An Evaluation of COVID-19's Impact on The Smart City Framework – Case of London

by Ahmed Gele
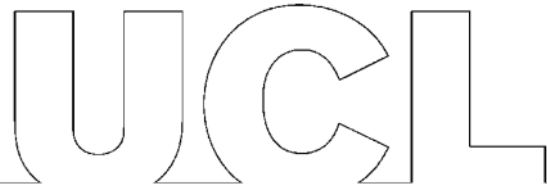
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ABSTRACT

When faced with a pandemic, vaccines may not always be a viable option. One solution is to go back and understand how our cities are designed, built and managed to reduce the impact of disease outbreaks. Disease outbreaks have transformed our cities in the past and will continue to transform the smart cities of today. This study investigates the Impact of COVID-19 on London and highlight opportunities to mitigate the impact on the city. The findings are based on semi-structured interviews with experts and categorised through the smart city framework, which includes, smart: economy, people, governance, mobility, environment and living.

1. INTRODUCTION

1.1 Background

Cities have evolved from small urban dwellings to mega-metropolises, creating densely packed areas which have proven to become petri dishes for the rise and spread of viral diseases. The world is now experiencing the greatest humanitarian disaster since the Second World War. (Guterres, 2020). A deadly coronavirus (COVID-19) outbreak in China has devastated the world and cities were not prepared. In a matter of weeks, the epicentre of Covid-19 had moved from China to Europe and then to America. A few months later, 12 million people had contracted the virus, and more than 600,000 excess deaths worldwide (Worldometers, 2020). Indirectly, the effects of the global pandemic have left billions of people suffering. What is alarming is that the numbers described are likely from underreporting, if adjustments to factor in asymptomatic patients and rapid testing, there would be an alarming increase in the weeks ahead (Burn-Murdoch, Romei, & Giles, 2020).

Unfortunately, Covid19 is not an exception; there seems to be a new viral pandemic almost every year – causing humanity to be trapped in an age of deadly outbreaks. This is not surprising, as we have been discovering an average of over three human pathogens annually since 1980 (Institute of Medicine, 2009). Nigeria in 2018 had experienced an extensive fever outbreak which was later identified as Lassa virus. The virus had claimed over 100 lives and infected several hundred more (WHO, Lassa Fever – Nigeria, 2018). In 2017 Brazil experienced an outbreak of yellow fever that crept into a highly populated and dense area of Rio de Janeiro and São Paulo, infecting 723 people and claiming the lives of 1/3 of those infected (WHO, 2018). We are undoubtedly more aware of these viral diseases following the unprecedented outbreak of Ebola in West Africa from 2014-2016, which killed more than 10,000 inhabitants (Gulland, 2016). And then shortly after the Zika virus outbreak from 2015-2017, in which babies were born with congenital disabilities such as undeveloped brains and damage to the nervous system (Colón-González, Peres, São Bernardo, Hunter, & Lake , 2017).

'Smart Cities'

Disease outbreaks throughout history have threatened the existence of all forms of cities by pushing their public health, economic and social facilities to their limit. These past few months, the novel coronavirus has laid bare how exposed the design, planning and management of today's 'smart cities' are to viral pandemics.

To mitigate the effects of the pandemic-driven crisis, smart cities such as London have adopted traditional methods, such as enforcing complete lockdowns and restricted movement in the city to slow down the virus and desperately flattening the curve (Sault, 2020). The effects of these measures are set to trigger the worst economic recession in decades, with the World Bank estimating 100 million people likely to experience poverty worldwide (Wahba, Sharif, Mizutori, & Sorkin, 2020).

This study aims to highlight sustainable ideas and concepts to mitigate disease outbreaks in 'smart cities' by exploring opportunities that have surfaced during the pandemic. Understanding the opportunities and threats is essential in learning how to stop the spread of the virus or mitigating its impact, allowing smart cities to become smarter and safer. To deal with this pandemic, architects, planners, and designers have already drawn their concepts visualising the post-pandemic world. However, there is limited research exploring the link between the smart city framework, public health and pandemics. To address this gap, the study aims to explore this relationship and present vital recommendations on how London as a smart city can reduce the spread of the virus or mitigate its impact on the city.

False hope – The Cure

For many, the light at the end of the tunnel is apparent – A vaccine that will grant immunity. This level of certainty is prompted by countless articles about vaccine development projects claiming to be standing at the doorstep of a significant breakthrough (Oxford, 2019). However, according to many experts like Dr David Nabarro, a Professor at the Imperial College London and special envoy to the WHO, a Coronavirus vaccine may never be developed (Picheta, 2020). Rachel roper, professor of immunology who had played a part in the development of the SARS vaccine, believes there's credible evidence to indicate that Covid-19 might just be resistant to vaccinations altogether (Wise, 2020).

The idea that a vaccination will be developed, faster than the current record of 4 years, breeds false hope among the public, especially when chances of succeeding are slim. Michael Osterholm, director of the Center for Infectious Disease Research and Policy at the University of Minnesota, explains that 'this sense of false hope has led many to underestimate the virus both in terms of its immediate negative effects and its potential to infect even wider swathes of the global population.' (Branswell, 2020).

We can no longer rely on vaccines as our first line of defence against pathogens. Our immune systems are exposed, making us vulnerable to all forms of increasing biological attacks - natural or manmade. We could still face another deadly pathogen tomorrow, next year or in the next decade, which could claim the lives of 10's of millions of people worldwide. Although our public health infrastructure in parts of the world has improved, without a reliable vaccine, we are still as vulnerable as we were 100 years ago (Paules & Fauci, 2017). However, if we can make our cities inherently safer, acting as a form of 'immune system' against not just pathogens but for other emergencies such as air pollution and poverty, we can change the course of civilisation.

1.2 Research Aim and Objectives

This study aims to investigate the impact COVID-19 has had on London through the smart city framework, and identify the opportunities to mitigate the impact on the city. The following research objectives have been derived to assist in fulfilling the research aim:

1. Investigate existing literature on both Smart Cities and the influence of disease outbreaks on the development of cities
2. Assess the Impact of COVID-19 in London within the smart city framework
3. Identify opportunities and challenges within the smart city framework to reduce the spread of the virus or mitigate the impact on London

1.3 Research Structure

This dissertation consists of 6 Chapters. Chapter 1 introduces the dissertation study background and outlines the research aim and objectives. Chapter 2 is separated into two sections; the first section will review the literature on smart city definitions, framework and the approaches to becoming a smart city. The second section of the chapter will explore how the design of cities

throughout history have been influenced by disease outbreaks. Chapter 3 stresses the methodology, outlines the framework of the study and methods used to obtain the data. This chapter also explores the limitations present in the study alongside ethical concerns. Chapter 4 explores the case study of London, providing an overview of the novel coronavirus effects (positive and negative) within the smart city framework. Chapter 5 analysis the key findings of the study and interviews. The final chapter concludes the key findings of the study and presents recommendations for how London as a smart city can best mitigate the impact of future outbreaks.

2. LITERATURE REVIEW

Cities are extremely important. They have been critical to human development for centuries, becoming an engine for global innovation and economic growth. However, the world is seeing a continued concentration of population in cities. By 2050, 70% of the world's populace will reside in urban centres (WHO, 2014). This rapid population growth is putting a vast amount of strain on our already burdened cities, through air pollution, limited resources, overcrowding, poverty and now at the forefront – battling and preventing infectious diseases. These interconnected problems of the 21st century bring a different degree of complexity which require bold and innovative solutions. The 'Smart Cities' concept could be the innovative solution that we need to survive the challenges we face today and those of the future.

2.1 Smart City Definition and Concept

The phrase "smart city" was first coined in 1994 (Dameri & Cocchia, 2013), but had only rapidly gained momentum in 2010, with the advent of smart city schemes and the European Union's use of the term 'Smart' to justify sustainable projects and activities in urban areas (Al-Hader & Rodzi, 2009). Although the concept is now widely recognised and used in various situations around the world, the phrase 'smart city' is still a confounding term and is used in ways that are not inherently consistent, due to the lack of clear understanding of its meaning (Hollands, 2008). Which raises questions, how does a widely discussed concept with no standard definition, improve public health, be measured or even used as a vision for what our future cities will become?

Technology is a dominant theme amongst scholars and stakeholders when defining a smart city. However, Nam & Pardo (2011), argue that the implementation of ICT infrastructure is not enough for a city to be considered smart. Furthermore, most definitions do not address health or healthcare directly. Those that do such as ICLEI describe a smart city as "a city that is prepared to provide conditions for a healthy and happy community under the challenging conditions that global, environmental, economic and social trends may bring." (Guan, 2012).

Other definitions tend to touch upon the topic of health through the improvement of 'quality of life'. This can be seen in Azkuna's (2012) definition where "A city can be considered as 'smart' when its investment in human and social capital and communications infrastructure actively promote sustainable economic development and high quality of life".

Due to the vast number of varying definitions found within the literature, Cavada et al. 2014, attempted to compile meanings from various academic literature and categorised them into three broad themes - Information Communication Technology (ICT), 'Resilience and Sustainability' and 'Innovation and Business'. These themes and the 29 associated definitions are then cross-matched to 3 stakeholders in the Smart Cities Matrix **(figure 1)**, people, governance and companies. Definitions are examined and discussed, to understand the debate as to what exactly it means to be a smart city. According to the analysis, most descriptions lie within two key themes 'Resilience and Sustainability' and 'Innovation and Business' (highlighted green) concerning Smart City governance, and completely ignores the input from Information technology (highlighted red). There is a relatively equal consideration of all three themes when looking at the Public and Commercial worlds (Cavada , Hunt, & Rogers, 2014).

		THEMES		
		ICT	**Resilience & Sustainability**	**Innovation & Business**
STAKEHOLDERS	**People** *(Academics, public)*	2 Definitions	3 Definitions	4 Definitions
	Governance *(Policy)*	**0** Definitions	**8** Definitions	**7** Definitions
	Companies *(Commercial)*	1 Definition	1 Definition	3 Definitions

Figure 1: Collection of Smart City Definitions Matrix by (Cavada , Hunt, & Rogers, 2014)

2.1.1 Smart City Dimensions

When developing a smart city, Dirks and Keeling (2009) emphasise the importance of natural incorporation of the various systems within the city. This is important, as the overall population health outcome depends on the coordination of multiple dimensions such as economy, environment and education. (McGovern, Miller, & Hughes-Cromwick, 2014). Researchers, intending to simplify what it means to be a smart city, have divided and sorted the concept into dimensions, to understand better the complexities of the concept in a holistic manner (Albino, Berardi, & Dangelico, 2015). Frameworks vary in the literature, according to the author. This study explores the model proposed by Lombardi, Giordano, Farouh, & Yousef (2012), where they present six components that connect to different aspects of urban life. These dimensions are 'connected with traditional regional and neoclassical theories of urban growth and development', where authors argue that the partnership between these dimensions influences the smartness of a city, (Lombardi, Giordano, Farouh, & Yousef, 2012). Thus improving public health which will reduce the impact of epidemics in the city.

Smart Economy

The relationship between the economy and health has long been recognised. In many parts of the world, an increase in wealth is linked to better health (Engelgau, Zhang, Jan, & Mahal, 2009). This dimension is focused on and driven by innovation. The result is to transform and strengthen a

municipality's economy. This is achieved by harnessing the (digital) technology and intelligent strategies to grow the entrepreneurial spirit of the people in a society. (Beesmart, 2019)

Smart People

The dimension is considered as the most essential component. The people dimension refers to the idea of 'smart people' which encompasses various factors such as access to information, creativity, progressiveness and participation in public life. Caragliu et al. 2009, supports this statement and suggests "smart solutions" originate from imagination, human resources and collaboration among applicable partners in the city (Caragliu, Del Bo, & Nijkamp, 2009).

Smart Governance

Governance is directly associated with urban health. Decisions made will either have a positive or negative outcome on the health of Inhabitants. This dimension comprises of various elements derived from the analysis of 'smart community' and 'smart growth' initiatives, which aim to strengthen the interaction between government and other stakeholders - citizens, businesses and other organisations of the civil society – within the city. This can be achieved by utilising co-creation, crowdsourcing and through e-governance, which is crucial in establishing a smart city that provides citizens with a useful participatory tool, allowing the decisions concerning health to be processed transparently and effectively (Paskaleva, 2009).

Smart Mobility

The connection between Smart mobility and the health of inhabitants in urban areas has been the subject of various studies in the last decade. This dimension focuses on increasing efficiency of accessibility and the quality of the services. By integrating information and communication technology (ICT) resulting in a healthy transport strategy. These strategies are intended to be cheaper, faster, safer and more environmentally friendly, that can handle daily needs of users by 'nudging' them towards choosing sustainable means of transport, such as walking and cycling. (Beesmart, 2019)

Smart Environment

Smart environment refers to the ability in how the city manages its built and natural environment to improve livability for all inhabitants. This is done by utilising innovation to support the governing and cultural changes that enable sustainable standards and actions. These smart environmental goals can include waste management systems, increase in green spaces and resource management. All of which directly or indirectly impacts the health of citizens (Remoundou & Koundouri, 2009)

Smart Living

Smart living aims to improve living standards for inhabitants by strengthening social and digital cohesion, healthcare, safety and smart infrastructure. This can be achieved by using information acquired through technology (5G) or both top-down and bottom-up initiatives to provide healthcare application and services with accurate context-awareness. (Beesmart, 2019)
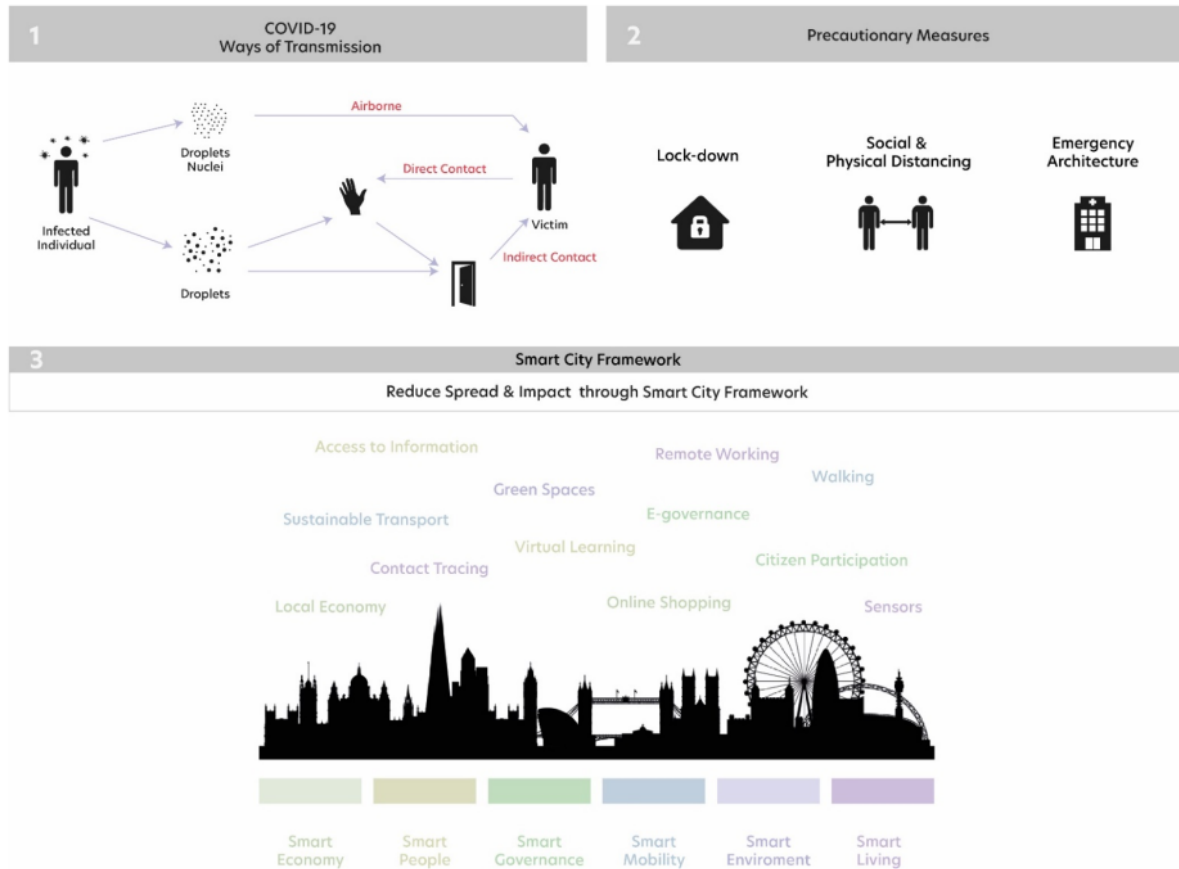

Figure 2: COVID-19 and Smart City Framework

2.1.2 Becoming a Smart City

There are two key strategies in becoming defined as a smart city: 'Top-down' and 'bottom-up' Initiatives. Top-down alludes to smart city projects where the municipality designs and manages it, this is often in collaboration with private-sector companies, primarily those in the technology and construction industry. While Bottom-up smart city projects allude to initiatives developed by those on the ground: citizens (Eliport, 2018)

2.1.3 Top-down Smart City

The philosophy of top-down strategy is one where cities monitor and analyse the condition of all it's critical infrastructure, focusing on technology, performance, strategic planning and coordinating information from various frameworks into a central control station. IBM and Cisco, among others, have now established themselves as market leaders, through their 'Smarter World' and their 'Smart Connected Communities' programs. They are among the few technological behemoths who have understood the capability of smart cities and are actively searching, collaborating with local governments to invest in their latest technology in upgrading the current infrastructure in their cities (Breuer, Walravens, & Ballon, 2014).

One of the first cities to adopt and incorporate IBM's smart city technology dubbed as the 'Intelligent Operations Center' was the Brazilian city of Rio de Janeiro. The ambition solution merged feeds from 560 cameras and showed more than 60 data layers, collected from strategically placed sensors across the area. The initiative was approved and installed as a response to a natural disaster that claimed the lives of almost 100 inhabitants. The system's original aim was to improve emergency response times, but the scale of the smart city solution expanded due to its impressive performance. Eduardo Paes, the mayor of Rio de Janeiro, is among the greatest proponents of the integrated solution, stating: "I sleep better thanks to it. The worst thing is not having the Information, to not have the tools to act. But we do now." (Soffel, 2013)

Many top-down initiatives are heavily criticised for multiple reasons in both academia and practice. According to Paul Sabatier (1986), "A fundamental flaw in the top-down model is that they start from the perspective of (central) decision-makers and thus tend to neglect other actors". This also referred to as the 'control room' approach, where the aim is to monitor all aspects of

urban life from a centralised system resulting in a wide range of data, that presents a "set of potentials disturbingly consonant with the exercise of authoritarianism" (Walravens, Breuer, & Ballon, 2014). This approach could potentially result in models where they are likely to ignore, or at least underestimate, the strategies used by street-level bureaucrats.

2.1.4 Bottom-up Smart City

Top-down perspectives are contrasted against a more imaginative, bottom-up understanding of what Smart Cities could look like. Through this viewpoint, progress and development come only from smart citizens "using" the municipality. Any type of top-down urbanisation is dismissed, especially those in partnerships with influential corporations that work towards centralisation (Breuer, Walravens, & Ballon, 2014).

These bottom-up initiatives include city mobile apps, such as Waze, which aim to reform the conventional top-down relationship between transportation companies and users. Non-digital bottom-up strategies can likewise be seen in citizen-led initiatives such as illegal bike lanes, where individuals who are dissatisfied with urban road networks take matters into their own hands and mark public bike lanes without approval (Walravens, Breuer, & Ballon, 2014). Such forms of initiatives are regularly alluded to as 'tactical urbanism'. This method comprises of "small scale interventions [that] are characterised by their community-focus, and realistic goals" (Berg, 2012) and are often seen as temporary and cheap streetscape, to improving the quality of life by addressing common neighbourhood issues.

Bottom-up initiatives can, at times, be viewed as chaotic. This "chaos" in the past has also been alluded to as "the default mode of urban development" (Breuer, Walravens, & Ballon, 2014). These urban developments can appear unstable whilst bristling with a growing network of social and economic ties, which decision-makers regularly fail to account for. For instance, Dharavi, one of Mumbai's largest informal settlements, is reported to generate up to 25 percent of the municipality's economy; However, there are neither official maps of the city nor accounts of its economic activity.

2.1.5 Middle out Smart City

Although both approaches in becoming a smart city have their advantages, they also have their drawbacks. Leading Shepard & Simeti, 2013 to the conclusion that "Change seldom arises from purely top-down or bottom-up systems and processes." However, a mixture of both approaches could birth successful initiatives, where a top-down approach provides the hardware through which people create applications they need. De la Peña (2013) contrasts the complexity of this method with the "non-hierarchical complexity" of the internet – as the internet is open and participatory, a smart city should actively and consciously enable and encourage inhabitants to shape their own urban experience.

2.1.6 Reflection

The importance of Smart Cities is widely understood and established in the literature. The concept also has the possibility of strengthening the bridge between academia and practice in investigating the impact technology has on urban living. However, it is clear whilst on this crusade to define the term, there lies a gap in the literature. There is little focus on the matter of public health in smart cities outside the improvement of digital services. This might be a result of those who define what it means to be a smart city – Governments and Corporations, which are driven by their interests.

Furthermore, there is little to no research concerning what citizens think, even though the focus of smart cities is improving the living standards of those citizens. We must not forget who the end-users are, who the main actors are and who is affected the most by the approach that is taken to become a smart city. These questions, in turn, could allow a more holistic approach when defining a smart city, which would define a clear goal so dimension, models and approaches to smart cities will become more aligned despite there being different stakeholders.

2.2 Pandemic and the Built Environment

Cities and disease outbreaks are closely linked throughout history, as health concerns have since driven the urban planning and design of cities (Wintle, 2020). In this section, we will explore various moments throughout history where disease outbreaks have forced civilisations to alter to alter their environment and behaviour.

2.2.1 The Sewage System

London, in the 1840s, experienced a wave of deadly outbreaks of waterborne diseases such as cholera, which had claimed tens of thousands of lives. This problem was linked to the terrible sanitary system and thick industrial gases produced in the city. This demanded direct strategic action, in which the city responded by installing a new sewerage network. (Hansen, 2012).

Joseph Bazalgette, a civil engineer, was employed to design an innovative system that would transform a vast area of marshland, into a network of pipes that would carry wastewater downstream and away from drinking supplies. This urban intervention against diseases helped wipe out cholera in the capital. This intervention also gave way to grand public parks and imperial promenades where built (Hansen, 2012).

The following year the network was tested, as the cholera outbreak returned one final time. Those affected by the outbreak were entirely confined to east London as they were not yet linked with the new sewage network. The final outbreak justified the expenses as it limited and prevented the disease from spreading, improving the overall living conditions London (Health, 2019).

2.2.2 Wider Streets and Public Green Spaces

In 1848 Paris had also experienced a cholera outbreak which killed around 19,000 people. During this period the city of Paris was overpopulated, and diseases were rampant. The dire condition compelled Emperor Napoleon III to set a new vision for the city, as it had been untouched since the Middle Ages (Featherstone, 2020).

This assignment was appointed to Baron Georges-Eugène Haussmann whose vision for embarking on one of the largest urban transformations since the 1966 fire of London, was to put an end to the catastrophes that had existed. Haussmann had set out to plan a symmetrical city, in which streets would be widened, to accommodate the rising population, which also lowered human to human transmission. The width expansions had also allowed an increase in heights for buildings to reduce overcrowding. The introduction of public green spaces allowed the city to breathe and maintain a geometric and symmetrical aesthetic (Kirkman, 2007).

2.2.3 Track and Trace

In this current pandemic, whilst countries around the world are starting to restrict the movement of their citizens to limit the spread of the virus, South Korea is easing its lockdown and allowing its citizens to roam freely once again. This turn of events is surprising as three months into the pandemic, South Korea had registered the greatest count of confirmed cases outside of Mainland China (Noack, Brice-Saddler, Beachum, & Armus, 2020). However, there was a sudden change (*Figure 3*) while the number of cases continued to rise in most other countries, Korea's numbers began to level off, indicating that officials were able to contain the spread of Covid-19.

This fantastic development was due to valuable lessons learnt when faced with another Coronavirus outbreak in 2015 – MERS. Lessons learnt from 2015 where quickly applied when faced with Covid-19 pandemic. By the time the country had 30 confirmed cases, Korea had already successfully developed a testing kit to identify the novel coronavirus. This was distributed to all health facilities and pop-up testing booths that were able to screen 20,000 people per day. The movements and journeys of those who tested positive were traced to identify those who they had been in contact with, to test them as well, regardless if they showed symptoms or not. This process of tracking and tracing continued to break the transmission link of the pathogen on a wide scale (Ahn, 2020).

However, these tests were only human to human transmission, not surface to human. For this type of transmission, South Korea was also able to trace back the steps of infected individuals, through the city, by employing mobile GPS and CCTV. After the MERS outbreak when they were not able to trace movements of the virus, Korea changed the law (Infectious Disease Control And Prevention Act , 2017) permitting the legislature to gather patient's information and security footage during outbreaks. With this legislation, Korea was now able to effectively turn the invisible virus, visible and alert all those in proximity to avoid the path of the virus. If an individual happened to cross the path of a virus, they would be alerted, in which they would have to get tested, starting the process of contact tracing again.
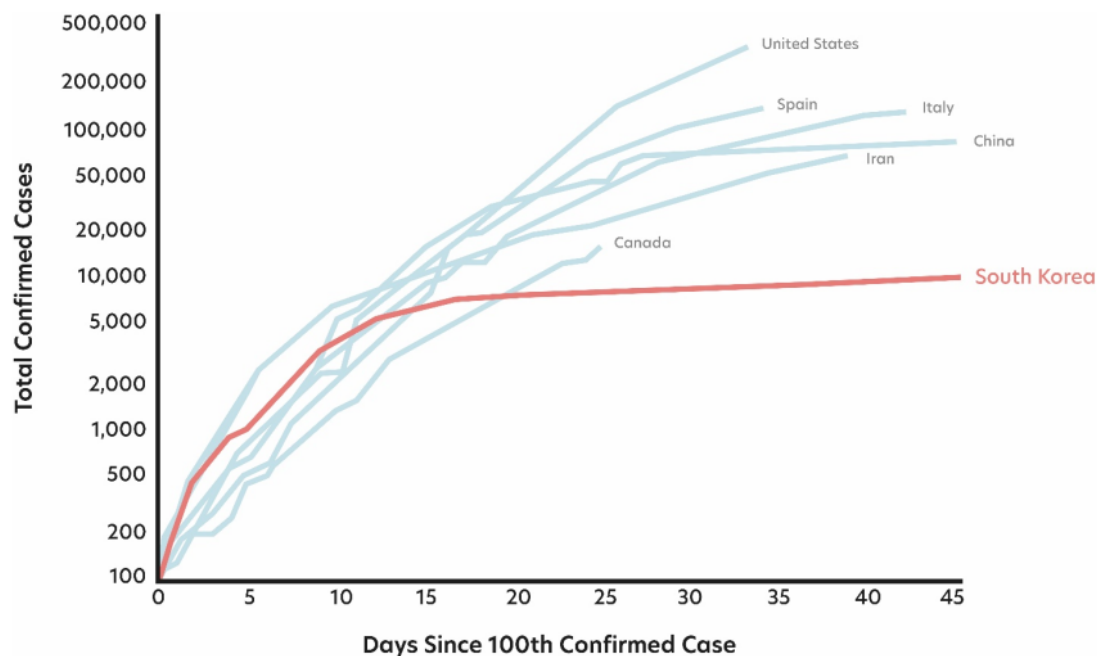
Figure 3: Total Confirmed Cases. - Chart in Log Scale. Source: (Johns Hopkins University, 2020)

2.2.4 Reflection – Effects on Built environment

Cities are undoubtedly complex systems, where their characteristics influence the wellbeing of its inhabitants. Before the current outbreak of COVID, 80% of worldwide deaths were related to noncommunicable illnesses, such as heart attacks, asthma and diabetes (WHO, 2018). However, the characteristics of our built environment have not responded effectively to preventing these noncommunicable diseases and virus outbreaks we face today.

In the past, early design codes were formed due to the disaster caused by poor sanitation, lack of natural light and fresh air. However, over the last few decades, institutional arrangements in the UK have separated health and design from each other. Public health is no longer under the jurisdiction of local authorities, but a subsidiary of health authorities, causing the separation between environmental health and planning/design (Barton, 2003). This increases the risk of poor coordination, and potentially compromising health within cities becoming more vulnerable to outbreaks.

History provides examples of catastrophes which reveal the loose threads that underpin the social fabric of the city. Covid-19 will indeed join the long list of those infectious diseases that have made us rethink our cities and how connected we are. However, an important reminder echoed by Dr Michele Acuto, is that changes we make today preparing for future pandemics will need to be weighed in the context of climate change and sustainability (Klaus, 2020).

Behavioural Change / **Enviromental Change**

Diseases in the Roman Empire — Second Century
- Infrastructure: Public baths division of water and sanitation systems. (Eadie, 1993)
- Isolation tents near hospitals (Belfiglio, 2017)

Black Death — 1346 - 1353
- Introduction to Urban planning for better layout of Cities. (Lilley, 2015)
- Quarantine and restrictions on movements. (Bramanti et al, 2016)
- Closure of ports and public baths to avoid contact with animals. (Cohn, 2008)

Cholera — 1852 - 1859
- Improved Sewage System (Hansen, 2012)
- Introduction of Green Spaces (Kirkman, 2007)
- Longer avenues and wider streets (Kirkman, 2007)
- Quarantine of goods and people (Glass & Black, 1992)

Tuberculosis — 1882 - Present
- Building design: Terraces, bolconies and flat roofs. (Campbell, 2005)
- Furniture: Reclining Chairs (Campbell, 2005)
- Social isolation (Campbell, 2005)

Spanish Flu — 1918 - 1919
- Social distancing – Lockdown of public spaces (Reyes et al, 2012)
- Use of masks. (Ott et al, 2007)

SARS-CoV-1 — 2003 - 2004
- Local building design: Improved ventilation and drainage systems in specific areas of Asia (e.g., Hong Kong). (Baldwin, 2006)
- Quarantine and social distancing. (Wilder-Smith et al, 2020)
- Contact Tracing (Ahn, 2020)

SARS-CoV-2 — 2019 - Present
- ???
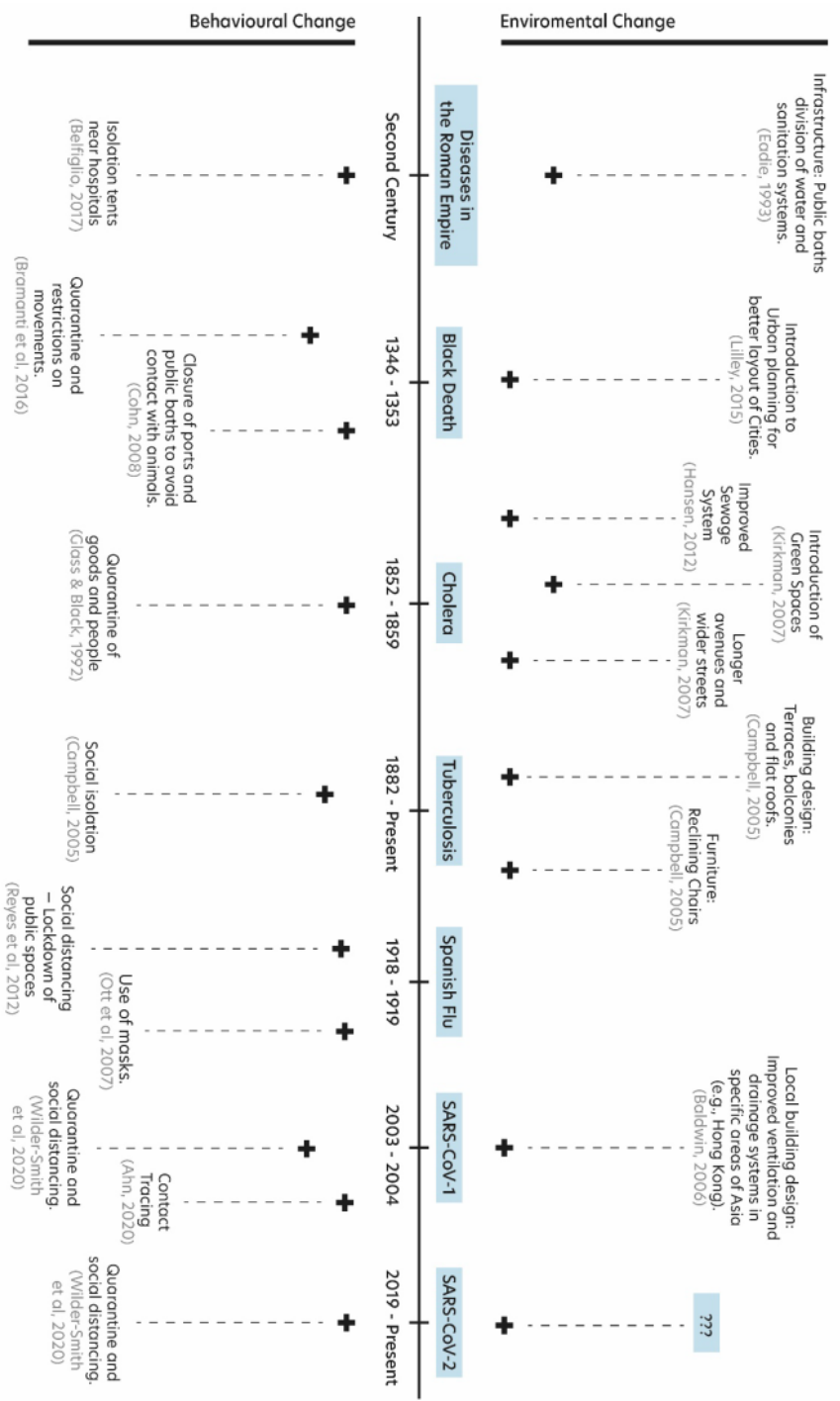- Quarantine and social distancing. (Wilder-Smith et al, 2020)

Figure 4: Epidemiological Disease, Environmental and Behavioural Change Timeline

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3. METHODOLOGY

This chapter presents the research approach, clarifying how the research objectives will be accomplished, the methodology and the reasons for its use, the limitations and finally, the ethical consideration of the research.

3.1 Research Design

The literature review reveals that there is a clear gap in the study of social science and pandemics, leading to the aim of the research in investigating how London has been impacted by novel coronavirus through the smart city framework and Identify opportunities to mitigate the impact on the city.

To achieve this aim, three objectives have been developed and outlined below in Table 1, along with the methods used to achieve these objectives.

Table 1: Research Objectives and Methodology

Research Objective		Methodology
1	Investigate existing literature relating to both Smart Cities and the influence of disease outbreaks on the development of cities	A dual literature review will be undertaken to achieve this objective. Section 1 will explore the literature on the concept of smart cities, the framework (dimensions) and approaches. Section 2 will explore the history of pandemics and their influence in the development of cities both in the sense of physical change and the behavioural response of citizens.
2	Assess the Impact of COVID-19 in London within the smart city framework	An analysis of the semi-structured interviews, government documents, research papers and articles will highlight the strengths and weaknesses London has faced within the smart city framework. The findings will allow opportunities to be identified that can reduce the impact of the virus and make London inherently safer.

| 3	Identify opportunities and challenges within the smart city framework to reduce the spread of the virus or mitigate the impact on London	This objective will be achieved by conducting semi-structured interviewing with experts on the theme of the study who reside or work in London. The data will be analysed and coded using Nvivo. This analysed data will be presented in the form of opportunities and threats facing London in reducing the spread of the virus or mitigating the impact on the city. This information will aid in the development of recommendations for London.

Methodology Diagram
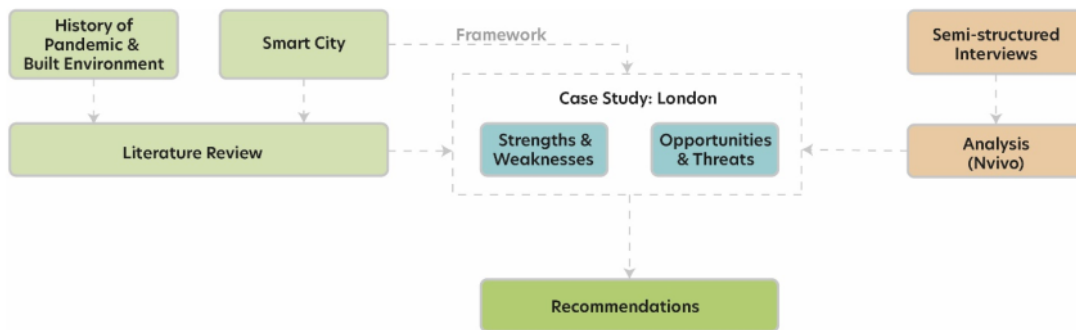
Figure 5: Methodology Diagram

3.1.1 Case Study Selection

The case of London was chosen to explore the effects of the novel coronavirus and recommend post-COVID steps to reduce the spread of the virus and mitigate the impact on the city. This was due to multiple factors. Firstly, London has been a major world hub for over three thousand years and is a world-leading city. Throughout history, London has undergone constant urban changes influenced by not only politics and power but also diseases, war and the great fire. With each of these periods changing the face of London, it will not come as a surprise when London, one of the most affected cities by the current pandemic will take post coronavirus measures to ensure future disasters can be averted.

Secondly, London is home to some of the world's leading researchers and practitioners in the field of urban studies and social science. These individuals are microcosms of the city and are experiencing first-hand the city's responses to COVID-19, which makes them ideal candidates in contributing to this study.

Thirdly, the results and recommendation presented in this study regarding London can be tailored to other smart cities around the world that are looking for solutions on the next steps to take post-COVID.

3.1.2 Data Collection Methods and Limitations

Secondary Data Collection

Secondary research was adopted to help build a comprehensive and in-depth understanding of topics in the literature review and case study. The mediums used to collect this detailed information ranged between, research papers, government documents, journals, articles and videos.

Interviews

The duration of interviews typically lasted between 40-90 minutes. The interviews were semi-structured and based on an interview guide (Appendix A). The interview guide was customised to each interviewee based on their role and experience regarding the theme of the subject. The semi-structure design of the interviews allowed questions to be explored, which gave the possibility to discover new themes and ideas during the discussions.

Experts were selected based on a narrow criteria, in ensuring that the study included perspectives in multiple dimensions within the smart city framework and the development of recommendations for London. All interviewees are experts in the built environment, have in-depth knowledge on public health, emergencies or pandemics and have extensive knowledge of London. List of the six interviewees are detailed in **Table 3**, Chapter 5.

3.4 Analysis Method

With consent from the participant, each interview was recorded and transcribed. This improved the analysis process as the author focused on asking questions and digging deeper into various

connected topics. After the transcription process, the dialogues were coded using the NVivo computer software, that allowed the information gathered to be categorised into 'codes' allowing patterns and underlying subject matters in the data to be discovered. A set of preestablished 'codes' were carried on from the smart city framework discussed in the literature review, however, during the process of analysing a sequence of new codes had been derived from the data, detailed within **Table 4**, Chapter 5.

3.5 Limitations

The study has investigated how a smart city can reduce the spread of the virus or mitigate the impact on a city; However, due to limitations this research only explored the case of London, restricting the volume of data that could be collected.

Additional limitations presented in this study can be observed in the number and type of interviewees selected to contribute to the study. The representation pool did not represent all stakeholders of the city, only experts with in-depth knowledge in both the research theme and location.

3.6 Ethic Consideration

This study does not hold any significant ethical risks. Participating in the project is voluntary. Informed consent is discussed with all members beforehand. The author will clarify the purpose of the research to participants before commencing interviews or data collection. All information relating to the research will be stored and secured safely. On completion of the dissertation, all data relating to the research will be disposed of as per university guidelines. This Master's dissertation will adhere to a high ethical standard of respect and consideration, ensuring the best possible outcome.

4. CASE OF LONDON ANALYSIS

This chapter will explore the strengths and weaknesses the pandemic has revealed on Lombardi et al.'s (2012), Smart City framework and how London has reacted from both top-down and bottom-up perspective. Understanding the pandemic's impact on different dimensions will allow

for future recommendations to be made. London is the United Kingdom's largest and most connected city and has found itself as the country's epicentre for the novel coronavirus. To save lives and halt the spread of the virus, the UK government followed suit of other affected countries and introduced a lockdown, in what many deem as a delayed response. The results of restricting the movement of people delivered a devastating impact on almost every aspect of life. Six months into the pandemic, it is now feasible with the available data to derive early observations regarding the impact of a novel coronavirus in London.
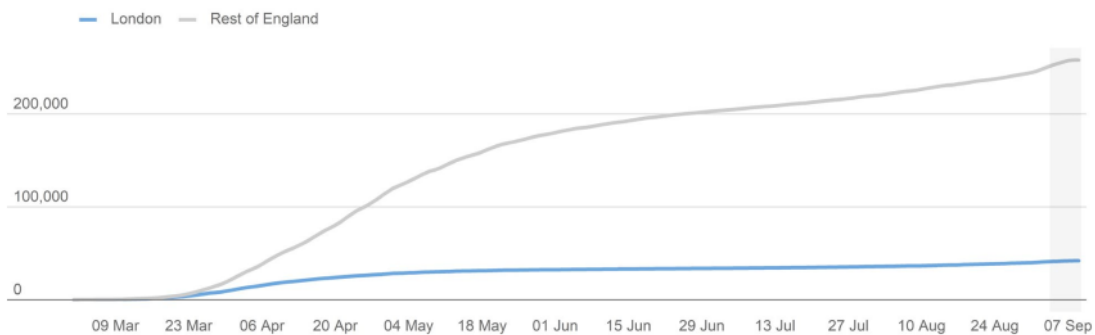

Figure 6: Cases in London Compared to the Rest of England (Source: (GLA, 2020))

4.1 Smart economy

The impact of novel coronavirus has shrunk the UK economy to its lowest point in 41 years. Measures to avoid the spread of the virus, such as restricting individuals from meeting, producing, buying and selling, has essentially put a stop to a large portion of economic activity.

High street and city centres were already facing a decline before the pandemic, with no innovative solutions being implemented. The effects of the current pandemic have accelerated the downfall of physical retail and rapidly increased the level of unemployment to a 40-year low. This economic impact has presented a sharp increase in mental health for groups all ages. Especially young adults who reported higher rates of hopelessness, not coping well and suicidal thoughts/feelings; This was due to the age group facing a triple threat of curtailed education, fading employment prospects and reduced social contact with peers (Kousoulis, et al., 2020).

As the government rushes to ease lockdown, it has introduced schemes such as 'eat out to help out' in hopes to trigger a large number of people visiting high streets (Kollewe, 2020). However, this has raised not only concern for the spread of the novel coronavirus, but also public health emergencies faced prior to COVID-19, such as obesity (Busby, 2020).

4.2 Smart people

The impact of this pandemic on education and cultural institutions has caused a major (unequal) interruption in growth and development. All stakeholders alike have scrambled to find new ways to address the temporary solutions to the structures we once had to meet these needs. The government has introduced and enforced multiple online initiatives such as 'bitesize Daily' where the BBC has collaborated with teachers and education experts in providing new interactive lessons every weekday for students between the ages of 5-15 (Department for Education, 2020).

However, this has shed light on multiple problems, in which researchers at the London School of Economics have stated that the closures have opened a "chasm" concerning the education of disadvantaged children and those who are better off (Eyles, Gibbons, & Montebruno, 2020). These remarks step from teachers reporting students having to share a laptop or tablets with family members and many not having access to the internet to partake in online classes (Adams, 2020). This has led to parents suing the government for not providing adequate education to their children.

Bottom-up initiatives have started to appear during this pandemic to fill gaps in which the government was unable to resolve. For example, a London based Initiative 'Store' aims to tackle the lack of diversity in the design industry by creating workshops for BAME students. To resolve the issue of unequal learning, Store provides learning kits to all enrolled students to follow through (Green, 2020). Other community lead initiatives such as doorstep fitness have been tackling genuine concern of physical inactivity amongst both the young and old while in quarantine (Young, 2020).

4.3 Smart governance

A report produced by The Institute for Public Policy Research in 2020 revealed that the UK is amongst the most centralised developed countries in the world. The reality of a centralised Britain

has become more apparent now than ever due to the arrival of COVID-19, with challenges how we should respond to the pandemic and who - Central Government, Local governments or Communities.

This was evident when health officials adopted a centralised approach to testing by deploying a single public laboratory in north London (MacAskill, 2020). The effects of this were realised too late when the government chief medical officer admitted that the government should have moved faster and established more than one public laboratory (MacAskill, 2020).

However, local boroughs in London, have been using technology to establish a more participatory and transparent form of governance by engaging with their citizens in virtual town halls to better understand the impact of the pandemic. London boroughs such as Sutton have seen higher participation in their sessions with 67% of members attending discussions (LGA, 2020).

4.4 Smart mobility

Before the pandemic, the mobility sector was experiencing growth and on the verge of a mobility renaissance. New forms of shared and connected transit were becoming ordinary as well as eco-friendly alternatives being used for daily urban travel. However, due to COVID-19, the word came to a sudden halt, reducing the usage mobility to unprecedented levels across the world (O'Hare, Dr Sabine, & Van Elsland, 2020).

However, the reduction of mobility has not only reduced the spread of the virus but has resulted in other positive impacts on public health. One benefit can be seen in the reduction levels of daylight pollution in London by 55%, a problem that claims 9,500 lives annually. Sarah MacFadyen, head of The British Lung Foundation and Asthma UK, said "As we begin to recover from Covid-19, we must keep these levels down and push them lower, to protect everyone's lungs" (Telegraph, 2020)

This reduction in the use of public transport due to fear of contracting the virus has forced citizens to make healthier and sustainable transport decisions – Walking and Cycling. In London, demand for Santander's cycle rental scheme has reached an all-time high (Bruce-Lockhart, 2020), which has prompted the UK government to announce a £2bn package for a "new era for cycling and

walking" which includes pop-up bikes lanes and expanding the width of pavements for social distances (Morton, 2020).

Other sustainable alternatives include the increase in purchase for personal electric vehicles. During the pandemic, the Tesla Model 3 accounted for almost 15% of UK sales and the country's best selling car (Hertzke, Middleton, Neu, & Weaver, 2020). Other electric modes of transportation such as the electric scooter, which were deemed ahead of their time, recently saw the UK government moving to legalise their use in public (Lime, 2020).

Use of transport modes[1], % of respondents   ● Pre-COVID-19   ● 2 weeks ago   ● Return to "normal life"

Walking or biking with private bike: 62, 60, 71

Shared e-scooters, e-bikes, or e-mopeds: 7, 6, 7

Ride hailing or conventional taxi: 10, 6, 9

Private car: 72, 48, 72

Public transport: 35, 11, 32

Car sharing: 9, 6, 9
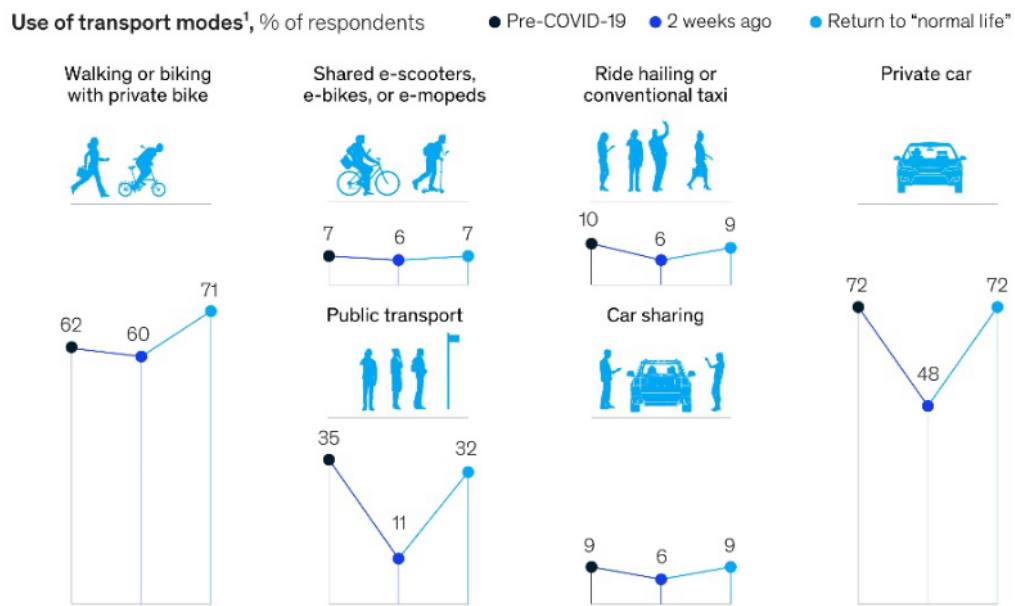
Figure 7: The UK mobility shift will mix in the next normal Source: (Hertzke, Middleton, Neu, & Weaver, 2020)

4.5 Smart environment

The majority of cities around the world are not designed to curb the spread of viruses. London's ability in response to the novel coronavirus outbreak has brought to light multiple issues regarding the design of the built environment. A recent study by the University College of London has shown that social distancing measures introduced by the governments are not practical when enforcing them in the streets of London as most pavements are simply not wide enough for people to use. This problem is amplified, particularly for individuals with mobility impairments, or

those travelling with children (Palominos & Smith, 2020). A lack of space for walking or cycling on the pavement is a long term problem that has been further amplified by the effects of the pandemic.

The issue of green spaces has also taken centre stage multiple times throughout this pandemic, as many citizens have broken lockdown and social distancing rules to experience public green spaces. This issue is due to the inequalities many communities face in London. Millions in densely populated neighbourhoods are forced to isolate themselves in cramped spaces, without facilities such as a garden or home gym. This issue, topped with the rise of mental health in light of the pandemic, has caused the increase of public health concerns in the UK (Sustrans, 2020).

4.6 Smart living

The way we live, work and conduct public affairs have changed dramatically due to the advent of COVID, requiring London to explore new methods to live in conjunction with the virus. The initial response from the government fell in line with responses seen all over the world – enforcing lockdown. After months of testing and delays, the governments introduced its version of the contact tracing app, which would aim to improve the way of living, through social and digital cohesion. However, the NHSX app was deemed as a failure and abandoned due to Apple and Google refusing to compromise on privacy restrictions (Murphy, Sabbagh, & Hern, 2020).

On the other hand, communities have taken matters into their own hands through citizen lead initiative, by using digital platforms to improve their lives. One instance of this can be found in thousands of neighbourhood WhatsApp groups, which aim In supporting the most vulnerable members in the community and tackling problems such as homelessness and poverty (Brom, 2020). This method of volunteering has gained traction and proved to be a useful tool in sustaining communities in times of crisis. The use of social media has changed to not only connect individuals but become a platform for civic engagement and active interaction. This and other neighbourhood initiatives have exhibited how technology can be harnessed to improve the lives of millions of people in times of emergency.

4.7 Strengths and Weaknesses Summary
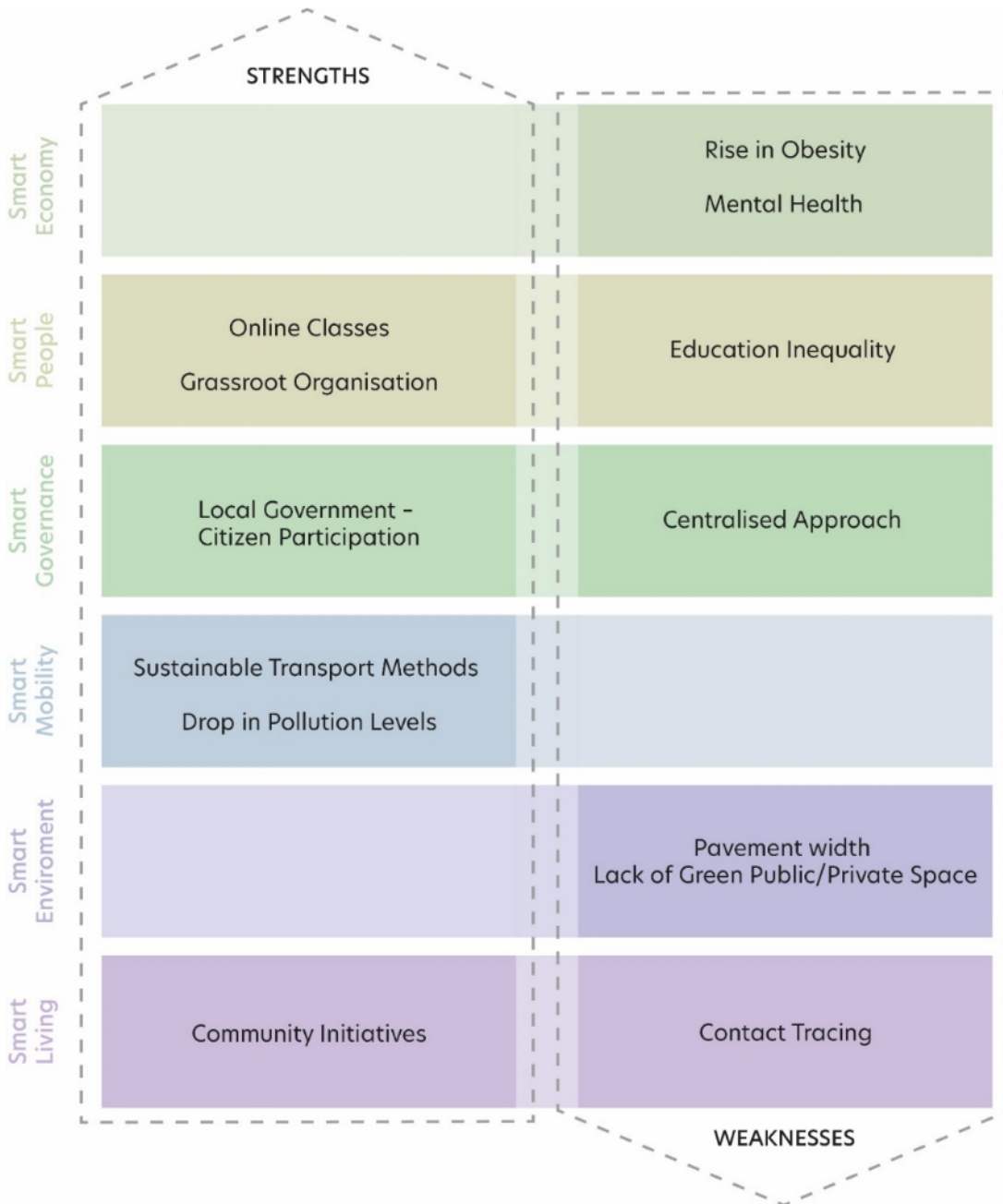
Figure 8: Strengths and Weaknesses

5. QUALITATIVE INTERVIEWS AND ANALYSIS

This chapter analyses the information and insights collected through the semi-structured Interviews, which will assist in achieving the research aim.

5.1 Scheduled Interviews

Interview Reference	Organisation(s)	Association(s)
Interviewee One, 2020	Royal Town Planning Institute (RTPI)	Former President of RTPI Urban Planner
Interviewee Two, 2020	Manchester University	Professor and Research - Expert on Cities and Pandemics
Interviewee Three, 2020	Jacobs	Senior Urban Designer
Interviewee Four, 2020	CASA UCL	Professor and Researcher
Interviewee Five, 2020	Member of Multiple London Borough Design Reviews Panels	Senior Urban Designer
Interviewee Six, 2020	University College of London (UCL)	Architect, Planner and Professor

Table 2: Scheduled Interviews

5.2 Interviews Weighted Words

Figure 9: Interview Word Cloud

The word cloud diagram is generated through Nvivo. The software was used to analyse the semi-structured interviews and identify the most commonly used words. Overall the word 'People' was identified as the most frequently used word. Naturally, this is linked to the critical benefactors of a 'healthy' smart city - People. The words 'digital', 'public' was also emphasised in this diagram as transparency was also a key theme discussed throughout the interviews when reviewing 'technology'. It was also interesting to discover 'People know' was formed in the centre as this was the main message emphasised by all experts – Using what 'people know' about their communities to make better decisions, in improving public health and other aspects to become a smarter city.

5.3 Interview Coded Themes

Beyond the six smart city framework themes derived from the literature, the analysis of the semi-structured Interviews produced key themes and patterns, by coding 'frequently used words'. The discovery of these codes was essential to the topic of smart cities and pandemics, for example

'People' was found to be used 16% and 'health' at 10%. Some interviews also focused specifically on 'Sustainability' as any future solutions or changes will need to be weighed in the context of climate change and sustainability.

Codes	Theme Description
SE	Smart Economy
SEN	Smart Environment
SG	Smart Governance
SL	Smart Living – Social and digital Cohesion
SM	Smart Mobility
SP	Smart People – Knowledge and Creativity
TEC	Technology – Data, infrastructure and use
H	Health
AP	Top-Down or Bottom-up approach
SS	Sustainability
INQ	Inequality

Table 3: Qualitative Data Coding table

5.4 Smart Cities and London

In discussion with the experts on the concept of smart cities and London, it was essential to understand their opinions and insights on what the buzzphrase meant. Many of the interviewees referred to the idea of a smart city as a 'real' but 'ambiguous' concept. Furthermore, cities such as London are considered smart on the "smart city spectrum" (Interviewee Three, 2020) as there is no end state, due to "cities getting smarter over time" (Interviewee Six, 2020).

A consistent message from the experts involved in the study was that smart cities did not hinge on technology as many believe, but were "very much about decentralisation" (Interviewee Four, 2020) of information. Decentralisation was by far the most dominant theme when analysing the interviews. As it is essential in fixing many problems in our society by allowing inhabitants to innovate and transform their lives through understanding their world clearer and

"...allow those who are not in the room to be able to take part in the decision-making process." – (Interviewee One, 2020)

This message was intensified even more so under the current circumstances of the pandemic, where citizens would require access to information to survive.

"...Smart cities can be very handy in a pandemic, because the city is equipped with lots of information networks that are related to transport, environment, lifestyle and people's homes and so you can pass around information very quickly" – (Interviewee Five, 2020)

5.5 Smart Health

Before the pandemic studies such as 'Healthy Placemaking' by the city council (2018) suggested that practitioners involved in the designing and planning of the built environment within cities have a substantial degree of understanding of the key values required in creating a healthy environment, but are faced with a range of obstacles when attempting to incorporate those values. Many of the interviewees supported this statement and furthered the discussion by adding:

"When we design new developments, we might have health as one of the agenda, and sometimes it's not even on the agenda. However, the times when it is on the agenda it's like the 9th item out of 10." – (Interviewee Five, 2020)

Another consistent message from experts involved in the study was that public health relied on cooperation between the dimensions presented within the smart city framework. Whilst ensuring that policies and decision-makers in areas such as mobility, economy and housing have a positive effect on long term wider health determinants and short-term mitigation of the current outbreak.

"They are all interconnected; you cannot talk about one and not focus on all six dimensions." – (Interviewee Five, 2020)

5.6 Technology and Pandemics

The effects of the 2019 novel coronavirus have accelerated the adoption of existing and new digital/technological tools in all dimensions of the smart city framework. It has allowed many citizens in London and around the world to be effective and efficient despite the current pandemic. From connecting millions working from home with colleagues and clients to shaping new digital habits, technology has been attempting to infiltrate almost every aspect of our lives to become smarter in reducing the spread of the virus and mitigating the impact on the city.

> *"It feels like this time we are on the edge of quite a rapid acceleration, where we're going to adopt technology in all those aspects. The most exciting aspect is how people might engage with their city, it may become a two-way relationship instead of a one-way relationship" – (Interviewee Three, 2020)*

However, many experts interviewed by the author have highlighted that the positives of this accelerated adoption of technology are exaggerated and at times, do more harm than good. For example, "fever detectors" which have been adopted worldwide and described as "fast and accurate" to identify symptoms of the novel coronavirus, is not manufactured for medical use. They are not reliable enough to know whether someone has a fever or not as they only determine one variable – temperature. This can easily be influenced by those attempting to overcome it, by digesting "powerful paracetamol and walking through borders by dipping your temperature temporarily." (Interviewee Two, 2020)

> *"There are opportunities but again where we overemphasise the smartness of the solution; we risk falling prey to this kind of land technology competitions and Losing sight of what could be a very effective low tech but proven way of going about it." – (Interviewee Five, 2020)*

5.7 Smart City Inequality

Experts express that these technological/digital tools could distract us from real issues that are amplified during emergencies, such as leaving many disadvantaged communities further behind, increasing social inequality to a much dire state.

"There's a chance it could widen the gap as previously we were trying to narrow/close the gap." – (Interviewee Three, 2020)

These biased tendencies of smart technologies are exacerbated by the digital divide and become even worse for disadvantaged groups such the elderly or BAME communities when faced with emergencies, presenting different challenges to different groups within the city. However, using the already available information to identify vulnerable groups and "design our cities smartly to avoid these inequalities happening" (Interviewee Five, 2020) could reduce the level inequality, thus saving lives.

"…utilising the data we already have and then putting it to better use if we actually directed it towards looking at where the vulnerable are going to be and where people are going to suffer more" - (Interviewee Two, 2020)

If the current trend of smart city initiatives continues, where the focus remains as a top-down approach propelled by corporate, techno-centric ideologies which typically do not even recognise injustice, not to mention how to reduce it. It would defeat the purpose of a city being considered smart.

"Smart city is the next big revolution that is going to come, but you want it to be set up in the right way to benefit people of London rather than a money-making machine." – (Interviewee Two, 2020)

5.8 Smart City Framework - Opportunities and Threats

5.5.1 Smart Economy

- Localised & Decarbonising Economy

Data shows that retail levels around central London are still 50-60% lower than last year (Heffer & Garcia, 2020), whereas recovery has been quicker in coastal towns and outer London. This is interesting as the data also shows more people are travelling; however, they are choosing not to visit city centres.

"I have done a fair amount of work on high streets and in the online world. COVID is affecting a journey that was already happening, and there seems to be 2 different stories of what the outcome will likely be..." (Interviewee One, 2020)

The expert refers to the two possibilities of consumers either continuing to cement the safe relationship with online retailers or practising the genuine feeling of hyper localisation of "what can I get safely at the end of my street?" (Interviewee One, 2020). This has been a very beneficial opportunity for local businesses as they have been quite innovative in what they can offer residence in the area.

- Carbon-based Economy

The main challenge facing this dimension is to recover but continue to be a carbon driven economy. This could reverse the already made progress during this lockdown of lowering the dangerous levels of greenhouses gasses, that has jeopardised millions of lives around the world through natural emergencies such as heatwaves and extreme storms and droughts.

"it's not just about pandemics; it's also about climate change." – (Interviewee Five, 2020)

5.5.2 Smart People

- Access to Growth and Development

With lockdown enforced, limiting the movement of citizens and impacting their ability to grow and develop through visiting places such as libraries, schools, museums and other aspects of life. This has allowed technology the opportunity to fill the gap of the sudden shift from the real world to the digital world, aiming to provide the same level of experience without people leaving their homes.

However, these same opportunities are limited as many groups lack adequate infrastructure to access these vital services. Experts involved in the study have highlighted these critical issues and stress the government need to be "very mindful of the digital divide" (Interviewee Two, 2020) and how the gap of inequality could increase exponentially.

5.5.3 Smart Governance

- Citizen Participation

This pandemic has presented governments the opportunity to utilise technology in modernising and future-proofing citizen participation. They are establishing a new normal for how citizens can amplify their voices and express their opinions on issues that affect them and their communities.

> *"...giving more power to the locales to emphasise the health aspect of any urban projects, developments or anything that goes on in cities in the future." –*
> *(Interviewee Five, 2020)*

This level of communication and participation would improve the citizen-state relationship while saving costs, providing immediacy of information to better respond to short term and long-term public health problems. These are tools that would improve the chances of mitigating the impact of the virus outbreak, and reduced inequality in disadvantaged communities who suffer the most in emergencies.

> *"smart technology is used in such a way that participation can be increased so, in fact, people can be involved in decision making, for example in planning decisions where communities are not just commentators" – (Interviewee Four, 2020)*

- Centralisation

A centralised approach poses a threat to citizens participating in decision making. This can lead to problems such dismissing many communities who are disadvantaged and generalise the public leading existing action plans for pandemics with:

> *"...2 massive assumptions about the public which are proven false by previous pandemics. One is that people will comply, so we just need to tell them what to do and when to do it – we obviously know it doesn't work like that. And the other is that people will panic, and which will result in riots and tear gas and looting – that also really doesn't apply at all, as shown by previous pandemics."*
> *– (Interviewee Two, 2020)*

5.5.4 Smart Mobility

- Sustainable Transportation

During this Lockdown, Londoners have had the opportunity to experience the pleasures of walking and cycling on widened pavements, closed roads and safer routes for cycling, enabling millions to move around the city quickly and sustainably.

These changes have brought about many benefits such as reducing the spread of the virus, Improved local economies due to an increase in localised trips, improving the health of residents and the improvement of the environment. One factor that has contributed to this change is the working and home dynamic, which has reduced carbon-based transport.

> *"...in the 80s the prediction was commuting won't happen anymore everyone will work from home, but it didn't actually happen, but now suddenly these kinds of ideas we were well aware of and expecting are now suddenly happening..." – (Interviewee Four, 2020)*

- Temporary Measures

A genuine threat against the aforementioned opportunities is their ability to remain post-COVID as they are considered temporary changes. Another threat presented is the dismissal of local people's voices and their ability in deciding what happens to their neighbourhood and city.

> *"We've seen how trying to build confidence back is a very challenging thing, not just around public transport but in our High Street widening pavements and so forth helping to give people confidence...temporary measures will help, I hope they will become permanent." – (Interviewee Six, 2020)*

5.5.5 Smart Environment

- People-centric Design

A key lesson learnt during this pandemic is the healing effect, and faster route to recover nature provides. The pandemic has presented an opportunity by highlighting the benefits of different design concepts and made us re-evaluate assumptions had on fundamental urban design and

architectural practices. These include density within our cities, access to public and private green spaces, building and apartment typologies that citizens have been forced to self-isolate within.

> *"If you think about the environment, it certainly has a key role to play so it can definitely act on that environment and improve some of the marginations that occur generally. Or a better situation when a crisis occurs for everyone to be on the same playing field." (Interviewee two, 2020)*

> *"...cities evolve, and it's often when there is an emergency [e.g. war or pandemic] when they often take the biggest steps forward..." – (Interviewee Three, 2020)*

5.5.6 Smart Liveability

- Community

The pandemic's impact on communities has brought multiple issues to light, forcing communities to innovate and not rely on top-down solutions. Interviewees have praised bottom-up approaches in implementing social cohesion through digital means to support those less vulnerable in their community.

Additional opportunities have presented themselves based on London being a collection of "small villages which are functioning self-sufficient units within themselves" (Interviewee Five, 2020) hence allowing for living standards to increase though taking advantage of the

> *"massive gap in the physical space, where retail is going to disappear from the High Street so as everything goes online and stores become less viable than when they used to be. That leaves a void for the community perhaps to move into." – (Interviewee Three, 2020)*

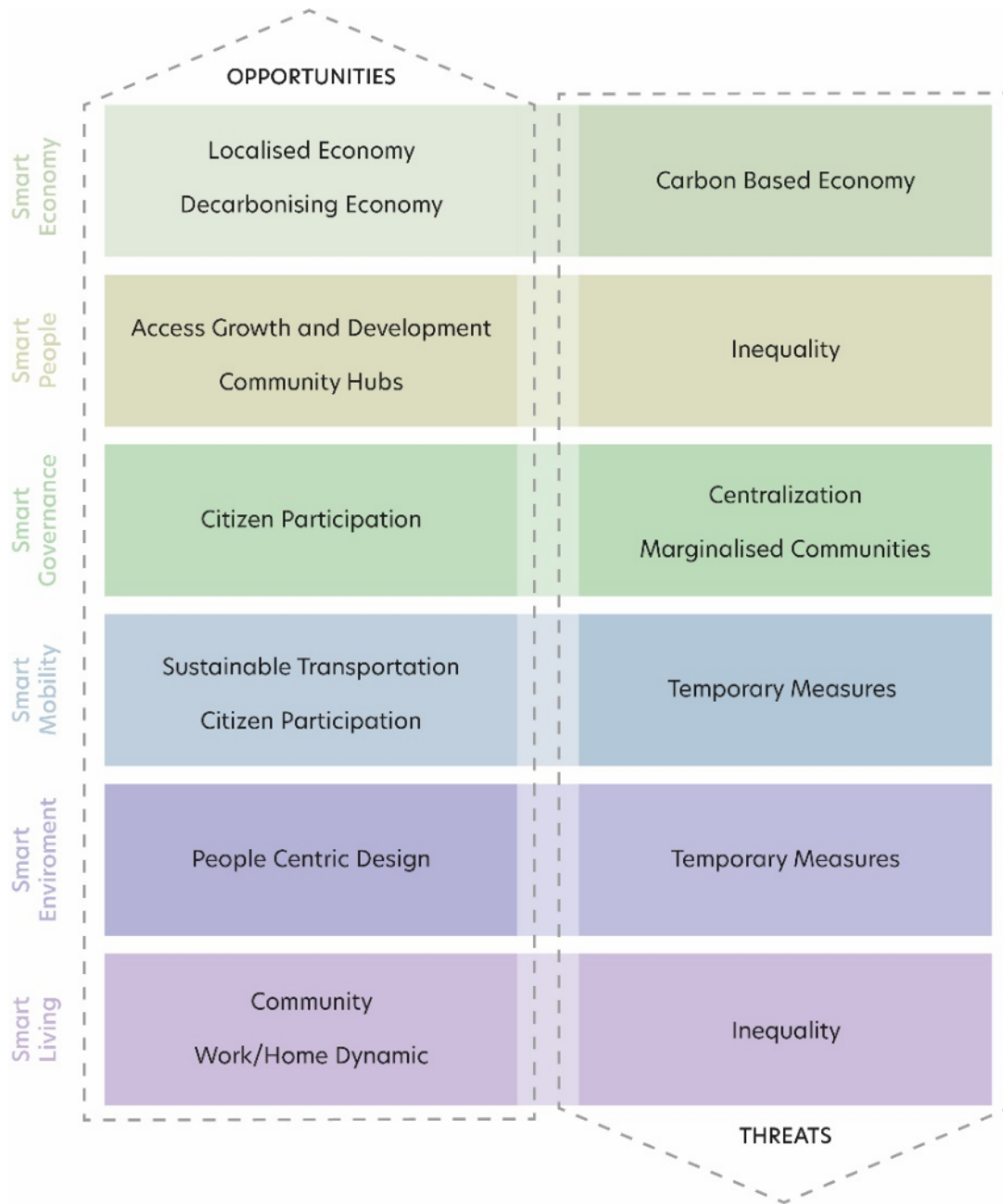## 5.6 Opportunities and Threats Summary

Figure 10: Opportunities and Threats

6. CONCLUSIONS & RECOMMENDATIONS

The aim of this study was to analyse the impact of COVID-19 and highlight opportunities for sustainable ideas and concepts to reduce the spread of the virus or mitigate the impact on London. This research topic has become increasingly important as the world continues to confront the current pandemic of COVID-19 and the stark reality of becoming part and parcel of life in cities for the foreseeable future. The subsequent segments of this chapter discuss the key findings in achieving the research objectives, proposal suggestions for future studies and recommendation for London based on the analysis derived from the study.

6.1 Findings Summary

The first objective of the study was to investigate the literature relating to smart cities and pandemics. It became evident that the smart city concept can be used to make London inherently safer when faced with emergencies such as COVID-19. This became even clearer when reviewing solutions cities had implemented throughout history **(figure 4)** to overcome or mitigate virus outbreaks; as technological advancements utilised by smart cities could amplify the effectiveness of existing solutions or introduce new methods in reducing the spread or mitigating the impact of the virus in London.

The literature had also revealed that mitigating the impact of the pandemic depended on the improvement of public health in key dimensions of the city. To achieve this, the study explored Lombardi et al.'s (2012) smart city framework where the combination of six dimensions created a holistic model that represented the neoclassical theories of urban growth and development **(figure 2)**.

Assessing the impact of coronavirus on London for the second objective confirmed that the dimensions were directly linked to public health and the spread of the virus. For example, this can be seen in the study when investigating the lack of private green spaces in London's densely populated areas which had influenced citizens to defy both the lockdown and social distancing rules, increasing the spread of the virus. The qualitative study had also concluded that the six

dimensions are interlinked, where the weakness in one dimension can influence public health indirectly through other dimensions, thus increasing the risk of transmission.

When investigating the third objective in Identifying the opportunities and challenges **(figure 11)**, It was clear that the concept of smart cities played a crucial role in creating a safer city. However, Experts Interviewed had Identified challenges that threatened the likelihood of those opportunities becoming successful. One of the main threats identified in the study was current solutions during COVID-19 being labelled as 'temporary measures' despite citizens voicing their support for measures to become permanent.

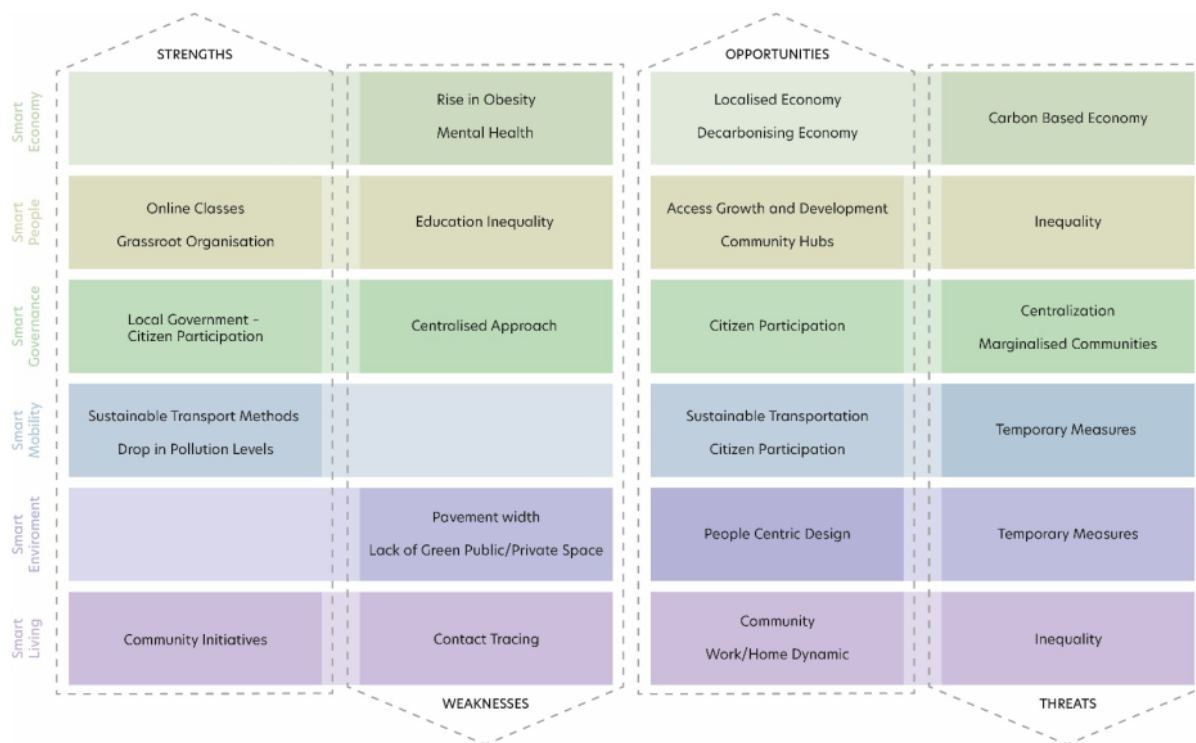|	STRENGTHS		OPPORTUNITIES	
Smart Economy		Rise in Obesity Mental Health	Localised Economy Decarbonising Economy	Carbon Based Economy
Smart People	Online Classes Grassroot Organisation	Education Inequality	Access Growth and Development Community Hubs	Inequality
Smart Governance	Local Government – Citizen Participation	Centralised Approach	Citizen Participation	Centralization Marginalised Communities
Smart Mobility	Sustainable Transport Methods Drop in Pollution Levels		Sustainable Transportation Citizen Participation	Temporary Measures
Smart Environment		Pavement width Lack of Green Public/Private Space	People Centric Design	Temporary Measures
Smart Living	Community Initiatives	Contact Tracing	Community Work/Home Dynamic	Inequality
		WEAKNESSES		THREATS

Figure 11: SWOT Analysis Summary

6.2 Further Research

In the literature review, topics which lacked research were highlighted for further studies. While some of these areas were discussed in the study others are yet to be explored. This includes

investigating the perspective of citizens on how they would shape the definition and concept of a 'Smart City'.

Another area that can be explored following from this study is a more in-depth look into the public health impact on specific smart city dimensions. The majority of research regarding health and smart cities tend to focus on 'E-Health' (health services and flow of information). Future research can also build on this current study by further understanding the links within the smart city framework and its potential influence on public health.

Future investigation can develop on this current study by exploring the views and insights of other stakeholders of the city such as Politicians, economists and citizens, to better understand the impact of the pandemic on the smart city framework.

6.3 Recommendations

The following recommendations are derived from the study to reduce the spread of the virus and mitigate the impact on London:

1. **Citizen Participation** is vital when responding to an emergency such as a pandemic. This means to decentralise efforts, as more problems can be targeted in stopping the spread or mitigating the impact on different groups or areas within the city.

2. **The Built Environment's** impact on health is now crystal clear to all stakeholders in the city, due to the arrival of COVID-19. The public health agenda in new and existing developments should be brought to the forefront in mitigating not only the Impact of virus outbreaks but also noncommunicable diseases.

3. **Sustainable Solutions** are critical and have been made clear with the number of emergencies humanity currently faces simultaneously. Short-term solutions presented in stopping the spread of the virus or mitigating the impact on cities should be sustainable and consider the long term implication on public health. As it will not be possible to self-isolate from other emergencies such as climate change.

4. **Technology and Digital Tools** are vital in facilitating strategies and responses to emergencies in ways that are, at times, difficult to accomplish manually. However, this may not always be the case, and traditional methods may yield better, long-term results to those most affected when faced with an emergency.

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8. APPENDICES

Appendix A: Semi-structured Interview Questions

Appendix B: Risk Assessment Form

Appendices A – Semi-structured interview Questions

1. Smart City
   a. How would you define a smart city?
   b. Would you consider London as a smart city?

2. London and COVID-19 (*Responses given for each dimensions)
   a. What problems and challenges has this pandemic uncovered in each dimension?
   b. What solutions are there to reduce the spread or mitigate the impact of the pandemic in each of the dimensions?
   c. What has been the role of technology during COVD-19?
   d. What are the opportunities in each dimension that could reduce the spread of the virus or mitigating its impact on the city?
   e. What risk do we face in not being able to tackle COVID-19
   f. What are your recommendations for London in reaching this aim?

3. Top-down and bottom-up Approaches (*Responses given for each dimensions)
   a. What approach has had more impact on reducing the spread of the virus or mitigate the impact on the city (Examples)?
   b. What could these approaches do differently to improve their chances of success?

RISK ASSESSMENT FORM

FIELD / LOCATION WORK

UCL

The Approved Code of Practice - Management of Fieldwork should be referred to when completing this form

http://www.ucl.ac.uk/estates/safetynet/guidance/fieldwork/acop.pdf

DEPARTMENT/SECTION
LOCATION(S)
PERSONS COVERED BY THE RISK ASSESSMENT

BRIEF DESCRIPTION OF FIELDWORK

Consider, in turn, each hazard (white on black). If **NO** hazard exists select **NO** and move to next hazard section.

If a hazard does exist select **YES** and assess the risks that could arise from that hazard in the risk assessment box.

Where risks are identified that are not adequately controlled they must be brought to the attention of your Departmental Management who should put temporary control measures in place or stop the work. Detail such risks in the final section.

ENVIRONMENT	The environment always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard
e.g. location, climate, terrain, neighbourhood, in outside organizations, pollution, animals.	Examples of risk: adverse weather, illness, hypothermia, assault, getting lost. Is the risk high / medium / low ?

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	work abroad incorporates Foreign Office advice
	participants have been trained and given all necessary information
	only accredited centres are used for rural field work
	participants will wear appropriate clothing and footwear for the specified environment
	trained leaders accompany the trip
	refuge is available
	work in outside organisations is subject to their having satisfactory H&S procedures in place
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EMERGENCIES	Where emergencies may arise use space below to identify and assess any risks
e.g. fire, accidents	Examples of risk: loss of property, loss of life

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	participants have registered with LOCATE at http://www.fco.gov.uk/en/travel-and-living-abroad/
	fire fighting equipment is carried on the trip and participants know how to use it
	contact numbers for emergency services are known to all participants
	participants have means of contacting emergency services
	participants have been trained and given all necessary information
	a plan for rescue has been formulated, all parties understand the procedure
	the plan for rescue /emergency has a reciprocal element
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

FIELDWORK   1   May 2010

EQUIPMENT	Is equipment used?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. clothing, outboard motors.	Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low ?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangement for equipment is followed
	participants have been provided with any necessary equipment appropriate for the work
	all equipment has been inspected, before issue, by a competent person
	all users have been advised of correct use
	special equipment is only issued to persons trained in its use by a competent person
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING	Is lone working		If 'No' move to next hazard
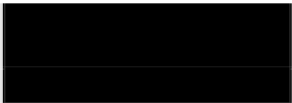
	a possibility?	NO	If 'Yes' use space below to identify and assess any risks
e.g. alone or in isolation lone interviews.	Examples of risk: difficult to summon help. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangement for lone/out of hours working for field work is followed
	lone or isolated working is not allowed
	location, route and expected time of return of lone workers is logged daily before work commences
	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
	all workers are fully familiar with emergency procedures
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

ILL HEALTH	The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this Hazard.
e.g. accident, illness, *personal attack, special personal considerations or vulnerabilities.*	Examples of risk: injury, asthma, allergies. Is the risk high / medium / low?
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	an appropriate number of trained first-aiders and first aid kits are present on the field trip
	all participants have had the necessary inoculations/ carry appropriate prophylactics
	participants have been advised of the physical demands of the trip and are deemed to be physically suited
	participants have been adequate advice on harmful plants, animals and substances they may encounter
	participants who require medication have advised the leader of this and carry sufficient medication for their needs
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

TRANSPORT	Will transport be required	NO	NO	Move to next hazard
		YES		**Use space below to identify and assess any risks**
e.g. hired vehicles	Examples of risk: accidents arising from lack of maintenance, suitability or training			
	Is the risk high / medium / low?			
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**			

	only public transport will be used
	the vehicle will be hired from a reputable supplier
	transport must be properly maintained in compliance with relevant national regulations
	drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
	drivers have been trained and hold the appropriate licence
	there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
	sufficient spare parts carried to meet foreseeable emergencies
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE PUBLIC	Will people be dealing with public	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks

e.g. interviews, observing	Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low?

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

☐	all participants are trained in interviewing techniques
☐	interviews are contracted out to a third party
☐	advice and support from local groups has been sought
☐	participants do not wear clothes that might cause offence or attract unwanted attention
☐	interviews are conducted at neutral locations or where neither party could be at risk
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

WORKING ON OR **NEAR WATER**	**Will people work on** **or near water?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any** **risks**
e.g. rivers, marshland, sea.	Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

☐	lone working on or near water will not be allowed
☐	coastguard information is understood; all work takes place outside those times when tides could prove a threat
☐	all participants are competent swimmers
☐	participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons
☐	boat is operated by a competent person
☐	all boats are equipped with an alternative means of propulsion e.g. oars
☐	participants have received any appropriate inoculations
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

MANUAL HANDLING (MH)	Do MH activities take place?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.	Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	the departmental written Arrangement for MH is followed
	the supervisor has attended a MH risk assessment course
	all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
	all persons performing MH tasks are adequately trained
	equipment components will be assembled on site
	any MH task outside the competence of staff will be done by contractors
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

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SUBSTANCES	Will participants work with	**NO**	If 'No' move to next hazard
			If 'Yes' use space below to identify and assess any
	substances		risks
e.g. plants, chemical, biohazard, waste	Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?		
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**		

	the departmental written Arrangements for dealing with hazardous substances and waste are followed
	all participants are given information, training and protective equipment for hazardous substances they may encounter
	participants who have allergies have advised the leader of this and carry sufficient medication for their needs
	waste is disposed of in a responsible manner
	suitable containers are provided for hazardous waste
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

OTHER HAZARDS	Have you identified any other hazards?	**NO**	If 'No' move to next section
			If 'Yes' use space below to identify and assess any
			risks
i.e. any other hazards must be noted and assessed here.	Hazard:		
	Risk: is the risk		
CONTROL MEASURES	**Give details of control measures in place to control the identified risks**		

Have you identified any risks that are not adequately controlled?	NO	**NO**	**Move to Declaration**
	YES		**Use space below to identify the risk and what**
			action was taken

Is this project subject to the UCL requirements on the ethics of Non-NHS Human Research?

If yes, please state your Project ID Number

For more information, please refer to: http://ethics.grad.ucl.ac.uk/

| DECLARATION | The work will be reassessed whenever there is a significant change and at least annually. Those participating in the work have read the assessment. |

Select the appropriate statement:

| X | I the undersigned have assessed the activity and associated risks and declare that there is no significant residual risk |

| | I the undersigned have assessed the activity and associated risks and declare that the risk will be controlled by the method(s) listed above |

NAME OF SUPERVISOR

Beatriz Mella Lira

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