Ethics of Using Smart City AI and Big Data: The Case of Four Large European Cities

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Abstract: By 2030, the population living in cities will increase by an additional 1.5 billion people, placing a great strain on resources, infrastructure, jobs and healthcare (UN 2018). It has become clear that to combat this change, a number of creative approaches need to be put in place to ensure the sustainable growth of cities - one such approach is the 'smart city' (UN 2018). Due to the relative infancy of smart cities, and the diversity of approaches and implementations of smart information systems (**Big Data and AI**),many of the ethical challenges are still being defined.

One of the reasons behind this challenge is a result of the varying **smart information systems (SIS)** being used in different urban contexts. This case study aspires to unpack some of these ethical challenges by looking at four different applications of SIS being deployed in large European cities: an AI used to understand citizens' complaints (**Amsterdam**), a parking permit chat-bot (**Helsinki**), a platform for data exchange (**Copenhagen**), and a project with an open-source algorithm (**Hamburg**).Upon first glance, these technologies seem very disparate, but they all factor into the equation of what goes into making a smart city, 'smart'.

Over the course of the interviews, what quickly became clear was the degree to whichsmart cities are in their infancy, meaning that the **availability and accuracy of data** remains an issue in a large majority of the cases. In terms of the **accuracy of recommendations** – due to the early stages of smart city implementation,

many projects remain wary of expanding the use of SIS, due to potential unforeseen issues and are therefore proceeding cautiously.

Data has been taken on as a potentially helpful tool for citizens and planners alike to regain control and access to information within their respective cities. **Consent, transparency and data ownership** featured as prominent ethical considerations in all cases, especially the focus on citizens regaining control over their own data. Further, it remained a point of contention to whom the data would belong – with an overall consensus that data should remain the property of the citizen or municipality and not necessarily that of private companies.

Throughout the process, it became clear that **collaboration** is at the heart of a successful smart city. Many of the projects utilised a collaborative **public-private** model to facilitate both the business development side and the **citizen-engagement** sides of the smart city. With differing degrees of success in the individual projects, this remained an important feature that experts believe will continue to develop in tandem with smart city projects. A bottom-up approach is clearly the most effective way to ensure that a smart city works and is used by its citizens.

Overall, this case study offers valuable insights into the development of smart cities in a European context: including the use and implementation of SIS in urban environments, what kinds of ethical issues are evaluated in the literature and how they contrast and diverge from those faced by professionals in practice. It is hoped that this case study will offer practitioners, policymakers, smart city organisations, and private ICT companies interesting observations about a more ethically-responsible approach towards SIS implementation in smart city projects.

Keywords: Smart cities, engagement, ICT, SIS, ethics, technology, AI

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Introduction

In 2015, the UN General Assembly established 17 key sustainable development goals to aim towards by the year 2030. These range from eliminating poverty, to providing universal education, gender equality, and climate action. Goal 11 strives towards achieving sustainable cities and communities because the population living in cities will increase by an additional 1.5 billion people by 2030 (totalling 5 billion), which is set to place a strain on resources, infrastructure, jobs, and healthcare (United Nations 2018). The UN has established that we need to implement creative approaches to handle these changes. There is a need to reduce ecological harm, pollution, and injustice on the one hand; while increasing safe and affordable housing, improving infrastructure, and providing safe cities for people to live in (United Nations 2018). As a result, a number of approaches have been proposed to ensure sustainable cities, such as the 'smart city' concept.

The smart city concept dates back to 2008 and 'is marked by real-time, interactive, and intelligent systems' (Li, Cao, and Yao 2015, p. 2). A smart city 'is one whose economy and governance are driven by innovation, creativity and entrepreneurship, enacted by smart people' (Kitchin 2014, p. 2).Therehave been many different definitions of the smart city, but it is typically grounded on a drive towards technological innovation to improve the lives of city-dwellers. Emerging technologies, such as smart information systems (AI and Big Data), offer us the potential to create more sustainable cities (Kitchin 2013; Kitchin 2014). However, it is important that the introduction of technology and data is done in an ethical manner, which will be the focus of this case study.

A **smart city** is typically a city grounded on a drive towards technological innovation to improve the lives of city-dwellers.

There are four organisations being evaluated in this case study, but it will focus on one uniting topic: the use of SIS in smart city projects. This paper may be read as a single case study in this regard, or else, as a multi-case study report because it focuses on four different organisations. Throughout this case study itself, the primary research questions will be: Which ethical issues arise in the use of SIS when strivingtowards smarter cities and how can these ethical issues be addressed?Answering these questions will be achieved by reviewing some of the most pertinent issues within the literature and by conducting interviews with four organisationsinvolved in the implementation of smart city technologies(Amsterdam CTO, Copenhagen Solution's City Data Exchange, MySMARTLife project in Hamburg, and Helsinki municipality). The aim of this case study is to identify ethical issues in the literature and if they correspond to those faced by organisations in practice. The report has four main sections:

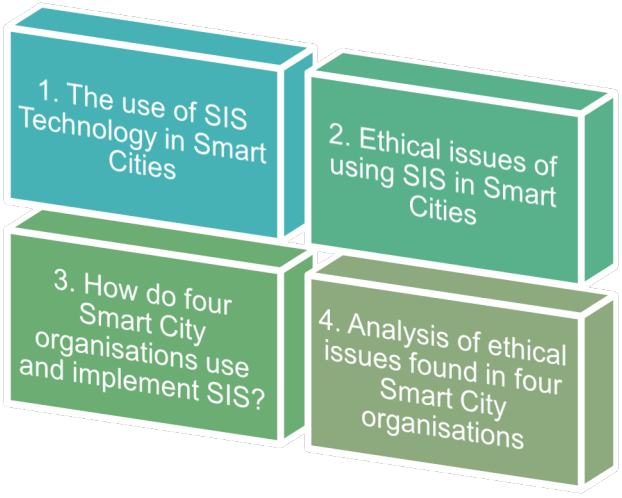


Figure 1: Four sections of report

Sections 1 and 2 focus on theoretical work and the literature within the field, while sections 3 and 4 assess the organisations interviewed between September and November 2018.

The Use of SIS Technology in Smart Cities

The definition of a smart city is often contested. IBM first coined the term in 2008 as referring to the integration of 'smart' technology within a city, either a pre-existing city or a newly created smart city, such as: Masdar near Abu Dhabi (developed by General Electric), Paredes in Portugal (developed by Microsoft), Dongtan in the Yangtze Delta (developed by Arup), and Songdo in South Korea (developed by Cisco) (Batty et al. 2012).

One of the binding components within smart city definitions is that they place a strong emphasis on the adaptation and integration of technology within cities, revolutionising how they function in practice. However, while not all definitions of a smart city contain strict adherence to the widespread endorsement and incorporation of technological development, technology usually plays a strong role in *most* smart city definitions:

> The term *Smart City* is a broad term that refers to the *smart* management of the cities socio-economic and environmental capital through the use of Information and Communication Technologies. These technological solutions are said to be *smart* as they provide ways to enable social, cultural and urban development, improving social and political capacities and/or efficiency (Vázquez-Salceda et al. 2014, p. IS-7).

The majority of academics, policymakers and individuals working on smart cities, discuss the fundamental role that technology will play in urban areas, particularly their widespread implementation and use of the Internet of Things (IoT), Artificial Intelligence, (AI), Big Data and Information and Communication Technology (ICT) infrastruc-

ture (Nigon et al. 2016). In an analysis of smart city literature, out of 125 different reports, 91% discussed how cutting-edge technologies and ICT were key factors; with AI being the most widely discussed technology (Rjab and Mellouli 2018). In smart city definitions, technology is applied to a wide number of applications: health, waste management, air quality monitoring, noise monitoring, transportation management, energy consumption, resident living environment, security, parking, lighting and infrastructure (Guo et al. 2018; Zanella et al. 2017, p. 23). Overall, the use of technology in smart cities can be categorised into six domains: economy, people, governance, mobility, environment and living (Albino, Berardi, and Dangelico 2015; Kitchin 2015b; Voda and Radu 2018, p. 111).

Figure 2: Use of technology in smart cities

Many theorists claim that technology is an overriding 'meta-factor' that is intertwined and engrained in all of the domains of a smart city due to the use of a wide array of different technologies to retrieve vast amounts of data from a city and its citizens (Chourabi et al. 2012). Some of the technologies used to retrieve data are digital cameras, sensors, transponders[1], GPS[2], kiosks, meters, personal devices, appliances, social networks, and machine-readable objects (Kitchin 2013, Kitchin 2016b). These technologies are used to monitor activity in the cityby way of traffic lights, traffic speeds and traffic flows, criminal activity,movement of pedestrians, number plates, media access control (MAC) addresses, faces and gaits, transport meter readings, energy usage, and environmental pollution (Kitchin 2015a, p. 4).

Retrieving this data from such an array of sources requires input from a wide array of stakeholders. These stakeholders include utility companies, transport providers, mobile phone operators, travel and accommodation websites, social media sites, crowdsourcing and citizen science, governmental bodies, financial institutions and retail chains, private

[1] A device for receiving a radio signal.

[2]Global Positioning System (GPS), a satellite-based radio-navigation system.

surveillance and security firms, emergency services, and entertainment systems (Kitchin 2016b, p. 2).

While the range of stakeholders providing data is vast, the number of companies using and implementing this data in smart city projects is restricted to a few big ICT companies namely General Electric, IBM, Cisco Systems, Siemens AG, Microsoft, Oracle, SAP, Intel, Arup, Alcatel, Hitachi, Fujitsu, and NEC (Albino, Berardi, and Dangelico 2015; Batty et al. 2012; Hollands 2015; Kitchin, Lauriault, and McArdle 2015; Sholla, Naaz, and Chishti 2017).

These companies are proposing ambitious plans for cities adopting their SIS technology, but it is important to identify the challenges and issues that may arise when implementing these technologies to ensure that the applications are ethically sound.

Ethical Issues of Using SIS in Smart Cities

Discussing and questioning ethical issues in the application of Smart City SIS technology remains an underdeveloped area of research. While many academics have analysed the *conceptual* idea of a smart city, few of them concentrate on the use and implementation of SIS technology within the smart city paradigm. Even the journal*Smart Cities* carried few relevant articles on SIS *implementation*.

To overcome this lack of immediate academic information, keyword searcheswere conducted, using multiple different variations for relevant articles for this case study, through a number of bibliographical databases: Google Scholar, ScienceDirect, Web of Science and Scopus. This provided a wide diversity of articles for this report. Their analysis showed the ethical issues fall broadly into four categories, which are presented below.

Conflicts of Interests and Bias

Major projects can be built bottom-up or top-down. Responsible innovation (Owen et al 2013) favours the inclusion of all relevant stakeholders in the development of major innovative projects such as smart cities. However, it is claimed in the literature that smart city ideologies are laden with neoliberal agendas whilst being packaged as socially just, inclusionary and sustainable projects (Kitchin 2014; Kitchin 2015b). This indicates that a top-down approach is prevalent. Smart cities, SIS and algorithmic governance have the potential to prioritise vested interests and values, benefiting corporations and state bodies, rather than citizens (Cardullo and Kitchin 2017; Kitchin 2016a).

Many smart city initiatives are devised by SIS technology corporations and city governments, disregarding civic participation and civic input (Foth 2017; Hollands 2015). As a result of the huge push towards technological advancements, this may lead to an overemphasis on the ‘the smart’, much to the detriment of ‘the city’ (Galdon-Clavell 2013, p. 718). Smart city initiatives may place a greater emphasis on technical fixes, instead of implementing political and social solutions to try to tackle urban issues (Kitchin 2015a, p. 9).

There are also many corporations using the smart city template as a test-bed for new technologies to sell their products (Kitchin 2015a, p. 9). However, due to the top-down nature of their invested interests, there is the concern that the involvement of third-party companies will have a detrimental effect on the organisation, decision-making and management of cities. Corporations are providing advice, guidance and implementing technologies within cities, and this may not be done impartially or in the best interests of the city (Kitchin et al. 2017). For example, IBM Smart City Index initiates different ranking methods to measure smart cities' development. This Index demonstrates a conflict of interests since companies like IBM are currently selling SIS to cities while also ranking competing cities based on their index.

Thetechnology drive behind the smart city philosophy may be seen as the *best*, or the *only* solution, to create sustainable urban environments. However, it does not consider the diversity and range of city habitats (Kitchin 2016a), which require equally diverse solutions. Advocating for the widespread adoption of smart city SIS may lead to the view of cities as homogenously interchangeable (O'Grady and O'Hare 2012, p. 1581). Many Smart city initiatives treat cities as though they are devoid of historical, spatial and cultural significance; 'treating cities as if they are all alike in terms of their political economy, culture, and governance' (Kitchin 2015a, p. 9). Even 'new' smart cities are distinctly different from pre-existing smart cities, further reinforcing the discrepancy of a one-size-fits-all approach (Shelton, Zook, and Wiig 2015). As such, smart city SIS may lead to the wiping out of cities' individuality and diversity (Foth 2017).

Due to the invested interests and general top-down approach to the Smart City, some authors request that smart cities need to incorporate citizens into the design, use and implementation of SIS to ensure they are meeting the needs of the community (Grey, Dyer, and Gleeson 2017, p. 48).

Economic Pressure

Most cities are far from reaching the desired benefits outlined in smart city agendas because they are still in the early stages of development (Kitchin 2016b). Therefore, it is presumptuous to imply that all cities adopting the smart city ideology, guided by SIS, will become successful. At the same time, monetary benefits are increasingly linked to efforts to become smart. Smart cities are being heralded as a pioneering and benchmarking initiative to strive towards. Cities will be ranked in terms of the 'smartness' (i.e. SIS development) and in turn, will receive increases or decreases in their national investment, foreign direct investment, and tourist trade (Kitchin, Lauriault, and McArdle 2015, p. 25). Therefore, the use of smart city SIS technologies may 'augment the cities competitiveness' (Voda and Radu 2018, p. 110); while others argue that 'AI is what makes a smart city 'smart'' (Srivastava, Bisht, and Narayan 2017). The use of SIS may allow cities to develop or else lose out on investment, development, and progress (Batty et al. 2012).

Inequalities

While there is a widespread promotion of SIS, there is concern that the technology may replace humans in many areas of the smart city (Munoz and Naqvi 2017, p. 7). Many people fear that SIS will replace customer service, driving, and factory jobs within the coming decade. In a recent Eurobarometer survey, 74% of people believed that there will

be greater job losses than job creation as a result of robots and AI (Capgemini Consulting 2017). There are also a number of practical requisites to accommodate an AI smart city: physical infrastructure modifications; intellectual infrastructure; informational infrastructure; governance and regulatory; and socio-economic (Munoz and Naqvi 2017). Smart cities need an intellectual infrastructure to deploy SIS, becoming hubs for technological innovation and advancements, which may subsequently lead to a 'brain-drain' in rural areas. The most educated and prosperous citizens will be located in cities, which could have a dramatic effect on the education, prosperity, and growth of rural areas.

Despite the potential negative effects of smart cities, if they are used inappropriately or there are vested interests at stake, they also offer the possibility of great benefits to cities. However, there is still the potential that SIS will create digital divides and inequalities, despite these benefits. For example, *wealthier areaswithin cities*may develop quicker than poorer areas. SIS is largely aimed at middle-to-upper class individuals who want a more technologically-savvy city. They are often more concerned with efficient services and amenities, rather than social inequalities within their city (Kohli 2014). Therefore, SIS may disadvantage poorer citizens *within* a city, because city officials are appealing to middle-to-upper class interests. Furthermore, poorer citizens may not be able to afford to use these technologies, even if they were available in their areas (Glasmeier and Christopherson 2015, p. 10).

With the introduction and development of smart city SIS, inequalities, power asymmetries and the wealth gap could become exacerbated. This could happen on several levels, from a global standpoint with the wealthier countries developing at a much quicker rate to cities within a country or even to the local neighbourhoods becoming drastically different due to an increase in technology in one neighbourhood. Smart city projects may also further reinforce current power symmetries and inequalities *between* cities, rather than tackling them at their root (Kitchin 2015a, p. 9). Rich cities will be able to implement and use SIS technologies, increasing productivity by up to 40%, while poorer cities get left behind (Munoz and Naqvi 2017, p. 4). This will cause a divergence between cities that can afford to implement SIS and those that cannot. While SIS may bring positive change for cities, they may also exacerbate inequalities with a 'digital divide' between cities (Chourabi et al. 2012, p. 2291).

Figure 3: Cameras Image, Pexels free stock photos

Privacy

There are many different concerns that arise when discussing privacy in the context of Smart cities, such as the use of technologies that track movement, technologies that scan bodies, and those that record and recognise audio. Due to these concerns, in order for citizens to accept SIS within the public space of the city, privacy must be ensured (Bartoli et al. 2011).

Body scanners, a technology that is largely being used in airports, could also be used in a number of different urban contexts. Body scannersare inherently intrusive; they scan individuals' bodies, revealing private aspects of oneself, such as medical conditions and appliances, body piercings, and prosthetics (Finn, Wright, and Friedewald 2013, pp. 11-12). Currently, most body scanners are controlled by humans; but the start-up Evolv, which is funded by Bill Gates, is testing the use of AI-checking body scanners in cities (Harris 2016).

Protection of one's property and physical space and overall privacy is very important to individuals (Kitchin 2016c, p. 5). With the use of these intrusive technologies, the protection of individuals' privacy may become more difficult. SIS technology has recently proliferated and is now found in our vehicles, homes, and belongings. These technologies have become crucial for ease of access to public spaces, amenities, and services, an example being apps such as those created by transportation providers and services such as Google Maps. With these daily SIS in mind, it becomes even more important that the data gathered in these 'private' spaces does not fall into the wrong hands to be used in a malicious way.

A respect of privacy is crucial for citizens to accept SIS in their public space.

Since Smart cities are based on the collection and use of data through SIS technologies, safeguarding the data is crucial for the maintenance of the goal of a Smart City to benefit citizens. The benefits of using SIS to collect data within the Smart City context can be enormous – but the question remains as to who has access to this data and how to protect this data from a security breach. For example, audio detection, voice recognition, electronic communication monitoring, recording and processing software can all be used to help safeguard the security of citizens in the case of a public issue (violence, theft etc.) The SIS technology has advanced rapidly, and Google has recently developed AI that can single out one voice from a crowd of people (Tung 2018). Similarly, DeepMind has been developing AI that can successfully lip-read what individuals are saying (Condliffe 2016). SIS such as these may safeguard smart city security, but they may also be used to infringe upon ordinary citizens' communication privacy.

Individuals may also want to ensure their privacy is protected in relation to their movement, purchases, transactions, and queries (Kitchin 2016c, p. 5). For example, individuals making queries about smart parking or smart bus services may have this data used to determine the patterns and habits of the user (Martínez-Ballesté, Pérez-Martínez, and Solanas 2013). Again, this kind of data can improve the accuracy and effectiveness of a service or in the wrong hands promote malicious intent or be used for commercial purposes (such as targeted advertising).

After evaluating the ethical issues in the literature on the use of SIS in smart cities, we can identify a wide number of concerns that need to be addressed. However, it is unclear if these issues are being identified and addressed in practice on smart city projects. The following sections will evaluate four organisations working on smart city projects to determine if the ethical issues found in the literature correlate with those in real-life examples. We chose these four projects because they cover a wide array of areas within smart city SIS implementation, such as: how do private companies see their involvement in these projects (MySMARTLife interviewee), ethical issues around the exchange of Big Data between private and public organisations (City Data Exchange), how to implement AI for the benefit of the public in an ethical manner (Helsinki municipality), and how can municipalities develop their own SIS and team to integrate it (Amsterdam). The case study also uses four advanced smart city projects to demonstrate how North European cities are implementing SIS in practice (Amsterdam, Helsinki, Copenhagen, and Hamburg).

A Case Study: Four Organisations Using Smart City SIS

This section will focus on four organisations using SIS technology within city contexts. The organisations that collaborated with us provide a good diversity of viewpoints about the use and implementation of SIS technology in Europe since they are working in different cities with different technological projects and platforms.

When we undertook our background research about smart cities in Europe, we found that a lot of the smaller cities and the organisations involved in these projects were approaching them theoretically, or else the integration of smart city technology was in its infancy stage, making it difficult to find appropriate projects to analyse. We wanted to interview organisations advanced in their development of smart city SIS technology, covering four major European cities (Amsterdam, Copenhagen, Hamburg, and Helsinki). Three of the organisations (Netherlands, Denmark, Finland) involved in our case study are within the top four rankings of the most advanced digital economies in the EU (European Commission 2018).

One of the issues that we encountered in our initial analysis of organisations using SIS in smart city projects was that the majority of them had very limited or early stages of technological development. Of the organisations that we found; none would have merited a complete case study on the topic of smart city SIS alone. Furthermore, smart cities in general are using a diverse array of technologies, and it was noted that none of these projects in their isolation illuminated the breadth of work in this field. It was noted that focusing on only one organisation would not provide sufficient insight into how these technologies are being used in practice, limiting our ability to draw specific understanding and provide recommendations for smart city projects as a whole. Analysing multiple organisations that have a unifying theme would allow us to gain a greater understanding of ethical issues across an array of European smart city projects. Broadening the scope to not only several companies and several technologies, but also several European countries allowed a much wider comparative lens.

Multi-sited research can be useful in such cases where information is limited as it can also help to determine a more comprehensive conclusion, however it is important to address the challenge of using multiple organisations and technologies. In an example discussing riots in cities, Yin (2014) states that, 'if you focused on the "why" question in more than one city, you would probably be doing a multiple-case study' (p. 7). However, he later asks the question: 'is it still a case study when more than one case is included in the same study?'. Yin (2014) proposes that case studies can be seen as research on a wide number of topics, such as processes, organisations, institutions or events (p. 12). While there are multiple organisations and institutions being analysed in this case study, they are all on a single process or event, namely, the development and use of SIS in smart city projects. One could argue that this paper is classified as a single case in itself, according to this outline, or that it is a multi-case study because it evaluates multiple different organisations using different technologies in smart city applications. While we aim to have this paper read as a single case study focusing on the ethical implementation of smart city SIS, it may also be read as a multi-case study report focusing on different organisations.

In our analysis, we conducted interviews with four individuals between September - November 2018. Before conducting these interviews, we compiled background research on the organisations and their use of smart city technologies. This information was retrieved from the organisations' website, policy documents, and newspaper articles on the projects. During the interviews, we discussed their involvement with SIS and if ethical issues became apparent in the process. We analysed the interviews using a qualitative analysis software tool (NVIVO) in order to understand, define, and assess the content of

the interviews. In a two-daySHERPA consortium workshop, the group evaluated interviews from 11 case studies and established a wide range of different topics, nodes, and themes from our interviews. This allowed us to effectively analyse the initial interviews from this smart city case study. Where necessary, we completed follow-up interviews to elucidate areas that were not clear in the initial interview.

Description of the Organisation(s) and Individual(s)

The following section will detail the organisations, projects and technologies used to assist in giving context to the analysis.

Figure 4: Amsterdam, photo, Pexels free stock photos

Amsterdam CTO

Amsterdam municipality has attempted to take a proactive approach to the development of its city, initiating a number of 'smart', technological and innovative solutions for current problems. Amsterdam has been pioneering European smart city development, assisting in over 80 smart city projects since 2009; collaborating with 250 tech stakeholders; receiving Europe's Capital of Innovation prize in 2016; and being ranked 3rd in the Global Innovation Index 2017 (Brokaw 2016; Macpherson 2017).

Amsterdam municipality aims to improve the city through six thematic areas: digital city; energy; mobility; circular city; government & education; and citizens & living (Roose 2015). One of the driving forces behind it is the Chief Technology Office (CTO), developing Big Data and AI projects to promote sustainability and citizen happiness. There are over fifty people employed in the CTO (Daalder 2018), and they work with Amsterdam municipality to encourage innovation through: 'e-health, circular economy, smart mobility, sharing economy, cooperation with start-ups and innovative procurement' (Amsterdam Smart City 2018a).

Interviewee 1 works for the CTO Innovation Team of the city of Amsterdam in an advisory/strategy role on how to incorporate AI to prepare the municipality for the future. She also works for the Public Tech programme,

> '*In which we investigate new technologies and what their impact is on society, on the organisation, on our citizens' (Interviewee 1).*

Figure 5: Copenhagen, photo: Doris Schroeder

Copenhagen Solutions Lab (City Data Exchange)

The City Data Exchange was a collaborative project between three organisations: The Municipality of Copenhagen, the Council Region of Copenhagen, and Hitachi. The project began in 2013 from public investment and ran for 5 years (concluding in 2017). The purpose of the project was to examine the possibilities of 'creating a marketplace for the exchange of data between public and private organizations', and was seen as a way to test the 'readiness of the market to deliver new data-sharing solutions' (Municipality of Copenhagen and Capital Region 2018, p. 2).

The technical platform is an IT solution for displaying, selling and purchasing data. It includes the ability to upload datasets for sale, to identify relevant datasets based on a series of criteria, to see metadata, to sample data and to purchase datasets. The data portal is 'open' and all data is aggregated and made anonymous. The interviewee, Interviewee 2, is responsible for the technical and data challenges at Copenhagen Solutions Lab and works for Copenhagen Municipality's open data platform, and for the city's share in the national open data platform, opendata.dk (Copenhagen Solutions Lab 2018).

Deutsche Telekom (MySMARTLife)

Deutsche Telekom is a leading German telecommunications company, with 168 million mobile customers, 28 million fixed-network lines and 19 million broadband lines worldwide (Deutsche Telekom 2018). It is present in over 50 countries, with 216,000 employees and it generated € 74.9 billion in 2017. The company also offers business-to-business services, with their own division T-Systems accounting for over 38,000 employees in 20 countries worldwide. T-Systems is involved in transforming cloud-based services, integrating innovative projects for business, through data analytics, IoT, and

machine-learning techniques (Deutsche Telekom 2018). Deutsche Telekom is also implementing many of these practices in smart city projects throughout Europe, and our interviewee 3 is involved in many of these.

Interviewee 3 participates in the various smart city working groups like Digital Gipfel, Bitkom and is co-chair of the DIN Smart City Standards Forum. He is involved in several European projects like rethink (www.rethink-project.eu) developing concepts for a decentralized communications architecture and a Smart City Application concept together with the City of München(Munich) and the EU H2020 Lighthouse Project "Grow Smarter". In 2012, he worked on the project "XIFI," the second part of the EU project series around "FIWARE". Since 2016 he has been the project lead for Deutsche Telekom at the EU Lighthouse project MySMARTLife(www.mysmartlife.eu), which was the focus of the interview.

MySMARTLifebegan in 2016 and is a Smart City pilot project that includes three 'lighthouse cities': Hamburg, Helsinki and Nantes. MySMARTLifeis funded under the EU's Horizon 2020 research and innovation programme with 27 partners from 6 countries, *'collaborating to make sustainable cities with smart people and a smart economy a reality' (Interviewee 3).*

There are three zones of intervention where the project MySMARTLifewill be implementing the project in the borough of Bergedorf in Hamburg, which we focused on during the interview. The 'integrated strategy' comprises Zone 1, where more than 1,400 residential units will be built with smart controls and connection to a low-energy district heating and smart adaptive lighting for bicycle routes. Zone 2, 'the retrofitting area' – where Smart Heating Islands will be the main feature alongside a lamp-post retrofit to be more environmentally efficient. Zone 3 is the mobility intervention using electric buses, e-cars, e-bikes and e-bus charging stations. This also includes a multi-modal mobility concept and innovative approaches like car-sharing e-community and parcel delivery system.

Figure 6: Helsinki, Photo: Sava Marinkovic, free images

Helsinki Municipality

Helsinki comprises 26 municipalities with 1.6 million inhabitants, generating over a third of Finland's Gross Domestic Product (GDP). Helsinki's location, harsh climates, andan ageingpopulationmeans that the municipality is keen on innovative and pioneering ideas to advance and improve citizen welfare. A number of key technological and transformative projects to improve citizens' lives have been developed, increasingsustainability while improving business and job creation. One of the notable examples of this was the

creation of Helsinki Smart Region, which aims to promote smart activities within Helsinki, by incorporating 'business, cities, public sector, research, education centres, start-ups and the citizen', to create 'sustainable mobility services, a healthy corporate environment, excellent living conditions' (Helsinki Smart Region 2018a).

Finland holds the fourth largest GDP share of expenditure on R&D (UNESCO Institute for Statistics 2018); the country is one of the leading digital hubs and is ranked first for its global impact on global innovation; it is second in best global network readiness and fourth in terms of digital performance in the EU; while Helsinki is the fourth best start-up ecosystem in Europe (Helsinki Smart Region 2018b). One of the key areas of investment and development are AI and Big Data analytics. We interviewed Interviewee 4, who is the Chief Digital Officer within the Helsinki municipality. Interviewee 4 is involved in multiple visualisation projects integrating new technologies and works on projects analysing Big Data and AI, looking at how algorithms make decisions and are used within society, specifically their use in a Helsinki context.

Description	Organisation 1	Organisation 2	Organisation 3	Organisation 4
Organisation	Amsterdam CTO	Copenhagen Solutions Lab	Deutsche Telekom	Helsinki Municipality
City	Amsterdam	Copenhagen	Hamburg	Helsinki
Sector	Public	Public	Private	Public
Name	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4
Length	48 minutes	45 minutes plus 30 min follow-up	45 minutes plus 30 min follow-up	49 minutes

Table 1: Interview details with four organisations

Description of SIS Technologies Being Used

This section will detail and describe which technologies were used by each company/project and the reasons for their implementation.

Amsterdam CTO

Interviewee 1, is involved in many projects, such as Signals (or Signalen in Dutch), which is a system for citizens to report their complaints or feedback about what is happening in their neighbourhood. For example, if a citizen sees a broken streetlight, garbage has not been collected, or there is a rat problem, they have the opportunity to report these incidents through an app or on the website. The innovation team use NLP (Natural Language Processing) to determine what citizens are saying in order to be able to help them quickly and effectively. Citizens can log their complaint anonymously or provide their name, telephone number, and additional information. These complaints are then sent to the relevant departments, i.e. the police department or the waste management department. The SIS technology also identifies if multiple complaints come from the same person, or if multiple people make complaints about the same issue, in which case it is prioritised.

Amsterdam CTO also has a chat-bot for the 'I Amsterdam' website called Goochem, which tells people about upcoming events in Amsterdam. The chat-bot is in Dutch, but there is the aim to develop it in English. Another project that Interviewee 1 is working on is determining asset management within the city through the use of panoramic

images and image recognition AI. This SIS is used to evaluate panoramic images to determine if specific areas have traffic signs and if these match the records that the municipality have. It is in its early stages of development, but it is hoped that this technology will be used for a wide range of asset management in the city. They also have an open data website called City Data[3], which has a wide range of different datasets available. It is an open platform which encourages citizen engagement with these datasets.

Copenhagen Solutions Lab (City Data Exchange)

The primary motivation in the City Data Exchange was to create an innovative platform for the exchange of data. The goal for this exchange was to improve the quality of life for citizens and the business environment of the region, through a partnership with Hitachi. Hitachi provided a cloud-based technology platform to exchange data between data brokers and companies requiring access to this data. Interviewee 2 explained that the platform was able to handle different kinds of data and was agnostic[4] in terms of input and output. Pricing was set by the data suppliers or data publishers on a per download basis. Interviewee 2 indicated that it was not a particularly technologically savvy algorithm that was used, stating it as:

> *'input- presentation – output' (Interviewee 2).*

He noted that it was an uncomplicated systems delivery platform. According to Interviewee 2, the project had no ethical issues because it was a purely technical platform. He saw the project as a technical solution to a technical problem.

'From an ethics point of view, I feel that both the initial layout of the project and also the actual delivery was pretty straightforward and has no ethical impacts' (Interviewee 2).

[3] https://data.amsterdam.nl/#?mpb=topografie&mpz=11&mpv=52.3731081:4.8932945&pgn=home

[4] In the context of IT technology, 'agnostic' means something (e.g. a software, hardware, business process) that can be operated on various systems.

Figure 7: MySMARTLife graphic, https://www.mysmartlife.eu/

Deutsche Telekom (MySMARTLife)

Our interviewees' work (Interviewee 3)centres on the 'digital transformation' aspects of a city and MySMARTLife focuses on designing new ways to shape the digital ecosystem of the city. According to the project plan, there are two phases of the project: the 'doing phase' and the 'monitoring phase', which will run until 2019. Part of the pilot project is a retrofit[5] of mobility interventions, these will be completed by the end of 2019. Overall, MySMARTLife has three main levels of activities: "Inclusive Cities", "Smart People" and "Smart Economy". "Inclusive Cities" refers to offering a high quality of life to residents, "Smart People" refers to the citizen engagement in the city's development. Smart Economy refers to the economic level aimed at increasing employment,

> *'attracting talents and providing goods and services according to the actual requirements' (Interviewee 3).*

The project planned technological solutions in connection with refurbishing buildings, utilising renewable technologies, clean transport and ICT solutions (MySMARTLife 2018a). Interviewee 3 describes the technology as agnostic, with regards to their cloud system. Regarding the used ICT system, based on OGC[6] standard already used in Hamburg and the DT Smart City Lab approach using oneM2M, he described their approach as cloud agnostic & interoperable, avoiding a vendor lock-in often feared by cities and

[5] The addition of new technologies to older systems.

[6]Open Geospatial Consortiumis an international organisation that tries to ensure quality open standards for the geospatial community.

communities. A standardized ICT back-end (open urban platform) guarantees interoperability and sustainability in terms of availability of data.

> *'You can do it, you can program it yourself' (Interviewee 3).*

There are two different methods of data collection being used, the first includes open data which is already being collected by the city of Hamburg through things such as electric mobility charging points. There is the aim that new data collected from 'objects' (i.e. smart street lights) will be integrated with existing data so that cities such as Hamburg can use this data to successfully. The project is doing this by ensuring that this data is usable. The purpose of the project is to integrate new data collected by way of street lights and mobility into existing data. The key motivations for this are to ensure sustainability in the energy sector, successfully implementing mobility goals, and improving traffic flow in cities. Interviewee 3 has worked on ensuring the platform's interoperability as an open urban standardised platform.

Helsinki Municipality

In Spring 2018, a team of 15 – 20 people developed an agenda to utilize machine-learning techniques for better customer experience and citizen engagement. The Helsinki municipality realised that this is one way that they can digitalise the city and transform some of their currently existing services. One way that they are doing this is through the use of AI chat-bots that respond directly to citizens' requests online. This service was developed initially to help the citizens of Helsinki to acquire parking permits but is hoped to be used and integrated for a wide array of different services in the future.

The chat-bot was built using IBM Watson technology because that is the web portal that the city runs on, so it was the obvious choice for the municipality. Interviewee 4, our interviewee, said that they were open to input from organisations specializing in the chat-bot development, such as Accenture and Boost AI in Norway. The chat-bot uses SIS technology and learns through supervised learning methods, but it is still limited to type-recognition. While there are ambitions to develop the chat-bot to detect voice recognition, they aim to improve text-recognition before developing voice recognition.

SIS Technologies Effectiveness During Use

Amsterdam CTO

Interviewee 1 mentioned that Amsterdam is starting an algorithmic auditing project with KPMG in November 2018 to look at the effectiveness of the algorithms that they use to determine if they are fit-for-purpose or if they need to change any aspects of them. The purpose of this auditing is to determine whether their SIS technologies are working effectively and to demonstrate the municipality's emphasis on transparency and to receive a critical third-party analysis of their projects.

> *'So, the decisions that are made by the algorithm, do they represent the algorithm? And is it implemented in a way that is correct? Do we have control over it? Like, do we monitor the decision that it makes?' (Interviewee 1).*

Interviewee 1 mentioned that there is an initial period in which interactions and collaborative effortsare emphasized between both the computer scientists creating algorithms and those working in the policy/legal division of the municipality to ensure that their algorithms abide by the legislation. However, she was unsure if they continued with this collaboration after this initial period.

Copenhagen Solutions Lab (City Data Exchange)

One of the expected impacts of the City Data Exchange project was to improve innovation in the region by creating a platform to facilitate data exchange. However, during the project, several problems became evident. The first was that each individual company had very different needs and expectations of the actual information derived from the data. The data requested was very specific and very expensive to deliver to a single customer. Throughout the project, the developers attempted to find ways to bundle the demands for data, but it was difficult to find a one-size-fits-all solution. Unfortunately, there were quite a fewtransactions overall - alluding to the failure of the platform as an intended marketplace. The main reason for this was due to the

> *'organisations having to both find the publishers or the suppliers and the customers' (Interviewee 2).*

This was a major impediment to the effectiveness of the platform. The platform was espoused as being able to handle a lot of different kinds of data, but sometimes there were tensions between the demands of the customers and the intended use of the platform:

> *'They (the companies using the platform) needed a specific supplier for their specific problem' (Interviewee 2).*

Another major issue was that the data that was most interesting for the buyers (mainly people movement patterns) was one of the most difficult to acquire. The idea of a general platform of data exchange was ineffective and upon reflection Interviewee 2 noted that if revisited the platform would only be a specific platform based on specific-use cases rather than a general platform. He noted that a more effectiveapproach should be based on general traits gathered from the specific-use cases:

'Public innovation should be built on experience and not expectations' (Interviewee 2).

Figure 8: Image from https://www.mysmartlife.eu/

Deutsche Telekom (MySMARTLife)

Due to the project's ongoing nature, the technology appears to be working as intended. Interviewee 3 maintains that the technology is relatively simple and at this stage, there was nothing to report back in terms of effectiveness. The data that is being collected is largely in the being based on pre-existing data and using the devices such as Smart lighting that have been put in place – this appears to be working as intended. Whether or not the individual technologies are effectively collecting data is another issue that has yet to be determined. Since the project is ongoing the effectiveness of the technology is something that could be revisited at a later stage once the project has culminated, if the opportunity arose.

> *'Many, many cities…have a lot of data available already. So therefore if there now is a question of what is the extended data, or the additional data... But you might have additional data, or you would maybe create, based on existing data, new data. This is what smart cities are about.'(Interviewee 3)*

Helsinki Municipality

Interviewee 4 raised the point that they are aware that they need to identify ways to integrate these new technologies and platforms within their currently existing platforms, which may not always be straightforward. There is a need for better understanding of SIS technologies and how they function so that they can be incorporated into feasible and effective ways. Furthermore, the team that is using and integrating these technologies needs to be aware of how they may potentially affect the relationship and dynamic of the team using them and for those that will interact with them. The use of AI is different from traditional ICT because

> *'it's more dynamic, rather than static' (Interviewee 4).*

However, he is aware of the limitations of the technology that they are using, that there are better chat-bots available on the market, so they are constantly looking for better options, solutions, and technologies to implement, within their budgetary constraints. He

also noted that the chat-bot that they were integrating had difficulties that a lot of other chat-bots do not face, namely, trying to understand the Finnish language. While text-recognition technology has been developed for the Finnish language, it may not be as advanced as the technology available to recognize English.

Stakeholder Engagement

Amsterdam CTO

Interviewee 1 stated that the aim of a digital city, and understanding how AI technologies impact a city, were very important for the municipality. One way of understanding this is by receiving citizen feedback, which Amsterdam retrieves through a 'Demo Thursday', which allowed the municipality to discuss their SIS projects with the public:

> *'So, everyone that comes along is able to say something or ask stuff or try to think of better ways to work with the whole plan' (Interviewee 1).*

Amsterdam Innovation Team places a great deal of importance on SIS that may have an effect on people and Interviewee 1 acknowledged that if they want to have

> *'an algorithm or if we want to apply machine learning for a really serious cause with really important decisions made by a machine then it should be so well investigated upfront because you can't make any mistakes. Because you have all these people here to take care of and you don't want to do something bad' (Interviewee 1).*

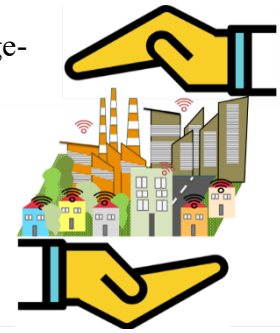
She stated that most of the rules that civil servants follow is common sense and are already captured in the civil servant oath. Amsterdam municipality AI experts are aware of these and factor these principles into their projects. However, she is aware that sometimes there are 'grey areas', where it becomes a little unclear about the best course of action to take.

Copenhagen Solutions Lab (City Data Exchange)

With the City Data Exchange, the stakeholders who were involved were the Municipality of Copenhagen and the Council Region of Copenhagen in collaboration with Hitachi (the platform provider). In contrast to the other projects, the main goal of the project was not citizen engagement but rather that of bettering business in the region through a marketplace of data exchange.

Deutsche Telekom (MySMARTLife)

Interviewee 3 stated that one of the grant requisites was citizen engagement, which was a big part of the project (MySMARTLife2018b). Within the project, each lighthouse city has an individual a plan for how to integrate citizens into the project. While the project aims to incorporate citizen engagement within the projects, it is important to note that citizens were not engaged prior to the implementation



of the project. Interviewee 3 identified this as a 'difficulty' and the 'weak spot of the project' because professionals

> *'start from a technology perspective and they talk to the people rather than the other way around' (Interviewee 3).*

He maintained that the majority of people will not understand the intricacies of the project and SIS technology, despite having very high expectations of the project:

> *'90 percent of the people won't understand you anymore because you are so deep in the subject' (Interviewee 3).*

He emphasizes that in order to include people in the discussion the topics need to be simplified. Some of the methods Hamburg is using to achieve this are the project office, the website, posters and a questionnaire. Citizen engagement is viewed by Interviewee 3 as integral to the project and Smart Cities in general because

> *'at the end of the day they use it rather than you have a dull city...which is full of technology, but no one wants to live there and it's maybe not useable because the people don't understand it' (Interviewee 3).*

In order to do this, they aimed to support cities by integrating a range of different stakeholders in the projects. There are also industrial stakeholders in each pilot project. For Hamburg, the industrial stakeholders are VW and Deutsche Telekom. There are also regional partners, two universities and city companies as well as the city itself.

Helsinki Municipality

Helsinki municipality developed their chat-bots because they viewed them as good user interfaces for many of the services they provide, a tool that could increase access to information between the municipality and the citizen. Using chat-bots there are a number of ways that citizens can engage with the municipality about voicing their opinions about the use of SIS. For example, there are apps and the municipality website where they can lodge complaints or concerns about any issues they want to raise, and these requests are then sent to the relevant department or division.

So, if they have any issues with the chat-bot, then those working on it will receive the concerns and feedback. In addition to accommodating citizens' concerns about SIS, there is a need to have fully qualified individuals working in the municipality on SIS. Interviewee 4 indicated that the municipality is creating different relationships with specialists developing AI in the city; for example, it is being taught in Helsinki University, which has over 20 AI specialists in a range of different fields.

Ethical Analysis of Smart Cities Using SIS

As a result of the four interviews conducted with the organisations discussed in the previous section, a few important overlapping ethical issues became prevalent when implementing SIS technology in practice:

The issues discussed in the interviews broadly reflect the same issues that are found in the smart city literature on the topic. There is a great deal of correlation and understanding of the most pressing ethical issues within the application of SIS technology in smart cities. While some projects had a greater concern for certain topics (i.e. Copenhagen and Helsinki had economic concerns), all shared an understanding of the importance of other ethical issues, such as privacy and data ownership. Overall, the organisations all wanted to achieve the best possible results in their respective projects and to use SIS to provide accurate recommendations and added benefit to society, as a result.

The Accuracy of SIS and Bias

Determining the accuracy of information and bias are both crucial components of the case study's validity. Interviewee 4 said that the chat-bot is still in its early stages of implementation for car parking permits and they are aware that there will be teething issues in the process. They hope that within the next half year they will be able to develop scenarios and protocols for when the bot does not work as intended. So far, the SIS technology appears to be working quite effectively in the demo stages and the hope is that the chat-bot will be able to understand the intent of the customer to provide them with sufficient information about their requests. Once it has been implemented, there is a process to determine whether it is working effectively, and the customer has the ability to give feedback about their experience.

Interviewee 4 also indicated that there were ways to effectively train their algorithms on useful data, such as calls logged from customers to the department, but was aware that this may invade privacy and violate the General Data Protection Regulation (GDPR). Therefore, they will look into the possibility of indicating to customers that their data would be used in this way and receive informed consent to do so. He indicated that all of the data would be anonymised and aggregated, so there would be no privacy violation of sensitive or personal information. He stated that there is a strong focus on having sufficient training for those working with machine-learning to ensure that they are aware of how it functions and to identify possible issues as a result of using it. Interviewee 4 mentioned that the disadvantages or harmful effects of using the chat-bot are minimal in comparison to other applications of SIS. He stated that the worst that could happen is that the chatbot does not work effectively, then the customer can just use the traditional way of getting the parking permit. It would be a minimal inconvenience, but he is aware that if it is used for other services, it may create greater issues.

This is very interesting because Interviewee 1 raised a similar concern about Amsterdam's implementation of SIS. She states that they are still in the developmental stage and their system is being used in situations that will have minimal negative impacts on the lives of Amsterdam citizens, such as with the example of the panoramic images project. It is not really a big problem if the SIS is ineffective, as the only real issue is that they will not have accurate information about the traffic lights in the city to compare with their

own data on traffic lights. However, one way that the department is combating potential issues with their SIS is by conducting external third-party algorithmic auditing from KPMG, in order to ensure they are working according to intent. This is to ensure that they work how they are supposed to and provide benefit to the people of Amsterdam.

Availability and Accuracy of Data

Interviewee 2 indicated that there were very few problems with the technical parts of the project but delivering results was not straightforward. The Copenhagen City Data Exchange was originally conceived as a general platform based on the idea that data is interchangeable, but in practice, the specificity of data-usage undermined this original idea:

> *'Talking about it as a general resource is obscuring the ability to provide value' (Interviewee 2).*

It was difficult to collect data from businesses because they were concerned it would affect their competitiveness. Interviewee 2 identified that the availability of data in itself was not sufficient for the creation of the marketplace due to the specificity of the needs from individual clients. He mentioned that if their platform had succeeded, it might have run into other issues, such as the data supplier with a valuable dataset may wanting some kind of control over how it is used.

Interviewee 3 noted that data availability is a fundamental requisite for the success of Smart City Projects, but in practice, this can be difficult. WhileInterviewee 4 also stated that data is very valuable nowadays and if algorithms have good training data they can work more optimally. He indicated that algorithms depend on the accuracy of data they are trained on, so there is a constant process of developing better procedures for acquiring and testing this data to ensure that it is fit-for-purpose.

Interviewee 4 hoped that the municipality will be able to retrieve and use their own training data for their algorithms, rather than relying on third-party vendors for this. While he was aware that they need to use vendors in a wide array of contexts for the successful integration of SIS technology, they do not want to become locked in by those organisations. The municipality wants to avoid dependence on third-party companies and is trying to create its own training data. This was a very interesting insight because Interviewee 2 also highlighted the fact that it was often difficult to retrieve data from private companies because they viewed the Copenhagen City Data Exchange platform as "parasitic" and of no benefit to them. Unless there was an identifiable benefit for the companies, they did not want to take part in the projects. However, Interviewee 3, who works for one of these private companies (Deutsche Telekom), indicated that they actually want to give control to the city. The city should

> *'own and reign over the data, not a company' (Interviewee 3).*

Interviewee 3 stated that city officials should work with private partners for the responsible collection of data. It is important that cities work together with private companies to form an 'agreement' for the purpose of data collection. Overall, this interaction between public-private was an interesting area of discussion with the interviewees and it appeared that the tensions were often underpinned by economic interests.

Economics and Inequalities

Interviewee 3 stated that smart cities are about collaboration between corporations and municipalities and not simply the sale of services according to a standard business model. He also mentioned that there are many issues to overcome, such as bureaucratic hurdles or negotiations with investors showing the difficulty of economics versus sustainability since renewable energy solutions are often not priced competitively - this complicates and slows down the projects he is involved in. In the City Data Exchange project, the city of Copenhagen and the council region of Copenhagen initially invested the funding into the project and hoped that Hitachi would develop the project further. In terms of Hitachi's benefit from the project, Interviewee 2 mentioned that

> *'they won an offer and got some seed capital to start up the organisation and the project' (Interviewee 2).*

According to Interviewee 2, Hitachi gained smart city acknowledgement and credit as a result. That being said, he stated that there was a tension between public and private entities within the project and indicated that public entities focus on providing value to citizens whereas this may have been a hindrance in the economic development of this project. One of the problems with Hitachi's involvement was the limitation of public funding as

> *'it forced them to continue the project beyond what they would normally do' (Interviewee 2).*

Interviewee 2 remarked thatthe outcome would have been a purely Hitachi product, it probably would have been terminated earlier, as they would have prioritised their invested interest. It would have been deemed too costly and loss-making to continue.This private sector response for ensuring profit can be contrasted with how public sector organisations may respond to the implementation of SIS. For example, Interviewee 4 indicated that the Helsinki municipality has an obligation to ensure job security for its staff, regardless of SIS efficiency. He stated that because it is the public sector, their jobs are protected, and if anything, the chat-bots are designed to take the strain off them and aid in their positions:

> *'they are training the software robot to handle more and more tasks, and I understand that it's been very welcome; there are a lot of mundane, routine tasks that now can be given to the software robot, and it needs to be trained' (Interviewee 4).*

Use of SIS technology…would not cause job losses, but rather reduce the workload of employees

The use of SIS technology within Helsinki municipality would not cause joblosses, but rather reduce the workload of employees in the public sector. There is the aim to have more services automated:

> *'instead of people answering questions, a machine can answer the questions and actually handle the permits. So, save time and resources, and then to be able to allocate existing human resources into tasks that require more human attention' (Interviewee 4).*

SIS will help municipality staff so that they are not restricted by time or workload constraints. Interviewee 4 also proposed that in the future, if they had access to more citizens' data, it may allow the municipality to use other forms of SIS to intervene in circumstances where citizensrisk falling into poverty. There is the possibility of helping them prevent this in advance, by using SIS and predictive algorithms. In addition to reducing inequality locally, some of the interviewees hoped that their projects could be used in other cities, as well. Interviewee 1 also stated that Amsterdam is working with other smart cities in their development of technology and innovative practices, both nationally and abroad. However, it is important that the transferral and use of data take privacy concerns into account.

Privacy and Data Ownership

Amsterdam is involved in a number of European projects, such as Decode, which unites a range of different stakeholders and smart cities to develop innovative ideas to progress their projects. One of the main focuses of this project is to allow citizens greater control over their personal data and to ensure their privacy.

Interviewee 1 elaborated that this is a very important factor for all of her colleagues working on SIS in the city of Amsterdam – that people have control over their own data. It is a given that all of her colleagues work with privacy concerns in the back of their mind when using SIS. They also ensure that people cannot be traced using their SIS because they only analyse areas when they have a minimum number of people, whereby it is impossible to identify individuals amongst the group. Interviewee 1 stated that when they retrieve data from a certain area, they will always ensure that there it is a large number of people to ensure that their data is not traceable to a particular individual.

In contrast to Amsterdam's approach, Interviewee 2 claimed that personal data never ended up on their portal, so privacy was not an issue. They were GDPR compliant almost a year before the policy came into effect and they follow it strictly in order to fulfil its requirements. He also mentioned that they had an onus of responsibility to ensure that they were GDPR complaint. He stated that

> *'GDPR compliance was the responsibility of the suppliers, […] they signed an agreement in which they stated they would be GDPR compliant' (Interviewee 2).*

Similarly, Interviewee 3's MySMARTLifeonly dealt with data that has no locational or personal aspects to it. The project only uses 'object data'; for example, data retrieved from lamp posts and waste disposal machines.

> *'The second level [personal data] is definitely coming but it will be and has to be handled in a different way this is a subject to be tackled as well and will have some more obstacles to be overcome' (Interviewee 3).*

However, in the follow-up interview, Interviewee 3clarified that if this data were obtained, there would be explicit consent from the individuals, and their data would be anonymised. While Helsinki's chat-bot project retrieves the name, address, and vehicle registration number, from citizens looking for parking permits, Interviewee 4 indicated that the goal is that

'information would be stored in your citizen profile. And if you want, any time, you can log into your profile, see what data the city has about you, where it has been used, and you can give your consent to use it elsewhere, take it out, et cetera. But basically, you control it' (Interviewee 4).

There is a strong emphasis on the citizens owning and controlling their data and personal information and consenting to its use. Interviewee 4 states that it would be unethical for a state to use citizens' data to intervene in their lives without their consent. However, it is also important to identify who has control over data in public-private smart city projects. For example, Interviewee 2 mentioned that

'only Hitachi had control over the data once they were published on the portal' (Interviewee 2).

Therefore, there is a need for transparency and involvement between partners in order to ensure a fair and equitable interaction within smart city projects. While private organisations may be best suited to control and manage SIS, there needs to be an understanding between partners and a strong degree of transparency in their relationship.

Transparency and Trust

In the City Data Exchange project, Interviewee 2 elaborated that transparency was not an issue in the City Data Exchange project because the systems and methods being used were very simple and the project did not try to conceal anything about how it functioned. While Interviewee 3 stated that there has to be a symbiotic relationship of trust between corporations, citizens and municipalities working on Smart City projects. He also mentioned the transparency law of the City of Hamburg, which requests by law that all city data is openly accessible and availability and this has been considered in MySMARTLife.

Transparency is a key component to citizens being able to trust their cities and allow Smart Cities to

Interviewee 3also mentioned that there is a transparency law which necessitates that some of the data needs to be publicly available or officially provided on the website, for their project in Hamburg. Interviewee 4 also understands that incorporating SIS within city contexts requires a great deal of trust from citizens for these technologies to be adapted successfully:

'And it's a very delicate trust issue' (Interviewee 4).

In the chat-bot project in Helsinki, they also aimed to be transparent to citizens, showing that they were not speaking with a human, but a bot:

'clearly explaining to people that, "You are now talking to a chat-bot"' (Interviewee 4).

Interviewee 1 also said that transparency and trust were important issues for Amsterdam municipality:

'you might want to make it transparent for all citizens', and she hopes that *'citizens trust our municipal as well as the city already' (Interviewee 1).*

Interviewee 1 claimed that those creating and using algorithms should be accountable for the choices that they make:

> *'So, it's our duty then, our responsibility to make sure that the algorithms are working' (Interviewee 1).*

Conclusion

This case study has offered many insights into the development, use and implementation of SIS technologies within smart city contexts in order to uncover ethical and social issues throughout these approaches.

We analysed four different organisations in order to retrieve an inclusive, varying look at how cities, semi-state bodies, and corporations develop and integrate SIS technologies in four major European cities (Amsterdam, Copenhagen, Hamburg, and Helsinki). The four interviewees were involved in varying projects, so we were interested to see if they had divergent concerns or if there were consistent overlapping ethical themes throughout. For instance, Interviewee 1 (Amsterdam) discussed her work on a Natural language processing(NLP) citizen complaint technology; Interviewee 2 (Copenhagen) spoke about sharing large datasets; Interviewee 3 (Hamburg) concentrated on an open standardized platform using smart energy and smart mobility solutions, and Interviewee 4 (Helsinki) discussed an AI customer-service chat-bot.

The level of public-private discussion throughout the four interviews was also very interesting, with a wide range of different approaches throughout. Amsterdam is attempting to implement SIS independently from corporate involvement, as much as possible. The data-sharing project in Copenhagen hired Hitachi to assist them, and the project in Helsinki used IBM Watson in-house but hoped to involve tech corporations in the future. While Interviewee 3,who is working on the project in Hamburg,is employed by Deutsche Telekom a large multinational German telecommunication provider. Throughout all four interviews, they highlighted the need to have a transparent relationship between public and private sectors in smart city development.

The diversity of interviewees and projects allowed for a diverse and informative mix of approaches and viewpoints for our case study. All four interviewees identified a range of ethical issues pertaining to their particular projects, with a great deal of overlap and similar issues being faced throughout. There was a great deal of similarity between organisations, particularly in relation to their concern and protocol for dealing with privacy concerns; understanding of the importance of accurate available data; economic concerns with implementing SIS; and ensuring trust and transparency to the general public. However, interviewing four different organisations also created limitations for our case study.

Limitations

One of the main limitations of this case study is that it was based on only one interview per organisation (four interviewees total from four organisations). While, each interviewee was very knowledgeable about SIS and their societal and ethical impacts within their contexts, the case study would have been improved by additional interviews in each organisation to avoid bias and allow for an increase in perspectives. While it was interesting and useful to incorporate a wide diversity of SIS, organisations, and smart city projects, it was a limiting factor when comparing them.

The case study focused on a few very specific applications of SIS within municipalities (chat-bots, SIS research project, SIS complaints procedure, and Big Data sharing), making it impossible to establish broader deductions about SIS in smart cities, generally. Also, each organisation adopted divergent approaches to ethical issues because of the different types of SIS being used. One example of this is their approach to citizen engagement: Amsterdam actively pursues citizen focus groups, MySMARTLife and the Helsinki project only integrate citizen feedback in the use stage, while Copenhagen had very little citizen engagement at all.

An additional limitation resulted from discrepancies in relation to their concern about certain ethical issues, such as their reason for being concerned about transparency (interviewee 1 – obligation to citizens, interviewee 2 – it was a non-issue, interviewee 3 – obliged by Hamburg law, interviewee 4 – acceptability requires transparency). Therefore, it was difficult to form a cohesive understanding of broader assumptions about the implementation of transparency in smart city projects. Furthermore, all four projects were at different stages of development, making it difficult to compare their successes and failures. For example, Helsinki's chat-bot and Amsterdam's SIS project is in its early stages of development, while Hamburg's MySMARTLife project is matured, and the Copenhagen project has ceased.

A further limitation came from the knowledge and expertise of the interviewers. The interviews were evenly shared between two interviewers with different backgrounds and approaches. One interviewer is an ethicist and the second is a cultural anthropologist, which may have led to different focuses of the interviews, namely, a concentration on ethical issues or social dimensions, respectively. While both had interview experience, only the latter had a background in process of social science interviews.

Contribution to Knowledge

While there have been case studies on smart cities before, they have been few in number,mostly non-European cities, and with little focus on SIS (Bakıcı,Almirall, and Wareham 2013; Hielkema and Hongisto 2013; Lee and Gong Hancock 2012; and Mahizhnan 1999). This case study offers an innovative analysis of smart cities by analysingorganisations not been discussed in the literature. This report provides fresh insights into the field of SIS in urban European contexts and how developers are approaching the ethical implementation of such technologies. While smart cities are discussed, evaluated, and critiqued within the field, there is rarely any detailed, specific analysis of the ethical implications of using SIS within smart city projects. This report offers theoretical value to the field of smart city knowledge, to urban SIS understandings, and to SIS ethics literature.

The interviews contained elements that were not addressed, or at least were given minimal attention, in the literature on smart cities, such as transparency and trust. While these area popular topic within data circles, they were not explicitly discussed in any smart city SIS literature. This report will greatly contribute to the debate by providing insights from four smart city projects and how they approach the issue of trust and transparency within their organisations.

Another issue is that the literature deals with the smart city concept and how it impacts the meaning of the city, too broadlyfor individual smart city projects. While the interviewees discussed most of the topics in the literature (such as privacy, transparency and trust), they did not draw out issues such as the digital divide between cities, countries, and rural areas. It became evident that there is a tension between theoretical concerns and those faced by people working 'on-the-ground'. The literature often concentrates on future-focused issues that may not even materialise, while also concentrating on 'big pictures' issues, whereas smart city projects are more concerned with pragmatic tangible issues relevant to their individual projects. Municipality SIS projects are primarily concerned with the impact of SIS on their citizens, rather than other groups within society.

Implications of this Report

Smart cities are a new development (first coined in 2008), along with the integration of SIS in urban contexts, so it is important to understand what kind of implications this will have on citizens' day-to-day lives and society as a whole. So far, there has been little policy to regulate SIS use in smart city projects, so this report hopes to offer unique feedback for future policy developments. Therefore, the effects of using SIS within smart city projects have not yet materialised, because of their infancy. While all four projects emphasised that their technologies had minimal-to-no harmful effects on the lives of citizens, this is not to say that more disruptive technologies will not be advanced in the future, making it vital that smart city projects continue to integrate ethical principles and approaches to avoid potentially harmful impacts.

As the case study gathered information from a variety of sources, conclusions from the comparison of these case studies can potentially be applied to other smart cities pilot projects. One such implication was the inclusion of citizen engagement in many of the projects – Amsterdam's Demo Thursday, Helsinki's apps for customers to lodge feedback, and Hamburg's citizen engagement project mandate. Although engaging citizens remains problematic, due to the often tokenistic nature of the application and lack of engaging citizens prior to the project planning, the move towards engaging citizens demonstrates a positive move away from the corporate agenda towards a citizen-centred.

It should also be noted that across all of the projects the importance of privacy, trust, transparency and compliance to laws such as GDPR were paramount. Methods to maintain the privacy of data were: the anonymization and aggregation of data (Helsinki and Hamburg)and GDPR compliance on the part of those who deliver the data (Copenhagen). Applications of transparency became apparent through both the chat-bot in Amsterdam, which explained clearly that it was a bot, and in Hamburg under the transparency law, but remained more abstract for the other projects. Trust, on the other hand, being

subjective is ‘a very delicate issue’ (Interviewee 4) and although being an ‘important issue’ has fewer concrete actions attached to it.

In addition, our case study will have implications for policy development in the areas of ethical use of SIS in smart cities of the future. There has been very little guidance on how to effectively and ethically implement SIS in smart cities within policy frameworks and guidelines, particularly in a European context. While there are many more general guidelines relating to AI use, privacy protection, cybersecurity protocols, and so forth; there are few frameworks for municipalities to follow when adapting and pioneering SIS technology within their cities. However, this is not to say that additional case studies on the ethical use of SIS in smart cities will not find different issues and bring new perspectives to the debate.

Further Research

This case study has provided a literature review of some of the most important ethical and social issues within the field of smart city SIS technologies. The review was also used as an overview to lend credence to our evaluations of the four organisations that we interviewed. However, there may be additional ethical issues within the literature, or that may arise in the coming years, that need to be evaluated and discussed. Overall, there is a distinct lack of empirical research done on smart cities, specifically analysing how they ethically use SIS technologies.

There is a need for more case study reports on smart cities generally, and more specifically, on European-based projects and smart city projects heavily involved integrating SIS technology. It may also be interesting to conduct further research on the projects discussed in this report at a future date to examine their progress and if they were successfully implemented. Overall, this case study hopes to offer a fresh examination of this topic, laying the groundwork for further research to be done in this area.

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References

Albino, Vito, Umberto Berardi, and Rosa Maria Dangelico, "Smart Cities: Definitions, Dimensions, Performance, and Initiatives", *Journal of Urban Technology*, Vol. 22, Issue 1, 2015, pp. 3-21.

Bakıcı, Tuba, EsteveAlmirall, and Jonathan Wareham, "A Smart City Initiative: The Case of Barcelona", *Journal of the Knowledge Economy* Vol. 4, Issue 2, 2013, pp. 135-148.

Bartoli, A., J. Hernández-Serrano, M. Soriano, M. Dohler, A. Kountouris, and D. Barthel, "Security and Privacy in your Smart City",*Proceedings of the Barcelona Smart Cities Congress*, Vol. 292, 2011, pp. 1-6.

Batty, Michael, Kay W. Axhausen, Fosca Giannotti, Alexei Pozdnoukhov, Armando Bazzani, Monica Wachowicz, Georgios Ouzounis, and Yuval Portugali, "Smart Cities of the Future", *The European Physical Journal Special Topics*, Vol. 214, Issue 1, 2012, pp. 481-518.

Brokaw, Leslie, "Six Lessons From Amsterdam's Smart City Initiative", *Sloan Review*, May 25th 2016, https://sloanreview.mit.edu/article/six-lessons-from-amsterdams-smart-city-initiative/

Chourabi, Hafedh, Taewoo Nam, Shawn Walker, J. Ramon Gil-Garcia, SehlMellouli, KarineNahon, Theresa A. Pardo, and Hans Jochen Scholl, "Understanding Smart Cities: An Integrative Framework", *45th Hawaii International Conference on System Science (HICSS)*, 2012, pp. 2289-2297.

Condliffe, Jamie, "AI Has Beaten Humans at Lip-reading", *Technology Review*, November 21st 2016, https://www.technologyreview.com/s/602949/ai-has-beaten-humans-at-lip-reading/

Copenhagen Solutions Lab, "Contact: Interviewee 2", *CPH Solutions Lab* [website], 2018, available here: https://cphsolutionslab.dk/en/people/frans-la-cour

Daalder, Leonieke, "Ger Baron (CTO of the Municipality of Amsterdam): 'How do we go from Government to GovTech?'", Marketing Facts, 6th March 2018: https://www.marketingfacts.nl/berichten/ger-baron-cto-gemeente-amsterdam-overheid-govtech

Deutsche Telekom, "At a Glance", *Deutsche Telekom* [website], retrieved November 6th 2018, available here: https://www.telekom.com/en/company/at-a-glance

European Commission, "The Digital Economy and Society Index", *European Commission* [website], 2018, available here: https://ec.europa.eu/digital-single-market/desi

Finn, Rachel L., David Wright, and Michael Friedewald. "Seven Types of Privacy", *European Data Protection: Coming of Age*, Springer, Dordrecht, 2013, pp. 3-32.

Foth, Marcus, "The Software-Sorted City: Big Data & Algorithms", Odendaal, Nancy and Alessandro Aurigi (Eds.), *Digital Cities 10: Towards a Localised Socio-Technical Understanding of the 'Real' Smart City*, 26 June 2017, Troyes, France, 2017.

Galdon-Clavell, Gemma, "(Not So) Smart Cities?: The Drivers, Impact and Risks of Surveillance-Enabled Smart Environments", *Science and Public Policy*, Vol. 40, 2013, p. pp. 717-723.

Glasmeier, Amy, and Susan Christopherson, "Thinking About Smart Cities", *Cambridge Journal of Regions, Economy and Society*, Vol. 8, 2015, pp. 3-12.

Guo, Kun, Yueming Lu, Hui Gao, and Ruohan Cao, "Artificial Intelligence-Based Semantic Internet of Things in a User-Centric Smart City", *Sensors*, Vol. 18, Issue 1341, 2018, pp. 1-22.

Harris, Mark, "AI-Powered Body Scanners Could Soon Be Inspecting you in Public Places", *The Guardian*, 2nd October 2016, 2016, https://www.theguardian.com/technology/2016/oct/25/airport-body-scanner-artificial-intelligence

Helsinki Smart Region, "About: Helsinki Region", *Helsinki Smart Region* [website], 2018a, available here: https://www.helsinkismart.fi/about/about-helsinki-region/

Helsinki Smart Region, "Why Finland and Why the Helsinki Region?",*Helsinki Smart Region* [website], 2018b, available here: https://www.helsinkismart.fi/about/top-rankings/

Hielkema, Hendrik, and PatriziaHongisto, "Developing the Helsinki Smart City: The Role of Competitions for Open Data Applications", *Journal of the Knowledge Economy* Vol 4, Issue 2, 2013, pp. 190-204.

Hollands, Robert G. "Critical Interventions into the Corporate Smart City",*Cambridge Journal of Regions, Economy and Society*, Vol. 8, Issue 1, 2015, pp. 61-77.

Kitchin, Rob, "Big Data and Human Geography: Opportunities, Challenges and Risks", *Dialogues in Human Geography*, Vol. 3, Issue 3, 2013, pp. 262-267.

Kitchin, Rob, "Data-Driven Networked Urbanism", *The Programmable City Working Paper 14*, 10th August 2015, 2015a.

Kitchin, Rob, "Getting Smarter about Smart Cities: Improving Data Privacy and Data Security", *Data Protection Unit*, Department of the Taoiseach, Dublin, Ireland, 2016a.

Kitchin, Rob, "Reframing, Reimagining and Remaking Smart Cities", *The Programmable City Working Paper 20*, 16th August 2016, 2016b.

Kitchen, Rob, "The Ethics of Smart Cities and Urban Science", *Phil. Trans. R. Soc. A,* Vol. 374, 2016c, pp. 1-15.

Kitchin, Rob, "The Promise and Perils of Smart Cities", *Society for Computers & Law*, Vol. 26, Issue 2, 2015b, pp. 1-5.

Kitchin, Rob, "The Real-Time City? Big Data and Smart Urbanism", *GeoJournal*, Vol. 79, 2014, pp. 1-14.

Kitchin, Rob, Claudio Coletta, Leighton Evans, Liam Heaphy and Darach Mac Donncha, "Smart Cities, Urban Technocrats, Epistemic Communities and Advocacy Coalitions", *The Programmable City Working Paper 26*, 8th March 2017, 2017.

Kitchin, Rob, Tracey P. Lauriault, and Gavin McArdle, "Smart Cities and the Politics of Urban Data", *Smart Urbanism: Utopian Vision or False Dawn?* Routledge, London, 2015, pp. 16-33. ISBN 9781138844223.

Kohli, Devika, "How Smart Cities Will Force the Poor Out", *Youth Ki Awaaz* [website], 2014, available here: https://www.youthkiawaaz.com/2015/07/smart-cities-keep-the-poor-out/

Lee, Jung-Hoon, and Marguerite Gong Hancock, "Toward a Framework for Smart Cities: A Comparison of Seoul, San Francisco and Amsterdam", *Research Paper, Yonsei University and Stanford University*, 2012.

Li, DeRen, JianJun Cao, and Yuan Yao, "Big Data in Smart Cities", *Science China Information Sciences*, Vol. 58, Issue 10, 2015, pp. 1-12.

Macpherson, Lauren, "8 Years On, Amsterdam is Still Leading the Way as a Smart City", *Towards Data Science*, 7th September 2017, https://towardsdatascience.com/8-years-on-amsterdam-is-still-leading-the-way-as-a-smart-city-79bd91c7ac13

Mahizhnan, Arun, "Smart Cities: The Singapore Case", *Cities*Vol. 16, Issue 1, 1999, pp. 13-18.

Martínez-Ballesté, Antoni, Pablo A. Pérez-Martínez, and AgustiSolanas, "The Pursuit of Citizens' Privacy: APrivacy-Aware Smart City is Possible",*IEEE Communications Magazine*, Vol. 51, Issue 6, 2013, pp. 136-141.

The Municipality of Copenhagen and Capital Region, "City Data Exchange – Lessons Learned From A Public/Private Data Collaboration", *CPH Solutions Lab* [website], March 2018, available here: https://cphsolutionslab.dk/content/2-what-we-do/3-data-platforms/3-city-data-exchange/1-learnings-from-the-city-data-exchange-project/city-data-exchange-cde-lessons-learned-from-a-public-private-data-collaboration.pdf?1527149474

Munoz, Mark J., Al Naqvi, "Artificial Intelligence and Urbanization: The rise of the Elysium City", *Economics and Political Economy*, Vol. 4, Issue 1, March 2017, pp. 1-13.

MySMARTLife, *MySMARTLife*[website], 2018a, available here: https://www.mySMARTLife.eu/mySMARTLife/

MySMARTLife, "An Integrated Planning Process, Where Citizens are Actively Involved in the Decision-Making", *MySMARTLife*[website], 2018b, available here: https://www.mySMARTLife.eu/mySMARTLife/

Nigon, Julien, EstèleGlize, David Dupas, FabriceCrasnier, JérémyBoes, “Use Cases of Pervasive Artificial Intelligence for Smart Cities Challenges”, *IEEE Workshop on Smart and Sustainable City (WSSC 2016) associated to the International Conference IEEE UIC 2016*, Toulouse, France, July 2016.

O'Grady, Michael, and Gregory O'Hare, "How Smart is Your City?",*Science*, Vol. 335, Issue 6076, 2012, pp. 1581-1582.

Owen, Richard, Jack Stilgoe, Phil Macnaghten, Mike Gorman, Erik Fisher, and Dave Guston. 2013. “A Framework for Responsible Innovation.” In Responsible Innovation, edited by Richard Owen, John Bessant, and Maggy Heintz, 27–50. London: John Wiley.

Rjab, AmalBen, and SehlMellouli, "Smart Cities in the Era of Artificial Intelligence and Internet of Things: Literature Review from 1990 to 2017",*Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age*, May 30-June 1, 2018, Delft, Netherlands, ACM, 2018.

Roose, Jonatan, “About Amsterdam Smart City”, Amsterdam Smart City [website], 2015, https://amsterdamsmartcity.com/p/about

Shelton, Taylor, Matthew Zook, and Alan Wiig, "The ‘Actually Existing Smart City’",*Cambridge Journal of Regions, Economy and Society*, Vol. 8, Issue 1, 2015, pp. 13-25.

Sholla, Sahil, RoohieNaaz, and Mohammad Ahsan Chishti. "Ethics Aware Object Oriented Smart City Architecture",*China Communications*, Vol. 14, Issue 5, 2017, pp. 160-173.

Srivastava, Shweta, Aditya Bisht, and Neetu Narayan, "Safety and security in smart cities using artificial intelligence—A review",*Data Science & Engineering-Confluence, 2017 7th International Conference on Cloud Computing*, IEEE, 2017, pp. 130-133.

Tung, Liam, “Google AI Can Pick Out a Single Speaker in a Crowd: Expect To See it in Tons of Products”, *ZDNet* [website], April 13th 2018, https://www.zdnet.com/article/google-ai-can-pick-out-a-single-speaker-in-a-crowd-expect-to-see-it-in-tons-of-products/

Vázquez-Salceda, Javier, Sergio Álvarez Napagao, José Arturo Tejeda Gómez, Luis Javier Oliva Felipe, Dario Garcia Gasulla, Ignasi Gómez Sebastià, and Víctor Codina Busquet, "Making Smart Cities Smarter Using Artificial Intelligence Techniques for Smarter Mobility", in *SMARTGREENS 2014: proceedings of the 3rd International Conference on Smart Grids and Green IT Systems*, pp. IS7-IS11. SciTePress, 2014.

Voda, Ana Iolanda, and Laura Diana Radu, "Artificial Intelligence and the Future of Smart Cities",*Broad Research in Artificial Intelligence and Neuroscience*, Vol. 9,

Issue 2, 2018, pp. 110-127.

UNESCO Institute for Statistics, “R&D Spending by Country”,*UNESCO* [website], 2018, available here: http://uis.unesco.org/apps/visualisations/research-and-development-spending/

United Nations, “Goal 11: Make Cities Inclusive, Safe, Resilient and Sustainable”, *UN* [website], 2018, available here: https://www.un.org/sustainabledevelopment/cities/

Yin, R.K.,*Case Study Research Design and Methods*, 5th ed., SAGE Publications, UK, 2014.

Zanella, Andrea, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, and Michele Zorzi, "Internet of Things for Smart Cities",*IEEE Internet of Things Journal*,Vol. 1, Issue 1, 2014, pp. 22-32.

Zhang, Kuan, Jianbing Ni, Kan Yang, Xiaohui Liang, Ju Ren, and Xuemin Sherman Shen, "Security and Privacy in Smart City Applications: Challenges and Solutions",*IEEE Communications Magazine*, Vol. 55, Issue 1, 2017, pp. 122-129.