system's spatio-temporal dynamics and evolve themselves. Current Research: Smartcard and Cellular data analysis, Modelling Urban Fires, Modelling urban Sprawl, Modelling urban traffic, Modelling urban parking, and Modelling Traffic Accidents.	2000

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Centre	Web address	Location	Brief description	Established date
City Center – TAU Research Center for Cities and Urbanism – Tel Aviv University	https://en-urban.tau.ac.il	Israel – Tel Aviv	TAU City Center – Tel Aviv University's Research Center for Cities and Urbanism is a unique interdisciplinary centre that brings together the many TAU researchers – faculty members, graduate, and postgraduate researchers – who study various aspects of cities and urbanism. The Center's interests include urban theory and its application in city planning, urban design, management, and policy formulation. Among the Center's goals are research, global connections, local cooperation, accessible knowledge, and teaching.	2015
Center for Spatial Information Science (CSIS) – University of Tokyo Urban Engineering	www.csis.u-tokyo.ac.jp/english/	Japan – Tokyo	In 1998 it was established as the Center for Spatial Information Science. CSIS was established as an internal joint-use facility by the University of Tokyo. It can be used by researchers from various faculties and research institutions within the university for their respective research works. CSIS does not concentrate on one specific field but encourages lateral research connections.	1998
United Nations University Operating Unit on Policy-Driven Electronic Governance (UNU-EGOV)	https://egov.unu.edu/	Portugal – Guimaraes	UNU-EGOV, part of the United Nations University (UNU) and based in the city of Guimarães, north of Portugal, is a think tank dedicated to Electronic Governance; a core centre of research, advisory services and training; a bridge between research and public policies; an innovation enhancer; a solid partner within the UN system and its Member States with a particular focus on sustainable development, social inclusion and active citizenship. UNU-EGOV strives to cement its role as an international reference of excellence in this area, bringing together multidisciplinary and multicultural teams around complex problems and emerging challenges.	2014

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Centre	Web address	Location	Brief description	Established date
The Smart Cities Research Center (SCRS)	https://www.kict.re.kr/menu.es?mid=a20210010000	Republic of Korea	In June 1983 KICT was established as a private foundation, and in July 2017 SCRS was designated as a government-funded research institute under the National Research Council of Science & Technology of the Ministry of Science and ICT. SCRS is a leading innovative interdisciplinary service to integrate construction industry and intelligent information technologies to resolve the urban problems. SCRC main roles are research and development of smart city services and technologies including human-centric policy design and strategic planning; developing the Smart City Living Lab and related convergence services and researching on cooperation among citizens, industries, and the government, as well as other countries related to smart city businesses.	1983 as foundation and 2017 as a centre
SMART Innovation Centre – Singapore-MIT Alliance for Research and Technology	https://smart.mit.edu/	Singapore	Established in 2007, SMART is MIT's first research centre outside of Cambridge, MA ,and its largest international research endeavour. The SMART Innovation Centre operates under the Singapore-MIT Alliance for Research and Technology (SMART) and is funded by the National Research Foundation (NRF). The SMART Innovation Centre identifies and nurtures a broad range of emerging technologies including but not limited to biotechnology, biomedical devices, information technology, new materials, nanotechnology, and energy innovations and will act as a catalyst to create a fertile environment for faculty and student entrepreneurship to grow.	2007

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Centre	Web address	Location	Brief description	Established date
Singapore-ETH Centre (SEC): Future Cities Laboratory (FCL)	https://fcl.ethz.ch/	Singapore	The Singapore-ETH Centre was established in 2010 by ETH Zurich – The Swiss Federal Institute of Technology and Singapore's National Research Foundation (NRF), as part of the NRF's CREATE campus. As ETH Zurich's only research centre outside of Switzerland, the centre has strengthened the research capacity of ETH Zurich to develop sustainable solutions to global challenges in Switzerland, Singapore, and the surrounding regions. Set in Asia, in a rapidly urbanising region, the Singapore-ETH Centre aims to provide practical solutions to some of the most pressing challenges on urban sustainability, resilience and health through its programmes: Future Cities Laboratory (FCL), Future Resilient Systems (FRS), and Future Health Technologies (FHT).	2010
Lee Kuan Yew Centre for Innovative Cities – Singapore University of Technology and Design	http://lkycic.sutd.edu.sg/	Singapore	The Lee Kuan Yew Centre for Innovative Cities (LKYCIC) was established in September 2012 as one of the research centres of excellence in the Singapore University of Technology and Design (SUTD). LKYCIC is only one of two institutions in Singapore that carry the name of our founding father Lee Kuan Yew. A focus on urban innovation and future cities, ageing, and technological innovation.	2012

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Centre	Web address	Location	Brief description	Established date
The Institut Municipal d'Informàtica (IMI) Barcelona	https://ajuntament.barcelona.cat/imi/es/el-instituto	Spain – Barcelona	The Municipal Institute of Information Technology (IMI) is a local independent Barcelona City Council body that was set up in 1990 to provide Barcelona City Council and the public companies under its wing with all their Information and Communication Technology Services. Tasks: It takes part in the design and implementation of Barcelona City Council's ICT strategy; it offers advice and support in all the City Councils projects or programmes requiring an information and telecommunication systems strategy; it promotes and implements technological projects for Barcelona City Council.	1990
Spatial Economics Group – VU (Vrie University)	https://sbe.vu.nl/en/departments-and-institutes/spatial-economics/index.aspx	The Netherlands – Amsterdam	Regional science and GIS group with extensive research into smart cities, transport, and spatial visualisation. The Department of Spatial Economics, at the School of Business and Economics of VU Amsterdam, is engaged in economic problems in which space plays a prominent role. The Department of Spatial Economics offers insights and applications in urban, regional, transport, and environmental challenges from a primarily economic perspective, often enriched through multidisciplinary collaborations.	1990

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Centre	Web address	Location	Brief description	Established date
AMS Amsterdam Institute for Advanced Metropolitan Solutions	https://www.ams-institute.org/	The Netherlands – Amsterdam	Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute) is a public–private institute founded in 2014 by Wageningen University & Research (WUR) and Delft University of Technology (TU Delft), together with Massachusetts Institute of Technology (MIT). The three core pillars of the institute are Research & Valorization, an Education Program, and a Value platform. The research portfolio revolves around applied technology in themes such as water, energy, waste, food, data and mobility, and integrating these themes to create an innovative, sustainable and just city. AMS Institute is involved in over 100 projects that focus on securing a city that is innovative, sustainable and just.	2014
Department of the Built Environment – Information Systems in the Built Environment (ISBE)	https://www.tue.nl/en/research/research-groups/information-systems-in-the-built-environment/	The Netherlands – Eindhoven	The ISBE Group carries out research and education in the field of information systems used for the engineering and management of the built environment, into which they are embedded. Research Project: Triangulum (Manchester, Eindhoven, Stavanger). In the Triangulum project an exploitation and replication framework is developed for smart city solutions across the domains of energy, transport and ICT. Research Labs in at TU/e: ht.tps://www.tue.nl/en/research/research-labs/	1990
Expertise Centre for Urban Dynamics and Sustainability – Faculty of Geosciences – Utrecht University	https://www.uu.nl/en/organisation/faculty-of-geosciences/laboratories-and-collaboration	The Netherlands – Utrecht	Transport and GIS group with strong interests in planning support systems and application of models to plan-making. The Utrecht focus areas link fundamental research to a social mission. Together with its partners, Utrecht University has made plans to tackle 20 key societal challenges. For this purpose, the university allocated 26 million euros for the period between 2018 and 2022.	1995

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Centre	Web address	Location	Brief description	Established date
The Martin Centre for Architectural and Urban Studies – University of Cambridge	www.martincentre.arct.cam.ac.uk/	UK – Cambridge	The Martin Centre for Architectural and Urban Studies – the research arm of the Department of Architecture – was founded by Professor Sir Leslie Martin in 1967 as the Centre for Land Use and Built Form Studies, and formally became The Martin Centre in 1974. It is one of the traditional urban modelling groups with focuses on urban energy, resources, and urban design.	1967
Cambridge Centre for Smart Infrastructure and Construction (CSIC) – University of Cambridge	http://www-smartinfrastructure.eng.cam.ac.uk/	UK – Cambridge	Cambridge Centre for Smart Infrastructure and Construction (CSIC): an Innovation and Knowledge Centre funded by EPSRC, Innovate UK and Industry Partners, CSIC is a world-leading centre in the development of smart infrastructure and data-driven solutions to enable smarter whole-life asset management decisions, for both new infrastructure and existing assets. Annual Report 2020 available: https.://www-smartinfrastructure.eng.cam.ac.uk/files/csic_02072020.pdf	2011
Warwick Institute for the Science of Cities (WISC) – The University of Warwick	http://www.wisc.warwick.ac.uk	UK – Coventry	Partner institution with CUSP, focusing on Data Science-Analytics, Sensors, Social Media Health, Intelligent Infrastructure, Urban Resilience, Energy. Through the Warwick Institute for the Science of Cities, Warwick brings its own strengths in areas including Data Science and Analytics, visualisation, data mining, machine learning, data streaming and on- and off-line analytics; Sensor and Wireless Networks; Social and Media Networks, smarter analysis of textual data and text mining of data drawn from social media and using social informatics to learn more about the 'mood' of urban citizens and organisations relating to the issues that surround them; Science and Technology for Health, Urban Resilience; Data Management and Privacy; Energy Solutions, etc.	2012

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Centre	Web address	Location	Brief description	Established date
Institute for Future Cities – University of Strathclyde	http://ifuturecities.com/	Uk – Glasgow	The Institute for Future Cities is a multidisciplinary research unit based within the international, award winning University of Strathclyde. They work with commercial, civic, and academic partners across the world to understand better the challenges faced by cities as places to live and work, and to help unlock the potential of cities to provide innovative ways of enhancing their quality of life. Their strength lies in their ability to respond quickly and agilely to the changing needs of cities and to help promote socially progressive and inclusive urban development. Crime, heritage, and energy as well as health, resilience, and the urban observatory involving data analytics and visualisation.	2010
Urban Big Data Centre (UBDC) – University of Glasgow	http://ubdc.ac.uk/	Uk – Glasgow	The Urban Big Data Centre (UBDC) is a research centre and national data service based at the University of Glasgow that promote the use of big data and innovative research methods to improve social, economic, and environmental well-being in cities, established in 2014. In its first phase – up to January 2019 – it was funded by the Economic and Social Research Council (ESRC), as part of the UK's national data infrastructure, focused on developing big data resources and urban analytics methods for a wide range of potential applications and users. UBDC is now jointly funded by the ESRC and the University of Glasgow as a research centre up to January 2024. As well as continuing to pioneer the science of urban analytics, the Centre will work closely with government and industry to ensure the benefits of that research are maximised. They provide data services and support urban research. UBDC's key research strands are Urban Impacts of COVID-19; Education and skills; Housing and neighbourhoods; Transport and infrastructure; Urban governance.	2014

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Centre	Web address	Location	Brief description	Established date
Technology & Innovation Centre – University of Strathclyde	https://www.strath.ac.uk/research/technologyandinnovationcentre/	UK – Glasgow	Our new Technology & Innovation Centre opens doors to new areas of research, innovation and technology development, all aimed towards creating new possibilities, new levels of dynamic collaborations and productive outcomes. Together, we'll work on solutions to challenges in enabling technologies and the low carbon economy, including low cost, greener power and energy; renewable technologies; photonics and sensors; advanced engineering; pharmaceutical manufacturing nanoscience.	2015
Leeds Institute for Data Analytics (LIDA) – University of Leeds	http://www.lida.leeds.ac.uk/	UK – Leeds	Established in 2014, with major investments from the UK Research Councils and the University of Leeds, LIDA has developed state of the art physical and IT infrastructures to raise the bar in standards of data quality, access, protection, and exploitation. Over 90 research centres, programmes, and projects are now based at the Institute and our infrastructure also supports in excess of £75 million research across the university.	2014
Consumer Data Research Centre – University of Leeds	https://www.cdrc.ac.uk/about/	UK – Leeds	The Consumer Data Research Centre (CDRC) was established in 2014 with funding from the UK Economic and Social Research Council and brings together world-class researchers from the University of Leeds, UCL, University of Liverpool and the University of Oxford. Research: Health and Wellbeing, Urban Mobility, Retail, Population, Housing and Infrastructure, Crime and Emergency Services, Ethical and Sustainable Consumption.	2014

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Centre	Web address	Location	Brief description	Established date
Center for Spatial Analysis and Policy (CSAP) – University of Leeds	www.geog.leeds.ac.uk/research/csap/ also the Leeds Institute for Data Analytics	UK – Leeds	The Centre for Spatial Analysis and Policy builds on that tradition by developing innovative ways of looking at the world to understand business, society, and the environment at different spatial scales and by providing applied or policy-related analyses of geographical behaviour. Our research: quantitative geography. Our particular research interests include population dynamics, migration, geodemographics, retailing, education, crime, and health.	1970, 2005, 2013 ?
Centre for Advanced Spatial Analysis (CASA – UCL)	www.casa.ucl.ac.uk www.blogs.casa.ucl.ac.uk www.spatialcomplexity.info	UK – London	The Centre for Advanced Spatial Analysis (CASA) is an interdisciplinary research institute focusing on the science of cities within The Bartlett Faculty of the Built Environment at UCL. Established as a GIS centre with focus, on visualisation, modelling and simulation, spatial data, and urban morphology. They seek to examine and offer solutions to the problems of resource efficiency and effective planning and governance shared by all cities. Their vision is to play a central role in the science of smart cities – applying it to city planning, policy, and architecture in the pursuit of making cities better places to live.	1995
Centre for Transport Studies (CTS) – Imperial	http://www.imperial.ac.uk/transport-studies	UK – London	The Centre for Transport Studies (CTS) carries out teaching and research in a broad range of aspects of transport studies. Principal areas of research include Intelligent transport systems (ITS); Transport operations; Transport and the environment; Railway operations and management; Transport economics; Positioning, navigation and geomatics; Travel demand modelling; Air traffic management; Transport safety; Logistics; Urban engineering systems.	2000

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Centre	Web address	Location	Brief description	Established date
Urban System Lab (USL) – Imperial	https://www.imperial.ac.uk/urban-systems-lab/	UK – London	The Urban Systems Lab (USL) was formed in October 2015 and has eight linked thematic research areas: Low carbon operation and resource efficiency; Resilience and adaptability; Systemic quality of service; Sensing, simulation and modelling; Economic performance; Advanced materials and processes; Health, well-being and quality of life; Business models and innovation.	2015
The Alan Turing Institute	https://www.turing.ac.uk/	UK – London	The Alan Turing Institute is the national institute for data science and artificial intelligence, with headquarters at the British Library. It was created as the national institute for data science in 2015. In 2017, as a result of a government recommendation, we added artificial intelligence to our remit.	2015
Connected Places CATAPULT – Urban Innovation Centre	https://cp.catapult.org.uk/about-us/	UK – London	Designed to be a collaborative hub for businesses, academics, city leaders and entrepreneurs to connect, develop, and create smart city solutions, the Urban Innovation Centre is currently home to the Connected Places CATAPULT and some of the world's best urban innovators. The Connected Places CATAPULT operates at the intersection between public and private sectors and between local government and transport authorities. In the last five years alone we have worked on 25 projects (and counting) in cities worldwide – most recently the £2.52 M Urban Links Africa programme funded by the Global Challenges Research Fund to work with six innovation-based city markets across Kenya and South Africa. Working with multiple HMG departments and global institutions we open the door to the Catapult Network on the global stage.	2015
Oxford Internet Institute (OII) – University of Oxford	www.oii.ox.ac.uk/	UK – Oxford	The Oxford Internet Institute was founded as a full department of the University of Oxford in 2001. The Institute is a multidisciplinary research and teaching department of the University of Oxford, dedicated to the social science of the Internet.	2001

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Centre	Web address	Location	Brief description	Established date
Smart Cities Smart Government Research-Practice Consortium – CTG – University at Albany	https://www.ctg.albany.edu/projects/smartcitiesconsortium/	USA – Albany – New York	The Smart Cities and Smart Governments Research-Practice Consortium is a robust global smart cities research community that focuses on innovations in technology, management, and policy that change the fabric of the world's cities. Through networking and connected research, the Consortium shares ideas, new knowledge, research, and practice innovations in the interest of increasing opportunities for all who live, and work, in these cities.	2015
UrbanSim – AI for Smarter Urban Development (OPUS Group U Cal Berkeley)	http://www.urbansim.com	USA – Berkeley, CA	UrbanSim is a simulation platform for supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, the economy, and the environment. Story: The UrbanSim modelling methodology was designed by Paul Waddell and developed over the course of many years and six National Science Foundation grants. It has been released as open source software and continuously improved and re-engineered as its usage has grown among planning agencies that needed rigorous methods to analyse the potential impacts of alternative transportation plans, and alternative land use plans, to evaluate their effectiveness, and by researchers in over 70 countries that have leveraged it to advance their research. In 2017 we launched UrbanCanvas Modeler, the world's first cloud-based urban simulation platform.	2008
Urban Center for Computation & Data (UrbanCCD) – University of Chicago	http://urbanccd.org/	USA – Chicago	A research initiative at the University of Chicago and Argonne National Laboratory. Focus on Big Data and Computing, sensing and instrumentation, spinning off from Argonne National Labs, moving into urban growth and change and visualisation.	2012
Senseable City Lab – Massachusetts Institute of Technology (MIT)	http://senseable.mit.edu/ http://senseable.mit.edu/livesingapore/	USA – Massachusetts	Sensing and visualisation in cities. LIVE Singapore is part the SMART (Singapore-MIT Alliance for Research and Technology) through various departments in particular DUSP (Urban Studies and Planning).	2004

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Centre	Web address	Location	Brief description	Established date
MIT Norman B. Leventhal Center of Advanced Urbanism (LCAU)	https://lcau.mit.edu/	USA – Massachusetts – Cambridge	Emerging focus on urban issues informed by ICT applications to multiple social and physical urban problems. The MIT Norman B. Leventhal Center for Advanced Urbanism is committed to fostering a rigorous design culture for the large scale; by focusing our disciplinary conversations about architecture, urban planning, landscape architecture, and systems thinking, not about the problems of yesterday, but of tomorrow. The MIT Norman B. Leventhal Center for Advanced Urbanism has been established at the initiative of the Dean and department Chairs of the School of Architecture and Planning and reflects a renewed drive to excellence in urbanism. Current research areas include: Climate + Urbanism, Environment + Urbanism, Technology + Urbanism, and Global + Urbanism.	2012
Data-Smart City Solutions – Harvard Kennedy School	http://datasmart.ash.harvard.edu/	USA – Massachusetts – Cambridge	Data-Smart City Solutions Research focus is the intersection of government and data, ranging from open data and predictive analytics to civic engagement technology. They seek to promote the combination of integrated, cross-agency data with community data to better discover and preemptively address civic problems. This website and their broader work are housed at the Ash Center for Democratic Governance and Innovation at Harvard Kennedy School (https://ash.harvard.edu/), the pre-eminent voice for innovation in government.	2013

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Centre	Web address	Location	Brief description	Established date
City Science – MIT Media Lab.	https://www.media.mit.edu/groups/city-science/overview/	USA – Massachusetts – Cambridge	A synthesis of work being done on sensing, participation, social physics, visualisation, and urban economics through the Media Lab. Founded in 1985, the MIT Media Lab is one of the world's leading research and academic organisations. Unconstrained by traditional disciplines, Media Lab designers, engineers, artists, and scientists strive to create technologies and experiences that enable people to understand and transform their lives, communities, and environments. The City Science research group (Ariel Noyman, City Science group, MIT Media Lab) proposes that new strategies must be found to create the places where people live and work in addition to the mobility systems that connect them, in order to meet the profound challenges of the future.	2012 (MIT Media LAB 1985)
Spatial Information Design Lab – Columbia University	https://entrepreneurship.columbia.edu/resource/spatial-information-design-lab/	USA – New York City	The Spatial Information Design Lab was founded in 2004 as an interdisciplinary research unit in the Graduate School of Architecture, Planning and Preservation at Columbia University. It's a Lab supporting visualisation and GIS related to projects in New York City and urban research	2004

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Centre	Web address	Location	Brief description	Established date
Marron Institute of Urban Management – New York University	https://marroninstitute.nyu.edu/about	USA – New York City	Established from an initiative by NY City Mayor to establish science campuses in the City; this is one of several initiatives at NYU. The NYU Marron Institute conducts innovative applied research, working with cities to take on critical challenges of urban living. Started with a generous gift from Donald B. Marron, the Institute operates on a model of academic venture capital in which the faculty who run research programmes receive seed funding. Faculty members use seed funds to develop their programmes, hire research staff, and build portfolios of externally funded projects that have the potential to improve outcomes in cities. Currently, the Marron Institute has four major research programmes focused on urban planning, environmental health, civic analytics, and public sector performance and innovation.	2011

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CUSP – Center for Urban Science and Progress – New York University	https://cusp.nyu.edu/	USA – New York City	New York University's Center for Urban Science and Progress (CUSP) is a unique research centre that uses NY City as its laboratory to help cities. CUSP's research and educational initiatives seek to improve city services; optimise decision-making by local governments; create smart urban infrastructures; address challenging urban issues such as crime, environmental pollution and public health issues; and inspire urban citizens to improve their quality of life. History: In 2012, New York City challenged top institutions around the world to design an applied science campus that would make the city a world capital of science and technology, as well as dramatically grow its economy. New York University and NYU-Poly, along with a consortium of world-class universities and some of the foremost international tech companies, proposed CUSP, a new kind of academic centre that functions in collaboration with the city itself. The proposal was accepted, and on 23 April 2012 Mayor Bloomberg announced the launch of CUSP.	2012
Cornell Tech – Cornell University	http://tech.cornell.edu/	USA – New York City	Established as part of the NY City Science Campus Initiative, partnered with Technion focusing on engineering and health education. Cornell Tech is a revolutionary model for graduate education that fuses technology with business and creative thinking. Cornell Tech brings together like-minded faculty, business leaders, tech entrepreneurs, and students in a catalytic environment to produce visionary ideas grounded in significant needs that will reinvent the way we live. Research: Human-Computer Interaction (HCI) & Social Computing, Security & Privacy, Artificial Intelligence and Robotics, Data & Modelling, Law and Policy.	2012

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Centre	Web address	Location	Brief description	Established date
Data Science Institute (SCI) – Columbia University	http://datascience.columbia.edu/smart-cities	USA – New York City	About the research centre: aim to develop, monitor, and improve infrastructure, buildings, transportation routes, the power supply, and everyday activities in crowded, urban environments. DSI Focus Areas include Climate, Health Care, Social Justice, Business and Finance, Foundations of Data Science. Their research detects and counteracts problems with ageing urban infrastructure, improves smart grid technology, calculates and communicates optimal transportation routes under congested traffic conditions, and deploys ubiquitous sensing devices. Drawing on Columbia's strengths in computer science, statistics, and industrial engineering and operations research, DSI was launched in 2012 to unite our expertise and a University-wide interest in this revolutionary approach.	2012
Rudin Center for Transportation Policy & Management – NYU Wagner	https://wagner.nyu.edu/rudincenter	USA – New York City	The Rudin Center for Transportation Policy and Management at NYU's Wagner School seeks to improve the flow of people and goods in the New York metropolitan area. We draw upon scholars, graduate students, and public officials who participate in our public forums and shape our research. We also prepare emerging leaders in the transportation field, explore how new technologies will influence mobility, and study how emerging patterns of work will affect locational preferences. Areas of Focus: NYC, global, equity, micromobility, technology, climate change, preparing leaders, economic development, etc. The Rudin Center was named in recognition of a gift from Lewis Rudin and receives support from leading firms in transportation, finance, and communications.	

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Centre	Web address	Location	Brief description	Established date
Cities, Scaling & Sustainability – Project of Santa Fe Institute (SFI)	http://www.santafe.edu/research/cities-scaling-and-sustainability/	USA – Santa Fe – New Mexico	The Santa Fe Institute (SFI) is an independent, nonprofit research and education centre that leads global research in complexity science. In 2005, the SFI's cities, scaling, and sustainability research was created with an interdisciplinary approach and quantitative synthesis of organisational and dynamical aspects of human social organisations, with an emphasis on cities. An important focus of this research area is to develop theoretical insights about cities that can inform quantitative analyses of their long-term sustainability in terms of the interplay between innovation, resource appropriation, and consumption and the makeup of their social and economic activity.	2005