BPLN0039_19145788

by Lili Pandolfi

Submission date: 25-Jun-2021 04:33PM (UTC+0100)
Submission ID: 157172616
File name: 716975_Lili_Pandolfi_BPLN0039_19145788_2914221_324577676.pdf (6.48M)
Word count: 20521
Character count: 118270

UNIVERSITY COLLEGE LONDON

FACULTY OF THE BUILT ENVIRONMENT

BARTLETT SCHOOL OF PLANNING

High Streets in Lockdown:

The effect of location and composition on high street resilience in London

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Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of the MPLAN in City Planning at University College London: I declare that this dissertation is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

Signature: 

Date: 25th June, 2021

Word Count: 15,530

Appendix word count: 2,564

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Acknowledgements

I would like to thank my dissertation advisor Prof. Jung Won Sonn for his invaluable help in the production of this dissertation, from start to finish. I would also like to thank Prof. Michael Short for his continued support in this and many other endeavours throughout the MPLAN course. Finally, I am grateful to Alexander Schmid for his guidance on the application of econometric methods and the use of Stata.

Abstract

During the COVID-19 pandemic, the UK government has applied national and regional lockdowns that have greatly reduced the ability to travel for daily activities such as work or shopping. The changes in behaviour resulting from these restrictions have had spatial implications by creating a shift in the urban system, and particularly the urban retail system. High streets located near offices have seen great reductions in footfall whereas those located near residential hubs were most resilient. During lockdown, high accessibility of the area by public transport and high median household income of the catchment area both led to lower footfall. However, high ratios of retail, residential and leisure land uses increased footfall, as well as distance to central London and high residential density within the high street catchment. Findings from this study show that, to create resilient high street, there should be a greater push for residential uses on and around the high street, and a preservation or increase of retail units, as well as a decrease in the centralisation of the workplace. Whilst there are certainly dangers to the deregulation of the planning system, the adaptability that it facilitates for land use change may allow for the creation of such resilient high street. Findings also encourage policies that seek to decentralise urban systems, such as the 15-minute city model.

I. Introduction

"We know most about something when it breaks down." (Lahoud, 2010, p.20)

In the 17th Century, the Bubonic plague called into question the organisation of cities, not only regarding hygienic standards influencing the spread of the plague, but also transport and street systems that influenced the resilience of the wider urban system. It promoted a redesign of the sewer system and an upheaval of the planning system (Liu, 2021). It is in such times of crisis that the underlying, long-term problems of the urban realm and its systems are brought to light (Wrigley and Lambiri, 2015b). Indeed, the way urban systems function under stress is more revelatory of these urban systems than studying their usual patterns of functionality (Lahoud, 2010). Therefore, COVID-19's devastating impacts highlight the responsibility of planners and policymakers to ensure that the urban realm, and the retail systems that support it, are resilient to similar future shocks. To provide this resilience, shocks must be perceived as opportunities for learning and improvement.

The COVID-19 pandemic and the chronology of UK lockdowns

In December 2019, the Wuhan region of China reported a novel coronavirus outbreak, and on March 11th 2020, the World Health Organisation declared it a pandemic (Kantis, Kiernan and Bardi, 2021). On the 23rd of March 2020 the Prime Minister of the UK announced a lockdown, ordering people to stay at home, and allowing only essential travel from the 26th of March onwards. These restrictions were gradually eased from early June, but reinstated in a second lockdown on the 5th of November which lasted until the 2nd of December 2020. Finally, the third lockdown began on the 6th of January 2021 and is due to end on July 19th 2020 (as of the date of publication) (Institute for Government, 2021). The purpose of these lockdowns was to curb the spread of the virus by minimising travel and the presence of multiple people in public spaces. The government urged Londoners to "walk or cycle where possible" and to "work from home where you can" (London.gov.uk, 2021). Homeworking was already on an upward trajectory before lockdown, with around 4.7% of the worker population performing this type of work. However, the proportion rose to 43.1% in April 2020 and remained high throughout the lockdown periods (Reuschke and

Felstead, 2020). Government guidelines encouraging an 'essential travel only' policy changed public behaviour, reducing transport ridership by 70% during lockdown in the UK (Gkiotsalitis and Cats, 2020).

A re-emerging interest in high street performance

As seen in the review of the literature below, it is in times of shock that attention is once again paid to high street performance and resilience. There was a spike in publications on this subject after, and relating to, the 2008 economic crisis, and to a lesser extent after the events of 9/11. It is no wonder then, that this subject is once again at the heart of research and policymaking in the context of the COVID-19 pandemic. For instance, the Centre for cities (2020) high streets recovery tracker initiative researched the differentiated impacts of lockdown on high streets in 62 cities in the UK and found that average footfall on high streets had fallen to 22% of pre-lockdown levels on average, whilst others such as the HSTF (2020) report on footfall data in 154 locations in England, found a decrease of 72.9%. But this figure hid significant variations; high streets in small towns (such as Blackpool, Aldershot, Basildon) had recovered up to 57% of their footfall at the end of lockdown whilst larger cities (such as London, Manchester, Bristol) had only recovered between 11% and 16% of their footfall (Centre for Cities, 2020). Indeed, the High Streets Task Force (2020, p.3), found that "smaller, multifunctional towns and districts that serve their local catchment effectively" were able to recover the quickest from the impact of lockdown. Similarly, Deloitte (2021) found that reopening rates at the end of the first lockdown (June 15th, 2020) were higher in commuter and seaside towns than in city centres, as the latter are more dependent on daily commuters. In their oral evidence to UK Parliament (2020b) on the topic of 'Supporting our High streets after COVID-19', Prof. Cathy Parker and Prof. Aude Bicquelet-Lock concur that lockdown trends have led larger centres to suffer the most whilst smaller town centres and district centres have shown themselves to be most resilient. From the "1st March to 30th June, district centres saw footfall drop by only 34.5%" compared "to a drop of 75.9% in cities over the same period." (High Streets Task Force, 2020; p.3)

These findings suggest that, due to working from home and reduced travel, workers were more likely to shop in their local high street rather than near their place of work or on their

commute. For instance, in July, 2020, reopening rates in Manchester's Spinningfields neighbourhood (home to many offices) were 58%, compared to 88% in the nearby commuter town of Sale (Bicquelet-Lock, 2020). Bicquelet-Lock summarises both her and fellow academics findings in the phrase: "Why are some high streets doing better than others? Location is important…" There are therefore established geographic and spatial implications to way people shop during lockdown, which can influence the performance of high streets.

Since there is differentiated recovery amongst high streets at the national level, it is interesting to test whether this spatial differentiation applies at the city level. Since working from home patterns are linked to an absence of people coming from outside the city, this raises the question of whether high streets located near offices (in urban centres) have performed worse than those located near residential centres (in outer urban locations/suburbs). At this meso scale, Centre for Cities (2020) found that local centres recovered more quicky than the city-centre, but are still not recovering to pre-COVID levels, particularly in the wealthier area of South Manchester where a higher proportion of city-centre workers reside. Their survey of consumers found that 59% used more local stores and services during lockdown. Furthermore Deloitte (2021) find that new working patterns imply local residents will spend more time in their local communities, increasing the demand for local retail and diverting spending power from city centres to the suburbs. Greater London is an interesting case study to test this theory as house prices in its central business district are so high that there are stark spatial variations between where people can afford to live and where their offices are located. The results for London may therefore not be applicable to smaller cities with lower land values in city centres.

It is important to investigate this potential phenomenon since, whilst tourism can be expected to return to normal once travel restrictions are lifted, lockdown's effect on commuting patterns may be long lasting. Corporations have become accustomed to this mode of working and have put in place preventative measures that will remain to curb the rise of future pandemics (Lichfield, 2020). In this context, offices have faced an unprecedented change in occupancy rates, location, spatial configuration, overall design and operating routines, which has implications for the vitality of high streets located near them. This is the potential phenomenon that this paper seeks to uncover and analyse. Having observed this new dynamic, there is now an important opportunity

for the local high street "to become again the focus for the exchange of goods, services and social interactions (*ibid*)." Uncovering the spatial factors associated with high street recovery can help us understand what factors contributed to resilience in lockdown, and by proxy, to other social, economic and environmental shocks affecting transport systems and the accessibility of local retail centres. It is important to study changes in shopping behaviour as it is very likely that, like after the 2008 recession, these will become "the new normal" after the pandemic (Nanda, Xu and Zhang, 2021).

Research Question and Aims

How have changes in the routines and behaviours of Londoners due to lockdown affected the impact of location, and spatial and compositional factors on high street performance.

Sub questions

1) How has the land use composition of the high street influenced its performance during lockdown?
2) What policy implications can be gleaned from this, regarding the current policy context of change of use class orders and permitted development rights, which allow conversions of retail and offices to residential?
3) How does the location of the high street in relation to the urban system and its pattern of land uses affect its performance during lockdown?
4) What implications does this have for the distribution of land uses throughout the city?
5) Do wealthier catchment areas lead to better high street performance during lockdown?
6) Does the typo-morphology of the high street have a significant influence on its performance, and if so, what are the implications for resilient urban design?

Hypotheses

Catchment area

1.A Lockdown has reduced the influence of distance to CBD/distance to Holborn on high street performance.

1.B Lockdown has reduced the influence of the PTAL score of the catchment on high street performance.

1.C Lockdown has reduced the influence of the income level of the catchment on high street performance.

> High streets in wealthy areas are assumed to be nearer to offices, and therefore to have experienced reduced footfall throughout lockdown. Conversely, high streets in lower income areas are assumed to have higher rates of residential land uses and therefore to have experienced increased footfall during lockdown.

1.D Lockdown has increased the influence of the residential density of the catchment on high street performance.

On the high street

2.A Lockdown's changes to the daily routines of Londoners has increased the performance of high streets with a higher proportion of residential, and reduced the performance of high streets with a higher proportion of offices.

2.B Lockdown has reduced the influence of leisure activities on high street performance.

In times of crisis, the main concern regarding retail is accessibility and location, less so the quality of the shopping experience. I hypothesise that, due to the reduction of mobility caused by the UK's national lockdown, the ability of high streets to attract consumers through a curated shopping experience is made irrelevant. This is a hypothesis which I will test using the presence of leisure activities on the high streets as a control variable.

Typo-morphology

3. During lockdown, high streets in the 'pedestrian' and 'plaza' typo-morphologies performed better than those fitting a 'main street' or 'market' typo-morphology.

Research Objectives

1. Use high street footfall data as a proxy for high street performance and select sites which will provide a continuous overview of footfall over pre-, during and post-lockdown periods in Greater London.
2. Identify, and collect data describing the spatial attributes and composition of high streets in London that are projected to affect high street performance, based on the literature review.
3. Through a multivariate panel regression in Stata, identify correlations between footfall performance and the aforementioned variables.
4. Evaluate the significance, explanatory value and level of influence of the spatial and compositional variables on high street performance outside of and during lockdown.
5. Extract lessons on the location and composition of high street that are most resilient to lockdown conditions, and conceptualise how these may be applied in the current policy context and/or what changes to the policy context are needed to account for these implications.

Limits of the study

This research does not seek to understand how the spread of coronavirus itself has impacted urban systems, nor how the behaviours of individuals in relation to fears of spreading the virus have changed their travel and shopping patterns. Rather I study whether and how the lockdown restrictions *resulting* from the pandemic (travel restrictions and working from home) have had an impact on the shopping patterns of households which differentially impacted retail centres in London, depending on their location and composition. Additionally, I am not studying the resilience of high streets compared to other retail formats such as shopping centres, but I am selecting to study only high streets, and to examine which of these are most resilient and why.

II. Literature Review

High Streets

"Shopping has always been central to the very idea of urbanity – cities are sites of exchange" (Rao, et al., 2017, p.544). Historically, high streets have been the locus of the urban shopping experience in the UK (Carmona, 2015). They are defined as complex mixed-use corridors that allow pedestrian access to everyday retail and services, as well as places of work and leisure. High streets are central to daily life for many people in Britain, with at least 38% of people of visiting their local high street several times a week (Just Economics, 2018 p.11), making them more than simply retail centres. They are a glue that binds local communities together (Fletcher et al., 2016). Indeed, high streets and town centres are crucial to the retail sector in terms of business but also in terms of linking retail to a sense of place (Findlay and Sparks, 2014). High streets and town centres are terms that are often used interchangeably, but the former can stretch beyond and even sit outside of town centres (GLA, 2019). In 2017, the High Streets for All report (We Made That/LSE Cities, 2017) found that, unlike town centres, 70% of London's high streets were not officially designated in the planning system. However, this has since been remedied by the Office of National Statistics (ONS) and Ordnance Survey (2019) research, which has designated 600 high streets in London alone (see Fig.1). In their research, the ONS and the Ordnance Survey defined the high street as "a named street predominately consisting of retailing, defined by a cluster of 15 or more retail addresses within 150 metres." The two organisations collaborated on a dataset showcasing high street locations and their composition throughout the UK, excluding other retail forms, such as retail parks and shopping centres. As the aforementioned high streets dataset is used in this study to provide information about the composition of high streets, this study will adopt the ONS and OS definition described above.

Map 1: Map of designated high streets in London (ONS and Ordnance Survey, 2020)

Within the urban retail hierarchy (see figure 1), the high street can be counted anywhere between the town centre and shopping parade scales depending on the number of addresses and the size of its catchment. Whilst retail is only one of the many uses on the high street, the retail literature is the major purveyor of academic research on this subject. Indeed, although retail is "routinely ignored at a strategic and national level" of policymaking and is only concerned with planning permission for individual retail sites, this land use has been of increasing interest in the academic literature (Findlay and Sparks, 2014). There has been a 26% increase in articles about retail between 2001 and 2008 alone (*ibid*), and the propoertion of this research produced by Business and Management Studies departments continues to grow whilst Geography departments have a declining contribution. This reflects a decline in the study of retail's spatial qualities, which as I will prove in this study, are central to the performance of high streets for outside of, and during, shocks and crises.

Figure 1: Scales of retail centres in the urban realm. (Wrigley and Lambiri, 2015a; inspired by Berry, 1967)

Long term retail crises

Rudlin (2020) sees three crises as having consecutively weakened retail centres in UK cities. The first crisis involved "the decimation of the independent retail sector that happened in the 70s and 80s". Gardner and Sheppard (1989) coined the term 'retail revolution' to define this change in urban retail structure towards large scale stores located outside of the city centre. Guy (1998) then described how out-of-town centres were causing the decline of shops at the convenience and neighbourhood level, namely on the high street. The urban patterns created by out-of-town retail forced consumers to travel greater distances to buy convenience goods (Barata-Salgueiro and Erkip, 2014) and marked the rise of car-centric travel for shopping. As of 2016, shopping trips in account for 19% of all journeys in England… and 64% of those journeys are made by car, whilst 25% are made by walking (Department of Transport, 2016).

The overall increase in car-dependence for travel to retail locations, which has created a path dependency towards more car-centric urban form, has implications for travel patterns and urban form. Thomas and Bromley (1993; 1995) and Guy (2007), found that consumers car-dependence marginalised consumer groups like the elderly and the disabled, thereby entrenching social inequalities, which in turn reduced the social cohesion of a community and the social sustainability of urban life. Therefore, creating high streets that are accessible and walkable can

create greater social cohesion. These shifts towards car use are occurring in the midst of a mental health crisis in the UK, creating an even greater need for social connection and interaction through active travel and in person shopping. Indeed, it is in this context that Don Mitchell famously asks: "Have we reached, then, the end of public space" and begun to seek only private interactions? However, London may prove itself to be an anomaly in this, as 63% of surveyed London high street users walked to their high street (GLA, 2017), 40% more than in the rest of the UK (Department of Transport, 2016). As London is the densest city in the UK (Statista, 2014), walkability to high streets can be expected to be much higher than elsewhere.

The second of Rudlin's crises was the lack of regulation over the out-of-town retail phenomenon throughout the 1990s, when mega malls and retail parks were allowed to multiply and change the retail landscape. Finally, the third crisis involved large investment into retailing in the 2000s, which expanded large chains (both in town and out-of-town) at the expense of independent retailers.

Additionally, Deloitte (2021, p.5) believe the long-term decline of the high street to be due, in part, to online retailing and distorted rents. Indeed, rising property values cause affordability pressures on high street businesses (We Made That/LSE Cities, 2017), and this dynamic is further enabled by the recent change to the Use Class Order applying to the Permitted Development Rights (2019). Amongst other uses, A1 (shops) and B1 (offices and businesses) uses can, as of September, 2019 be converted to C3 (dwellinghouses) without planning permission. Relaxation of planning regulation may also entail that the future holds an even greater mix of uses catering more precisely to the wants and needs of local communities (Deloitte, 2021). Indeed, the decline of retail is not always lamented, as it is only one part of the economic success of high streets in London (GLA, 2019). The High Street London Report (We Made That and LSE Cities, 2017) found that shops and services account for much less than half of the non-residential use on or adjacent to most high streets. It is therefore not surprising that 45% of high streets users surveyed in London stated that their visit to the high street was not motivated by retail (*ibid*.) and (Vaughan et al., 2009) found this to be two thirds of trips. There are therefore other forces at play in the decline of the high street, beyond simply retail decline.

Long term trends: consumer behaviour

Long term shifts have been occurring on the high street, either causing or resulting from changes in consumer behaviour. For instance, shopping has evolved from a necessity to a leisure and entertainment activity (Gardner and Sheppard, 1989) with evidence from Hart et al. (2014) suggesting "that the 'leisure aspect' of shopping trips is a significant driver of footfall" (Wrigley and Lambiri, 2015b, p.16). High streets have been influenced by the rise of convenience culture, defined in Wrigley and Lambiri (2015a, p.41) ie. the bargain that households are willing to make with retailers to invest more time in their shopping experience. Convenience culture links retail to the local community, making consumers value authenticity and responsible shopping, and is expected to grow to 24% of the grocery market by 2019. The academic realm of retail resilience (citations) as well as consultancy work (Deloitte, 2021) has found that high street performance, both now and in the future, depends on high street experiences rather than retail alone

Local shopping is therefore, partly, the result of a consumer base that is increasingly driven by ethical decision-making. The Market Report by Ethical Consumer (2013) finds that the proportion of shoppers seeking out local produce increased from 15 to 42% between 2005 and 2012, and 40% of local shoppers "said they were prepared to pay a premium for locally produced foods" (Wrigley and Lambiri, 2015a, p.42). This was attributed to smaller households, an ageing population, longer working hours and busier lifestyles (*ibid*). In fact, during the pandemic, the most important concern for shoppers when choosing where to spend their money was whether a business "take(s) extra steps to ensure the safety and well-being of their employees" (62% of respondents) and are "local to the area" (57% of respondents) (see Appendix 1) (Deloitte, 2021). It is interesting that in a time when long range travel is discouraged, the proximity of a business is only a second concern behind the managerial decisions with regards to staff safety. Indeed, one must remember that whilst economic and geographical models create systems of behaviour under the assumption that humans are perfectly rational and self-interested, humans are moral agents that do not act in systematic or predictable ways, sometimes acting on principle rather than convenience or gain (Zsolnai, 2002). This must be acknowledged in the analysis, when attempting to systematise the behaviours of Londoners regarding travel restrictions and their associated shopping patterns.

Trends accelerated by lockdown

"Generally, there is a lack of consistent longitudinal (year on year) place-based data on shops which can give a longer-term perspective distinguishing temporary and more lasting changes" (Findlay and Sparks, 2014, p.8). In Fig. 2, Wrigley and Lambiri (2015a) have attempted to differentiate these, even dividing them by short-, medium- and long-term effects on high street performance. However, this diagram does not acknowledge the fact that these trends reinforce each other, and particularly the fact that short-term shocks tend to accelerate long-term trends. As noted by Scott Corfe, research director at the Social Market Foundation think tank during the HCLGC Oral Evidence (2020), the solutions to the downturn caused by lockdown "will be enough to help some businesses through the current cyclical downturn", but the pandemic has also accelerated long term trends that began before this crisis. One of these is a shift towards home working which may be expected to move towards a hybrid model post-pandemic (Reuschke and Felstead, 2020; Swinney, 2020). Another shift, linked to the first, is the decline in demand for office space.

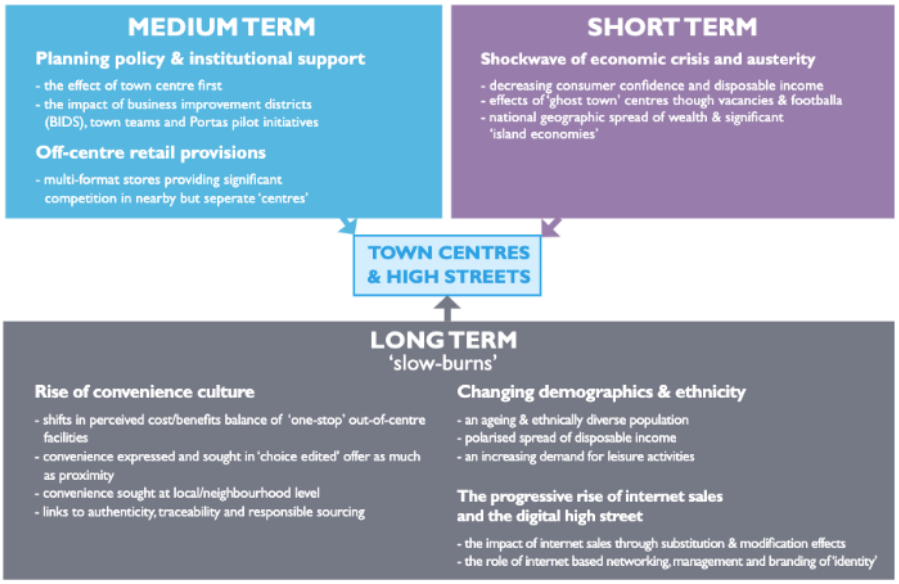

Figure 2: Diagram of the short-, medium- and long-term forces shaping the high street (Wrigley and Lambiri, 2015a)

Wrigley and Lambiri (2015a) found that "there are remarkably few publicly available studies which have analysed the drivers of the differential performance of UK town centres/high streets" particularly in the context of the economic crisis and its subsequent period of austerity (p.19). In July of the same year, they therefore fill this gap, finding a strong post-recession divide in high street performance between the North/South of the UK and between catchments with higher levels of disposable household income, higher managerial jobs etc ('strong socio-economic context') and those with a 'weak socio-economic context' (Wrigley and Lambiri, 2015b). They discover a post-recession trend towards shopping little, often and closer to home have been rising due to consciousness over waste. The IGD (2014) confirms this, finding an increase in the frequency of shopping trips, leading to more "top up" shopping, which the Deloitte consumer report (2013) to make up 59% of the shopping trips on the high street.

History of resilience

The question of how to maintain the vitality of high streets during crises directly implicates the concept of resilience. This concept has only recently been applied to urban systems and the retail systems within them since the 1990s, but it emerged in the fields of physics and psychology (Anthony, 1974) in the 1960s and 70s. In physics, it indicates the ability of an object to return to its original position after a shock, and in psychology, the ability to successfully survive a shock or trauma (Barata-Salgueiro and Erkip, 2014). The concept was then introduced into ecology in 1973 by C.S Holling to understand nonlinear dynamics in natural systems, such as the processes by which ecosystems maintain themselves in the face of natural disturbance (ex: fires, droughts, floods, etc) (Marcus and Colding, 2014). Resilience is, in this context, a measure of the ability of systems to absorb change and disturbance without losing the relationship between their constituent elements (Graugaard, 2012). According to Holling (1973), there are three interrelated properties of resilience: 1) the amount of change the system can undergo and still retain the same controls on function and structure; 2) the degree to which the system is capable of self-organisation; and 3) the ability to build and increase the capacity for learning and adaptation. These definitions have shaped the resilience discourse to this day (Gößling-Reisemann et al., 2018).

Two major interpretations of resilience have emerged from Holling's work. An engineering-based interpretation of resilience describes the ability of the system to return to its pre-trauma state, whilst a new ecological definition focuses on the scale of shock that a system can absorb before it is destabilised and moves to a new configuration (Martin, 2011). The ecological definition of resilience has been applied to policy by inspiring the idea of tipping points. For instance, it has been used to study the tipping points involved in corporate food store entry in ecologies of small independent retailers (Wrigley and Dolega, 2011). Resilience was therefore introduced into planning in the 1990s and the literature surrounding it has grown at a fast pace since then (Leon and March, 2016; Sharifi and Yamagata, 2014).

Whilst many contributors to the literature are satisfied with applying an ecological definition to urban resilience (Karrholm et al., 2014), others (Martin, 2011; Wrigley and Dolega, 2011; Ozuduru and Guldmann, 2013) claim this definition do not capture the subtle nature of high street adaptation. Instead, they push for Martin (2011)'s definition of 'adaptive resilience' based in 'complex systems theory' which focuses on the capacity of complex adaptive systems to self-organise into new configurations, not a previous equilibrium. Such a concept of resilient urban form may at first seem oxymoronic since urban form is rigid and apparently in constant equilibrium (Sharifi, 2019c), but Martin's (2011) definition acknowledges that urban systems are a dynamic and evolutionary process rather than a fixed structure. Indeed, urban systems are never in equilibrium, and any definition of urban resilience that seeks the return to a state of stability gravely misunderstands the nature of how they function (Barata-Salgueiro and Erkip, 2014; Frommer, 2013; Foster, 2007; Sharifi and Yamagata, 2014). Sharifi and Yamagata (2014) reinterpret this definition in the context of urban resilience, by avoiding the question: 'How long until the system regains its functions', and asking '*how* does the system reorganise in order to retain its functions, even as it is undergoing a shock.'

I will be applying an adaptive resilience interpretation in this study of high streets in London's urban system, by avoiding a comparison pre- and post-lockdown performance but rather explores the evolution of the high street even as it is under stress, therefore seeking to understand the *process* of resilience. Indeed, whilst studies such as Deloitte (2013) and HSTF (2020) focus on "bouncing back" by comparing post-lockdown performance to pre-lockdown, this study adopts an

adaptive resilience perspective by analysing the performance of high streets *during* lockdown. The emphasis is therefore not placed on an end state but on the process of change. Furthermore, focusing on an end result would overlooks planners' ability to shape that end result, and in this case to shape the post-lockdown high street towards more resilient forms and compositions.

Theory of resilient urban design

Land use locations and urban form

Land use models have long been used by geographers to schematise the typical location of land uses and activities in the city. The Burgess model (1925) (fig.3) operates on an assumption that land uses naturally develop in concentric circles, with dense office space and factories in the centre and decreasingly dense residential uses expanding outwards. Indeed, office floorspace is spatially concentrated in central London "as occupiers seek to take advantage of agglomeration benefits, such as access to skilled workers" (GLA, 2014, p.V). Retail also tends to congregate in major employment centres often coinciding with transport hub, particularly aimed at workers (Wrigley and Lambiri, 2015a). Based on this premise, commuting patterns form an inward flow from the commuter zone to the central business district (henceforth referred to as the CBD).

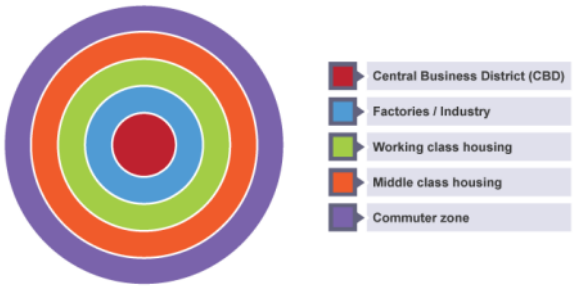

Figure 3: Diagram of the Burgess Model (BBC, 2020)

However, London once again defeats oversimplification, as 52% of jobs and 47% of businesses located outside of the Central Activities Zone (CAZ) were located on a high street throughout the city (GLA, 2017). Indeed, the rate at which jobs and businesses has grown in outer

London high streets was higher than in inner city high streets between 2013-2018 (*ibid*). Therefore, the land use distribution of London may follow the more nuanced Hoyt (1939) model.

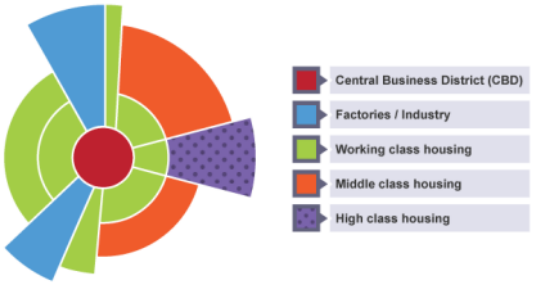

Figure 4: Diagram of the Hoyt model (BBC, 2020)

In Hoyt's model, cities do not expand in perfect concentric circles but rather the economies in the city develop according to topographical and geographical features that benefit their operations, such as rivers and existing transportation lines, leaving housing to nestle itself in leftover locations. In this vision, the city is not actively decentralised through policies such as localism or the 15-minute city (which I will explore further in the following section), but is imagined as a naturally decentralised entity. The patterns of commuting become more complex than simply from a commuter belt into the centre. The Hoyt model and other decentralised models begin to imagine a greater mix of uses at a finer grain, which creates a canvas on which fractal patterns and decentralised neighbourhoods can be created for resilience.

Models and theories of resilient urban form

It is evident from the emphasis on scaling and redundancy in the urban resilience literature, that cities following a monocentric model, such as the Burgess model, are deemed the least resilient to shocks. The Sharifi (2019a) review of theoretical and empirical evidence on resilience in the physical structure of cities has found a great focus on the scaling behaviour of urban phenomena (Batty and Longley 1994, Salat, 2014; Qubbaj, Shutters and Muneepeerakul, 2015). Indeed, the dynamic interplay between scales is key to producing urban forms that are adaptable to changing economic, environmental and social circumstances (Feliciotti et al., 2017). Sharifi divides this phenomenon into three scales: the macro, meso and micro scale. Most relevant to my research are

the meso scale (neighbourhood and street level) and an understanding of the patterns at play in the macro scale (city scale). The following table presents the relevant urban form elements at the macro scale and what purpose they have for resilience.

Resilience in the context of what?	Resilience for what?

• Urban form elements
  • Scale hierarchy
  • City size
  • Development type
  • Degree of clustering
  • Landscape/Habitat connectivity
	• Resilience characteristics
	  • Robustness
	  • Stability
	  • Redundancy
	  • Diversity
	  • Flexibility
	  • Modularity
	  • Self organization
	  • Efficiency

Table 1: Macro scale resilience principles. Adapted from Sharifi (2019a)

As seen in Table 1, scale hierarchy, the degree of clustering and connectivity of the system form part of the context one must be aware of when analysing resilience. Whilst this study does not directly study degree of clustering or scaling in street networks across London, the lessons from resilient urban patterns have implications for the dispersion of land uses throughout the city, and how they should be ordered and concentrated for optimal resilience. Therefore, I will delve into this area of the literature below.

Decentralisation and fractal patterns

Previously to Sharifi's work, scale hierarchy was already a central subject of urban resilience, as models like fractal geometry and inverse power law were developed in the 90s. Inverse Power Law, also called "Zipf's law", describes the proportional distribution of any spatial element, from the distribution of cities within a country (Gabaix, 1999) to subway stations within a city (Sharifi, 2018b). The logic of this spatial distribution is fractal geometry, which is the repetition of patterns at various scales ie. the idea that each component should be a reduced size copy of the whole (Salat, 2012). Fractal geometry is found in nature (such as plants and snowflakes) but can be found in cities when they are hierarchically organised into distinct yet

similar neighbourhoods and blocks (Sharifi, 2019b). Each system within the system is expected to function independently, yet "the subcomponents of a fractal feature are (also) inter-related and collectively form a harmonic and integrated whole" (Batty and Longley, 1994, p.123)

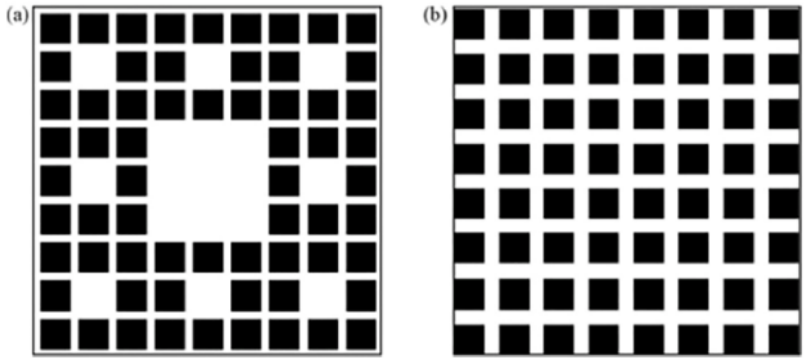

Figure 5: Fractal vs. uniform pattern (Thomas, Frankhauser and Biernacki, 2008).

Fractal geometry is the foundation of Central Place Theory, which Batty and Longley (1994) specifically apply to the context of the distribution of neighourhood centres within cities. The aspects which would have to be scaled up or down are the catchment area, the type of population served, the diversity in offering and many more. Multiple Centrality Assessment (MCA) theory, also plays with the concept of scale, suggesting that different levels of urban form determine the centrality of the given area or urban elements (Feliciotti et al., 2017). For instance, the street's location within a street network determines its centrality and therefore its potential to support retail and attract footfall (Porta et al., 2012).

The literature has long debated the benefits of polycentric city design, which may flow out of fractal patterns if centres are created following scaling and inverse power law principles. Polycentricity is found to contribute to urban resilience by enhancing the modularity of cities, as it decentralises and distributes infrastructure, functions and institutions across scales of the system (Dieleman, 2013). Such theories have inspired policies which are currently spreading in planning policy in cities throughout the world, particularly in the form of the 15-minute city. The 15-minute city is an urban strategy of decentralisation formulated by Carlos Moreno, special envoy of smart cities in Paris. The concept aims for 15-minute trips by active travel or public transport between

the home and essential daily activities (ex: work, education, healthcare). Indeed, as the result of the lockdown rules, city centres have had to cater to their residential catchment, much like smaller towns and districts already do. Indeed, the meso scale is the scale where a significant share of residents' daily activities take place, and therefore has important implications for community-level resilience. Unlike the macro scale, studying resilience at the meso scale allows a more granular and context-specific understanding of urban form and its elements. Barata-Salgueiro and Erkip (2014) also argue it is most appropriate to consider retail in planning and policy at the local or municipal levels, and I argue that the lockdown further enhances this due to limited accessibility and working from home.

High street performance and spatiality during crises

The role of retail has often disregarded in urban policy-making (Ozuduru and Guldmann, 2013) and in the wider urban resilience literature, yet retail district resilience is essential to building sustainable cities (Barata-Salgueiro and Erkip, 2014). After the economic downturn of 2008 however, issues such of economic resilience, future-proofing and town centre performance, grew increasingly popular in debates among academics, practitioners and policy makers (Coca-Stefaniak and Carroll, 2014). This new wave of literature analysed the resilience of the high street to sudden shocks, which I will call short term resilience as opposed to long term resilience. In this wave, Wrigley and Dolega (2011) produced one of the few studies to focus on spatiality of high street resilience, but their study of 267 town centres and high streets interprets spatiality on the national scale, exploring the North/South divide in performance. Additionally, in this newfound focus on retail, this land use was also subjected to modelling and systematisation. Fernandes and Chamusca (2012) find that specialisations, locations, forms and formats of retail have multiplied and diversified in the urban realm. Emerging patterns of retail location caused spatial problems, namely the ability of suburbs to create centrality whilst the city centre declines.

Bringing together resilient urban form theories and retail resilience, Rao et al. (2017), study the relationship between shopping and the urban morphology, asking how the city's access networks connect to its shopping networks, and how retail morphologies have changed over time. They develop a diagrammatic typology that "seeks to understand retailing in terms of

diagrammatic socio-spatial relations." This approach has its roots in the tradition of typo-morphology which explores the typical forms of the units making up the city ie. the building type, the block type etc (Marshall, 2005; Moudon, 1994). The 'type' is a form that naturally emerges throughout urban history; one that is tried and tested. This approach is also rooted in Alexander et al.'s (1977) notion of pattern language, with each pattern represented diagrammatically. Rao et al. (2017, p.545) vouch for the utility of retail type diagrams as they "illuminate the complex interrelations of the sociality, spatiality and economy of retailing."

Figure 4 represents the four typo-morphologies identified by Rao et al. (2017), inspired by Kostof (1991). The market network is a highly permeable grid of retail uses, often a temporary structure taking place within a plaza. Fractal patterns are once again at play here, as the market network is a lower scale version of a grid street network. Plazas (or market squares) are open public spaces surrounded by retail, where all shops are visible from the centre and accessible from the same space. The pedestrian and main streets both involve lines of shops, with the former exclusively including pedestrian flows and the latter both pedestrian and vehicular flows.

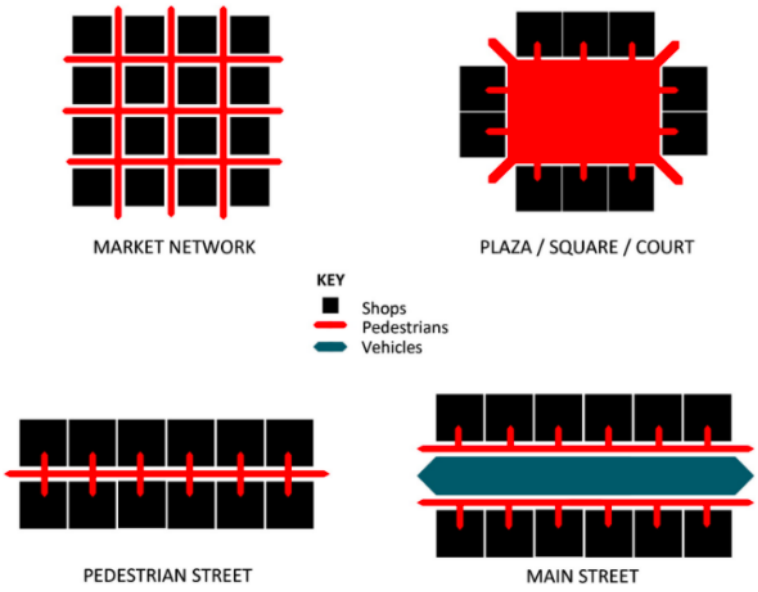

Figure 6: Typo-morphologies of retail identified by Rao et al (2017)

In this study, the characteristics of resilience are divided into spatial and compositional variables. The first, explored above, incorporates accessibility, typo-morphology and location (in relation to the city centre and to land uses like offices and residential). The second component, explored below, is that of composition, that is: the land uses occurring on the high street.

The literature has recently begun to highlight how the mix of uses on this scale can be key components of their sustainability (Ruiz-Apilanez et al., 2015; NPPF, 2012, Genecon, 2011; Feliciotti, Romice and Porta, 2016). Deloitte (2021) note that the high streets often escape the 'monoculture' that befalls city centres (mostly composed of offices) or shopping centres (composed of retail and leisure). The diversity of its uses is its key to long-term recovery (Vaughan, 2015) by encouraging sustainable mobility, economic resilience, local identity, and the social life of the neighbourhood (Jones et al., 2007). In this study, I will not be studying composition within but between various land uses. For instance, whilst it may be interesting to explore the differential impact of two types of retail (comparing a shoe shop and a greengrocers) on high street footfall, this lies outside the scope of this study. I will analyse the differential impact of, for instance, retail land uses compared to residential land uses on the high street's performance. Results focusing on classification of uses will be most relevant to the planning system, particularly when deriving lessons on how the deregulation of the planning process regarding change of use will, or can, impact high street diversity.

Public sector response

UK policymakers and planners have attempted to improve high street retail resilience through Business Improvement District designations that promote revitalisation, or a "town centres first policy' and 'sequential test' policy which have taken an infill development approach (Ozuduru and Guldmann, 2013). Other approaches have attempted to improve performance by increasing the number of residents living in and around high streets, with the purpose of supporting local shops and services (GLA, 2014). As early as 1989, the project 'Living over the Shops' already sought to increase residential land uses on the high street, and URBED's "Tapping the Potential" report found that the government's 'social housing over shops' scheme had created an additional 1.5M one bed flats in 1999. Indeed, a strong residential foundation can provide a consistent level

of local demand for a wide variety of different uses (Deloitte, 2021). Such evidence led the Strategic Housing Land Availability Assessment (GLA, 2017), to designate high streets and town centres as ideal places for residential intensification: a strategy that is being delivered across London, and particularly in outer London boroughs such as Woolwich and Canning Town. The Homes on our High Street report (GDL, 2017) also finds an untapped potential for homes above shops on or near the high street, which could house 300,000 people (Federation of Master Builders, 2017). Stakeholders from both the public and private sector are involved in this new push, as the rationale for residential on the high street not only hopes to to stimulate demand on high streets but also to meet the demand for housing in the midst of a housing crisis (*ibid*).

Table of factors affecting high street resilience

The table below is an adaptation of a table in Wrigley and Lambiri (2015a) in which they represented the KPIs of high street performance according to four major reports and other academic sources added by the author. Instead of KPIs, this table explores the factors influencing high street performance, found in the literature review. In the column to the right are the variables that I have formulated to account for these factors in this study. Eight studies and reports are included in this table. Factors that are analysed by proxy in this study are underlined, and those that are directly studied are underlined and in bold. Categories, when there are any, are italicised.

Table 2. Table of factors affecting high street resilience in the literature

Source		Factors influencing resilience	Variable
NPPF (2012)		• **Diversity of uses**	Retail to office and residential ratio Residential to address count ratio Office to address count ratio
		• Proportion of vacant street level property	*See Methods for explanation of footfall over vacancy as performance proxy*
		• Commercial yields on non-domestic property	
		• Customers' views and behaviour	
		• Commercial rents	
		• **Pedestrian flows**	Daily footfall sum
		• Accessibility by both private and public modes of transport	PTAL score
		• Perceptions of safety and occurrence of crime	
		• Environmental quality of town centre	Proxy: Typo-morphology
'Understanding High Street Performance' report. Genecon (2011)	Focus on footfall as opposed to vacancy rates.	• Footfall	Dependent variable: daily footfall sum
		• Consumer and business satisfaction	
		• **Diversity**	Residential to address count ratio, Retail to office and residential ratio, Office to address count ratio
		• Economic activity	Proxy: daily footfall sum

National Performance Framework for Town centres in Coca-Stefaniak 'Successful town Centres" (2013)	Existing indicators are too biased towards retail metrics. Proposes a matrix including multiple areas of focus.	***Diversity and vitality of place***	
		• **Retail offer**	Retail to office and residential ratio
		• **Culture and leisure offer**	Leisure to address count ratio
		• Events	
		• Reported crime	
		Markets Economic characteristics	
		• Retail sales	
		• Partnership working	
		• Charity shops	
		• Vacant retail units	
		• Evening / night-time economy	
		People and footfall	
		• **Footfall**	Daily footfall sum
		• **Geographical catchment**	800 meter radius (see explanation in Methods)
		• **Access**	PTAL score
		• Community spirit	
		• Car parking	
		Consumer and business perceptions	
		• Business confidence	
		• Visitor satisfaction	
		• Attractiveness	Proxy: typo-morphology
		• Crime and safety perceptions	
Wrigley and Lambiri (2015a) (A review of the literature)	Focuses rather on explanatory variables of high street performance rather than KPIs. Therefore, this study is most relevant to the formulation of independent variables.	• The positioning of a town centre or high street in the regional/local economy	Distance to CBD Distance to Holborn
		• **The size of the town centre/high street**	Address count
		• Retail/service balance	
		• **Centre diversity vs. centre homogeneity**	Residential to address count ratio, Retail to office and residential ratio, Office to address count ratio
		• Structural vacancy	*See Methods for explanation of footfall over vacancy as performance proxy*
		• **Structural configuration**	Typo-morphology dummy
		• Institutional support/business practice environments	
		• Percentage vacant units	

Distressed Property Taskforce Report (2013)		• Change in prime zone A rents	
		• Change of total residents in catchment	Proxy: household average in the catchment (but does not measure change of this variable over time).
		• Job seekers allowance claimant change within catchment	Proxy: Median household income in catchment
		• **Diversity**	Residential to address count ratio, Retail to office and residential ratio, Office to address count ratio
		• Town Centre institutional support	
		• Suitability of retail premises	
		• Attractiveness and atmosphere of the town	Proxy: Typo-morphology
Feliciotti, Romice and Porta. (2016).		• **Diversity**: Diversity of uses and transport modes affecting liveability, economic attractiveness, health	Residential to address count ratio, Retail to office and residential ratio, Office to address count ratio
		• Redundancy: repetition of land uses and systems.	
		• Modularity: "a system where functions or services are locally distributed and spread across decentralised sub-systems." (Ahern, 2011)	This can only be inferred by an interaction of the all of the variables.
		• **Connectivity**: good internal connectivity and weak long-range connectivity (Salingaros, 2000)	External connectivity: PTAL score, internal connectivity proxy: typo-morphology.
Wrigley and Lambiri (2015b)		• **Economic context**: disposable household income, higher managerial jobs	Median household income in high street catchment
		• **Size of the city/town centre**	Address count
		•	
High Streets Task Force (2020)		• **Outdoor/indoor shopping**	
		• **Density of retailers**	Retail to office and residential ratio
		• **Proportion of office space**	Office to address count ratio
		• Shopping centre format	

III. Methods

Multivariate econometric method

There is a small supply of studies attempting "to relate performance to potential drivers of performance" of high streets in the UK (Wrigley and Lambiri, 2015a; p.16): that is, studies that ask "Which of the many potential drivers that have been suggested can be shown – holding all other things constant – to have had an impact on centre/high street performance? (*ibid*)" In this report, Wrigley and Lambiri suggest that the only way to answer this question is by statistical modelling, using the multivariate econometric approach commonly applied in the social sciences. Such analysis can select a single or composite dependent variable as a proxy for explanatory elements established in the Table 2. The panel regression model is selected as the form of multivariate regression that is most ideal in the case of causal inference of panel data (where multiple N units is studied over a T time series) (Bruna and Yu, 2013). Panel regression allows the consideration of several independent variables at different points in time, and reduces the likelihood of false inference due to reciprocal causality (Hao, 2016). In fact, the panel regression model also controls for time-invariant differences between the units studied (in this case: high street locations) so the results cannot be biased due to time invariant characteristics that are omitted in the regression (Kohler and Kreuter, 2005).

The regression takes the form of the following equation:

$$Yit = \beta 1X1,it + \cdots + \beta kXk,it + \alpha i + uit$$

with $i = 1,\ldots, n$ and $t = 1,\ldots, T$

Choice of footfall as a proxy for high street performance

The variable that is most commonly used as a proxy for high street performance in the literature has been vacancy rates (Wrigley and Dolega, 2011; Wrigley and Lambiri, 2015a). Yet Findlay and Sparks (2010) findings show that retail/service unit vacancies are not uniformly and inevitably an indicator of the fragility of a high street, as they may simply be a sign of temporary readjustment to accommodate a new market demand. Indeed, not all vacancy is the same: long-term vacancy affects shoppers' perception of the retail centre and dwell time, but short-term vacancy is churn-

related and necessary for the adjustment of retail to demand (Wrigley and Lambiri, 2015b), as retailers adjust to shifting consumer tastes and change their preferred micro-locations in on the high street (Wrigley and Lambiri, 2015a). Therefore, High Streets Taskforce (2020, p.7) argues that the most important indicator to measure high street performance is footfall as it is "very responsive", measuring changes in real time, and it is a good proxy for other indicators such as "spend, property/rental values and occupancy rates." This proxy is also easy to understand by multiple stakeholders and is inexpensive to acquire. For this reason, footfall is a better indicator of high street resilience, as it measures the vitality of the high street even as it is undergoing necessary restructuring and facing potentially healthy levels of vacancy.

In the Oral Evidence to the HCLGC (2020) on, Paul Swinney (director of the Centre for Cities) noted that one must differentiate between business failures on the high street and the failure of the high street itself as a retail structure. Whilst certain businesses may fail to evolve with their customer base and therefore go out of business, this should be separated from phenomena specifically relating to the high street. By using footfall instead of vacancy rate, I therefore avoid the conflation between the failure of individual businesses and the failure of the high street. Therefore, as suggested by the aforementioned sources, this study uses footfall as a dependent variable. It is likely that in the surge of literature produced in the mid 2010s on the subject of high street resilience, vacancy rates were not used because they were thought to be a superior proxy for high street performance when compared to footfall. Sensor technology was not as advanced, as widely accessible, nor even used for the specific purpose of counting footfall. Footfall counts were manually recorded, making them an unreliable proxy for high street performance. As this technology becomes increasingly available and reliable nowadays, it is therefore a preferable alternative to vacancy rates when studying retail resilience.

U040	RECREATION AND LEISURE	U041	Outdoor amenity and open spaces
		U042	Amusement and show places
		U043	Libraries, museums and galleries
		U044	Sports facilities and grounds
		U045	Holiday parks and camps
		U046	Allotments and city farms

U070	RESIDENTIAL	U071	Dwellings
		U072	Hotels, boarding and guest houses
		U073	Residential institutions
U080	COMMUNITY SERVICES	U081	Medical and health care services
		U082	Places of worship
		U083	Education
		U084	Community services
U090	RETAIL	U091	Shops
		U092	Financial and professional services
		U093	Restaurants and cafes
		U094	Public houses and bars

Table 3. Description of land uses (MHCLG, 2006, p. 16, 20)

According to the National Land Use Database (MHCLG, 2006), in its classification of land uses, retail land use classification is composed of shops ie. premises for the sale and display of goods to visiting members of the public (including hairdressers, travel agencies, post offices, showrooms, launderettes, petrol filling stations). It also includes financial and professional services such as banks, estate agencies and betting offices, as well as restaurants, public houses and bars.

Process of selection and cleaning of the data

The dataset used for footfall comprises aggregated footfall counts at daily five-minute intervals. There are currently 1151 sensors operating in 107 cities across the UK as of Aug 2018. However, these were narrowed down to locations that 1) are located in Greater London, and 2) demonstrated continuous counts through the 1st of January 2018 to 29th of February 2021. The threshold for locations to be considered 'continuous' was if they contained at least 9 out of 12 months of footfall counts for each year (with 2020 and 2021 being lumped together, and expecting 11/14 months of data). 36 high streets were therefore selected for analysis.

The variable 'Footfall_sum' represents the daily sum of footfall counts, taken at 5-minute intervals in each location. A log transformation is used to fix the skewness of this data, which is not normally distributed as seen below

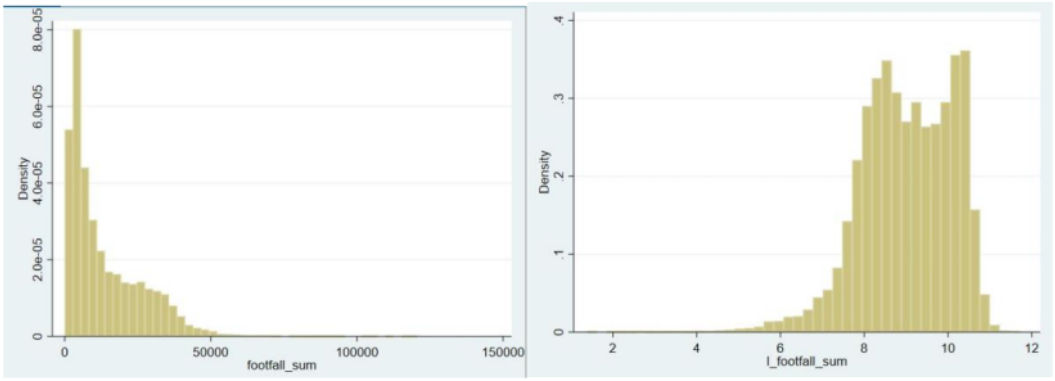

Figure 7 (left) and Figure 8 (right), respectively: histogram of the Footfall_sum data before log transformation, and histogram of the Footfall_sum data after log transformation.

Formulation of Independent Variables

Table 4. Table of independent variables

Variable	Description	Description of Raw Data	Original Source
Residential to address count ratio	Calculated by author: Residential count/address count	High Streets Dataset	ONS and Ordnance Survey (2020)
Office to address count ratio	Calculated by author: Office count/address count	High Streets Dataset	ONS and Ordnance Survey (2020)
Retail to office and residential ratio	Ratio provided in dataset	High Streets Dataset	ONS and Ordnance Survey (2020)
Distance to CBD	Distance from the high street to the nearest edge of the Central Business District boundaries, measured in ArcGIS.	Central business district boundaries file, imported into ArcGIS for measurement.	London Datastore
Distance to Holborn	Distance from the high street to Holborn station, calculated with the Google maps measurement feature.	Holborn Station Location	Google Maps, and Evans. (1973). *The Journey to Work—II: The Central Business District,* which designates Holborn as the centre of the CBD
Lockdown dummy	Dummy variable representing whether a given date is within lockdown or not.	A date is given the value 1 if it is within a lockdown period; 0 if it is outside of a lockdown period.	Institute for Government (2021), *Timeline of UK coronavirus lockdowns, March 2020 to March 2021*
PTAL average	Average of Public Transport Accessibility Level (PTAL)	"PTALS are a detailed and accurate measure of the	TFL (2014) accessed through LSOA dataset

	scores for LSOAs within an 800m radius of the high street.	accessibility of a point to the public transport network, taking into account walk access time and service availability. The method is essentially a way of measuring the density of the public transport network at any location within Greater London." (TFL, 2020) Scores ranging from 0:very poor access to 8: excellent access	
Persons per hectare average	Average of persons per hectare in LSOAs present within an 800m radius of the high street.		Census data 2013 accessed through LSOA dataset
Median household income	Average of the Median annual household income estimate for all LSOAs selected within an 800m radius of the high street.	"Mean and median average gross annual household income 2011/12. This income data is unequivalised - that is it takes no account of average household size or composition within each area."	GLA (2011/2012) accessed through LSOA dataset
Typo-morphology dummy (plaza, market, pedestrian, main street)	4 columns are inserted in the Stata panel dataset representing each typo-morphology. When a high street does not match the typo-morphology, it is given the value 0. When it matches the typology, it is given the value 1	'Towards a genealogy of urban shopping: types, adaptation and resilience": definition of 4 typo-morphologies defining most retail centres.	Rao et al. (2017)
Weekend dummy	Excel formula: if day of the week is labelled Saturday or Sunday, the date associated with the footfall count was marked as weekend (1), if not, it was marked as weekday (0)	"Day of the week" variable from LDC footfall data.	LDC (2021)

ONS High streets data description

The ONS high streets dataset is a high street specific dataset that provides street level information. It originates from a collaboration between the Ordnance Survey and Office of National Statistics and was created in 2019. It includes only named streets "predominately consisting of retailing, defined by a cluster of 15 or more retail addresses within 150 metres." A limitation of the dataset is that it may not capture smaller high streets due to this definition. Additionally, highs streets with a composition that is not retail-centred may not appear.

Defining the retail catchment

As established in the literature review, the most pertinent scale at which to analyse the patterns of retail is at the meso, neighbourhood level. As the extent of neighbourhoods is subjective and disputed, I turn to the retail catchment for a standardised definition in the study which places the high street at the centre of this study's definition of the neighbourhood. Dolega, Pavlis and Singleton (2016) define a retail catchment as the areal extent from which the main patrons of a store or retail centre may be found. As lockdown has called for reduced travel by public transport and increased active travel (UITP, 2020), research methods must assume consumers were likely to use active travel methods to reach retail locations. An 800m radius is the standard definition of walking distance in town and transport planning: a measure that was reasserted in the Planning for Walking Toolkit by TFL, in 2020.

A map of Lower Layer Super Output Areas boundaries was imported into ArcGIS for spatial analysis. LSOAs are a useful unit to report demographic and spatial statistics at a small scale; they capture data on an average pf 1,722 persons per London LSOA as of 2010, the last reported Census year. ArcGIS is a software allowing the visualisation, management and analysis of geographic data. On the LSOA map visualised in ArcGIS, a buffer of 800m was created around the sensor location of each selected high stree. LSOAs where at least 60% of the territory was contained within the buffer were selected for analysis. The data associated with each groups of LSOAs was then selected and utilised to calculate the independent variables for each location, such as: PTAL score, average households, median household income, and persons per hectare. In using the scale of the catchment, I am able to assert information about the wider context of the

high street and follow the guidance of Barata-Salgueiro and Erkip (2014) who found the local and neighbourhood level to be the most appropriate scale of analysis for resilience.

Limitations

1. The final panel dataset was unbalanced, meaning not all observations were fully accounted for throughout the time period of 01/01/2018 to 29/02/2021. Even though the data was sifted for continuity and only sites with the monst reliable data were selected, the very high frequency of counts (daily) and the fragile nature of sensors, which often require maintenance, meant that the dataset could not realistically be complete. However, an unbalanced data is a common problem in comparative studies and is not incompatible with the running of a panel regression, whose results will still be significant and reliable.

2. The median household income for each catchment shows that the selected streets skew towards the higher end of income brackets. The average income in Greater London is £30,677 and the mean of household income in the dataset is £41,585. The results of the study must therefore acknowledge that they may not account for trends or land use composition of high streets in lower income neighbourhoods. Indeed, the ability to work from home was divided according to income, qualification level and the skill-level of Londoners (Reuschke and Felstead, 2020). Therefore, areas with lower median income per household may also represent areas where workers are least likely to be working from home (working potentially in lower paying, essential work). These workers may therefore have continued to shop on high streets near their work. The results of the regression may therefore indicate a greater impact of lockdown and working from home patterns on high streets than is realistically the case in a range of high streets.

3. The accuracy of the LSOA data may be higher for central London high streets. As these locations are usually denser, the LSOAs contained within the 800m buffer are geographically smaller. LSOA boundaries were therefore less likely to be bisected by the buffer, and the final selection was more likely to form a perfect circle of 800m radius. However, walking distance is not absolutely decided by an 800m radius to begin with. The choice to participate in active travel is also based on age, resident behaviour, on the ability/disability of individuals, type of active travel (walking or

cycling). Since many factors affect the catchment size beyond distance, the 800m radius should only be taken as an simplified indicator recommended for policymaking, and not an exact boundary which must be precisely followed. The effect of this limitation on the collection of data will only produce negligible effects on the data and results.

4. Some independent variables are correlated with each other, which may lead to the common problem of multicollinearity in the regression. Of two variables that are found to be collinear, I retain the one which is 1) most relevant to this study, or 2) has the highest R-squared value. If both variables pass both tests, they are regressed separately to avoid omission of results due to multicollinearity. Variables affected by multicollinearity include residential_address ratio and office_address ratio and retail_office_resi as these partly complete each other.

Ethical Considerations

The footfall data used as a proxy for high street performance is based on the SmartStreetSensor footfall data collected by the Local Data Company, and acquired by the author from the Consumer Data Research Centre upon request through a project proposal. The agreement, including a copy of the project proposal (see Appendix 2) outlines the limitations of what can be done with the data due to its sensitive nature. A description of the data profile is cited below (CDRC):

"The (original) dataset contains details of passive Wi-Fi signal probing from a sensor network across Great Britain. These data are used as a proxy for estimating footfall at retail locations. The sensors capture signals sent by Wi-Fi enabled devices present in their range. The potentially identifiable information collected on the mobile devices is hashed at sensor level and the data is sent to the central server via an encrypted channel for storage."

Therefore, although the information is initially identifiable, it is processed so that it is anonymised once provided to the author for analysis. There are therefore no ethical considerations beyond the ones addressed in the agreement with the CDRC.

IV. Analysis of Results and Discussion

Spatial and demographic variables

The independent variables selected for this study have an explanatory factor of 66.4% over daily footfall sum from 2018-2021. All dependent variables are significant as seen by the P values worth 0.000 (see Table 5). As a log transformation of daily footfall sum is used, the coefficients of the dependent variables must be multiplied by 100 to perceive the percentage change in footfall when the variable increases by one unit (for a 'count' variable) or by one percentage point (for a log transformed variables). The coefficients in the table below have therefore been multiplied by 100 to reflect this.

The aim of this multivariate panel regression is to assert to what extent the spatial, composition and other variables of London's high street contribute to its footfall outside of, and during lockdown. It is therefore important to create an interaction variable between each independent variable and the lockdown dummy. The coefficient of this interaction variable will assert the variation in the coefficient and significance of the independent variable during the entire duration of the study compared to lockdown periods. The table below presents the difference between the impact of the variable independently ('Coeff indiv' column) and during lockdown ('Interaction Coeff' column), with large increases appearing in dark green, mild increases in light green, mild decreases in light orange, and large decreases in dark orange. Variables were log transformed when data was skewed and/or when a percentage change interpretation was preferable to a unit change interpretation.

Table 5. Table showing regression results

Variable	**Coeff (indiv)**	**P>t**	**R Squared**	**Interaction Coeff (i.var##i.Lockdown)**	**P>t**	**R Squared**
Log of distance to Holborn	-38.15	0.000	40.08	31.02	0.000	13.80
Log of residential to address count ratio	-61.20	0.000	16.80	-70.67	0.213	0.2052
Log_retail_ratio	-61.9	0.000	8.90	80.93	0.000	13.53
Weekend	-26.03	0.000	.92	13.25	0.007	5.52
Log_dist_CBD	3.02	0.000	0.49	5.59	0.000	0.62
Log_pers_ph	-22.06	0.000	.64	-9.16	0.12	4.29
Leisure ratio	5.73	0.000	1.07	10.81	0.000	5.36
Address count	.06	0.000	5.62	-.02	0.000	10.93
Community Space count	3.30	0.000	3.45	.74	0.035	7.76
PTAL average (800m radius)	10.49	0.000	1.69	-22.48	0.000	6.02
Log_office_ratio	31.46	0.000	8.74	-24.36	0.000	12.92
Log_median_income	89.78	0.000	.89	-136.2	0.000	4.89
Interaction var (Weekends during Lockdown)				13.25	0.007	0.0552
Eat out to help out	-33.27	0.000	.13			
Typomorphology						
Pedestrian	-91.76	0.000	2.82	-156.7	0.000	7.75
Plaza	-72.49	0.000	1.16	99.21	0.000	5.67
Market Network (shopping centre)	103.5	0.000	1.85	-52.22		6.40
Main street	44.10	0.000	1.15	-63.28	0.000	5.76

Lockdown restrictions had an impact on footfall of -79.6% (significant p=0) which matches the 75.9% decrease in footfall in major cities (between the 1st of March and 30th of June) found by the High Streets Task Force (2020). As expected, this impact was not equally felt throughout the selected high streets, as seen by the impact of the independent variables on performance.

Hypothesis 1.A Lockdown has reduced the influence of distance to CBD/Holborn on high street performance.

One variable of interest was the effect of distance to Holborn and distance to the CBD boundaries on footfall during lockdown. Distance to Holborn is used when analysing location of the high street in relation to urban design implications or land use models. CBD is used when the implications of the analysis skew towards an economic outcome, linked to offices or income level. These variable has major implications on the understanding of land use models (Burgess, Hoyt, Central Place Theory etc) and their application in the London context. Indeed, Hypothesis 1.A was founded on an assumption of monocentricity and concentric land use distribution ie. that a central business district was composed largely of offices, and then residential uses surrounded the CBD in rings of increasingly wealthy and less dense development. However, the scatter plots show no correlation between distance to Holborn and density within the dataset (fig. 9), and only a negligible negative correlation with average household income (fig. 10). This implies that Greater London follows a decentralised, and potentially polycentric model akin to the Hoyt model or Central Place Theory, where land uses in cities overlap and are ordered like a lattice. Therefore, distance to the centre has a lower influence on land use and demographics than other variables (ie. the variables selected in this study).

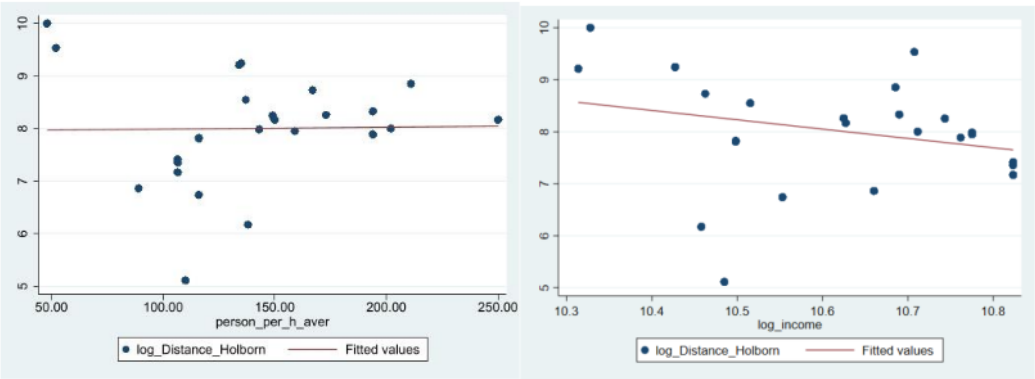

Figure 9 (left) Figure 10 (right) showing the correlation between distance to Holborn and spatial factors

The assumption of Hypothesis 1.A is therefore rejected by the correlation between the chosen independent variables, however, the hypothesis itself is substantiated by the results in table 4. Indeed, a 1% increase in the log of distance to CBD caused a -38,15% effect on footfall outside of lockdown, but a positive effect of 31,02% on footfall during lockdown. This suggests that high streets further away from the CBD performed worse than central high streets before lockdown, but during lockdown this logic was reversed. This confirms the opinions of speakers at the Oral Evidence to UK Parliament (2020b) who generally predicted a better performance of outer London high streets, partly due to the logic that central high streets include more offices which were less frequently visited during lockdown.

Hypothesis 1.B Lockdown has reduced the influence the PTAL score of the catchment on high street performance.

The behaviour of the variable 'PTAL score of LSOAs within 800m radius of the high street' suggests that accessibility had a positive influence of 10.49% on footfall generally, but in lockdown this became a negative relationship of -22.48%. This reinforces Salingaros (2000) findings that optimal resilience is achieved when there is good internal connectivity but weak long-range connectivity. By proxy, this also indicates that power law, as it applies to the connectivity of street networks, is also beneficial for resilience. Indeed. Porta et al., (2012) had applied this fractal pattern and power law thinking by suggesting that street patterns and the connectivity they create should increase as the scale decreases. Hypothesis 1.B is therefore substantiated.

Hypothesis 1.C Lockdown has reduced the influence of the income level of the catchment on high street performance.

Log of Median income per LSOA within 800m of the high street had an effect that changed from positive to negative between pre-lockdown and lockdown periods. Generally, a 1% increase in median income of local households would increase high street footfall by 89.78%. However, during lockdown, this 1% increase in income was linked to a -136.2% change in footfall. This ascertains Findlay and Sparks' (2010) findings that secondary retail centres showcasing different land use mix, offering and purpose, generally experienced lower vacancy rates throughout and after the recession, regardless of whether they were in deprived or prosperous areas. However, this counters claims by Wrigley and Lambiri (2015b) and Wrigley and Dolega (2011), whose studies of resilience to the 2008 economic crash found a strong influence of socio-economic context, disposable household income and job skill level (see Appendix 2). These findings confirm the assumptions of Hypothesis 2.B, namely that high streets with high ratios of offices and more likely to have wealthy catchments, and that ones with high residential ratios are more likely to house low-income households in their catchment. It is difficult, however, to ascertain whether income was at the source of this effect or due to the spatial variables that income is correlated with (see Figs. 11, 12, 13, 14).

These findings have implications for land use distribution in London, which impact the interpretation of results. As seen in Fig. 11 below, the higher the ratio of residential on the high street, the lower the average income of the local area. Meanwhile, high streets with high ratios of offices were strongly correlated with higher income groups (fig.12).

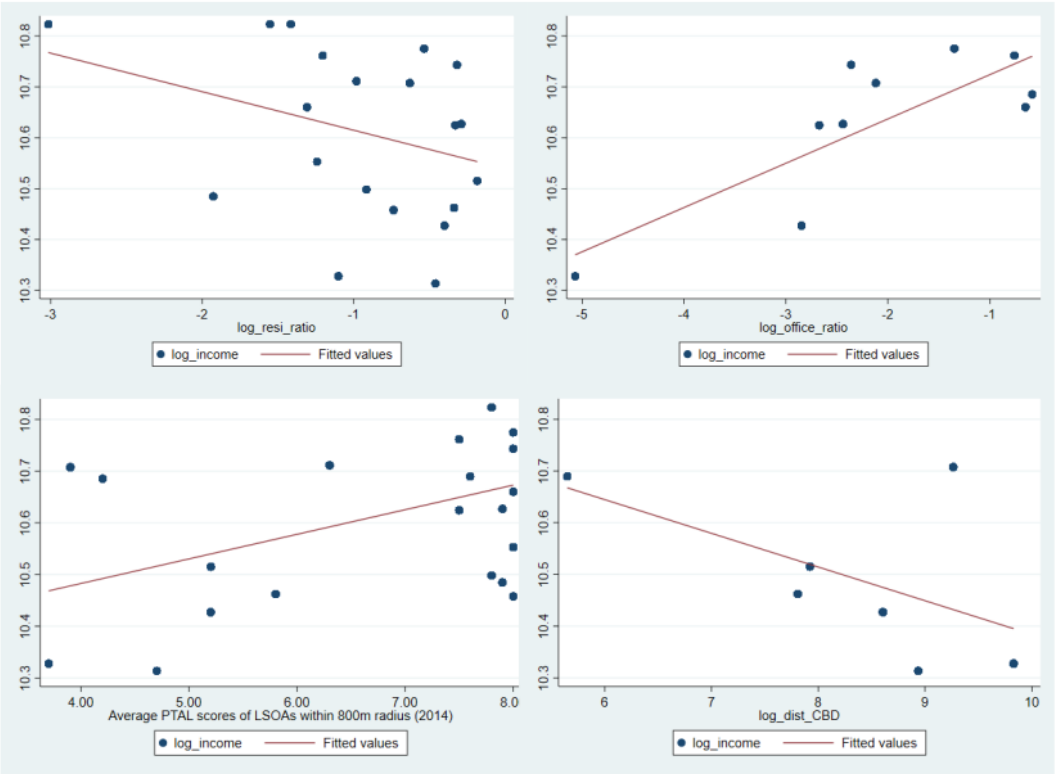

Fig 11, 12, 13 14 (clockwise) demonstrating the correlation between level of income in the catchment and residential ratio and office ratio, distance to CBD and PTAL score.

Fig 14 correlating income with distance to CBD is further proof that the Burgess (1925) model does not apply in the context of dataset. Whilst this model finds that low-income households live in the inner residential rungs of the city and higher income commuters live in the outer rungs, this study's findings suggest that the opposite is true. Furthermore, hypothesis 2B assumed a generalised capacity to work from home, and that all workers from residential areas necessarily travelled to the centre before lockdown, and would have ceased to do so during lockdown. In analysing the influence of income, this misconception must be acknowledged and accounted for. The hypothesis that high streets in outer London residential areas saw a revival assumes that the flow of travel from residential to the workplace was 1) taking place from the outside rings into the inner city, but also 2) was taking place at all. As established when critiquing the application of a

Burgess model to the London context, the city does not follow an urban form of such simplistic concentric zones, but rather overlapping land uses throughout (akin to the Hoyt (1939) model).

Regarding the second point, in 2010, Gort Scott Architects found that it was a misconception that a majority of workers travel into the city, as indeed half of Londoners do not leave their local area on a daily basis. Reuschke and Felstead (2020) found that lower income workers were most likely to continue commuting for work throughout the pandemic, so the half of Londoners found to be working from home by Gort Scott Architects (2010) are likely to be higher income workers. As the data skews towards high streets in wealthier neighbourhoods (see Limitations) and as household income is highly correlated with spatial variables, it is difficult to ascertain the influence of this variable in this study.

Hypothesis 1.D Lockdown has increased the influence of the residential density of the catchment on high street performance.

The residential density of the area within walking distance of the high street was also found to have a significant effect on footfall. For every percentage increase in persons per hectare within 800m of the high street, footfall reduced by 22.06%, meaning the higher the density, the lower the footfall. However, during lockdown, density had a negative effect on footfall of only 9.16%, representing a 13 percentage point increase compared to periods outside of lockdown. Therefore, Hypothesis 1.D is accepted as valid. Even though the sign of the coefficient did not change, this hypothesis relates to a change in the influence of the variable, which is the case here. Whilst the effect remains negative, this increase suggests a greater number of residents in the local community shopped on high streets within walking distance of their homes. Perhaps, the reason the coefficient remained negative is due to the increase in leisure time caused by working from home, giving time for Londoners to walk longer distances (beyond 800m) to reach retail locations that were best suited to their needs. Indeed, the study does not account for the possibility that the 800 meter catchment may have expanded during lockdown, due to consumer behaviour.

Changes on the high Street

Hypothesis 2.A Lockdown's changes to the daily routines of Londoners has increased the performance of high streets with a higher proportion of residential, and reduced the performance of high streets with a higher proportion of offices.

The factors that influenced footfall the most were variables related to the composition of the high street's land uses.

Throughout 2018-2021, retail to office and residential ratio was negatively correlated with footfall, which implies that a high composition of retail was not the main driver for visits to the high street. However, the relationship changed from a -61.9% effect to a positive 80.93% effect during lockdown. This proposes a counter-argument to some of the retail resilience literature, which largely suggests that retail is no longer the dominant land use anchoring footfall in high streets (HSTF, 2020; Wrigley and Lambiri, 2015b) and predicts a decline of retail as the dominant high street occupier (HSTF, 2020). Such literature finds that "multifunctional" (non-retail dominant) towns suffered lower drops in footfall than their counterparts (*ibid*). Multifunctionality in itself is not descriptive of the high street's resilience, however. The specific land uses which coexist on the high street remain important, and a healthy ratio of retail is necessary to keep high streets alive when all units are closed except for essential uses.

The supremacy of retail as the land use driving footfall is explained by the coefficients of the other variables representing high street composition. The effect of a 1% increase in office to address count ratio changed the impact on footfall from 31.4% outside of lockdown to -24.3 % during lockdown. This suggests that offices used to bring footfall to the high street, but in lockdown, they contributed to a reduction in footfall. This implies that workers visited the high street less during lockdown, so retail became the main purpose of visits, and the ratio of retail locations to other land uses became more explanatory of high street performance during this period.

The change in the role of offices as a driver of footfall can also be interpreted from the effect of the weekend dummy on footfall outside of, and during lockdown. Outside of lockdown, weekend footfall is -26.03% compared to weekdays. However, during lockdown, it is predicted to

be 13.25% higher on weekends during lockdown than weekends outside of lockdown. This mirrors the impact of the office to address ratio, since offices are most often visited on weekdays. Indeed, the interaction variable between office to address count ratio shows that the impact of office to residential ratio on weekends is generally -54.71% what it would be (264.21%) during the week.

This reflects findings by Deloitte (2021), which used geospatial simulation to model the behaviour of specific uses around high concentrations of offices (in this case, the Deloitte head office in the City of London).

> "At a time when the office has been closed, or open with skeleton staff, there has been little demand for sandwiches or smart shirts as the comparison between those who live, as opposed to work, in close proximity to the office indicates" (*ibid*, p.8).

This research found that the population living within 0.5km of the Deloitte office "is just 3.3% of the population that would normally work within the same catchment".

Conversely to the office ratio variable, a percentage change increase in residential to address count ratio on the high street grew significantly during lockdown. Outside of lockdown periods, a 1% increase in this variable caused a 61.2% decrease in footfall, whereas during lockdown it caused an 80.93% increase. This confirms the hypothesis that, due to limited mobility and local shopping habits, residents living on high streets were most likely to shop on their specific high street. The additional percentage of residents who were also shoppers may represent those who used to shop on high streets near their work.

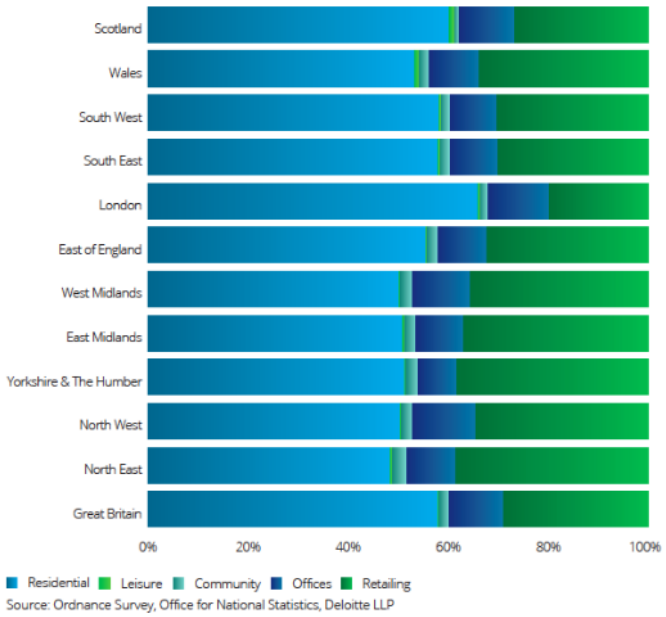

Fig 15. Bar graph of land use composition on high streets, per region of the UK

As seen in Fig. 15, London already contains a greater proportion of residential land uses on the high street than anywhere else in the UK at over 60%, and also the smallest proportion of retail at 20%, meaning that London high streets may be best equipped for lockdown resilience. However, as demonstrated by a study of the dataset, the statement carries variations, as residential ratio ranges from 4% to 83% for the selected high streets. Hypothesis 2.A is therefore accepted as true, according to the results of the regression, and within the limits of the dataset.

The supposed decreasing importance of retail on the high street has been contentious in the literature. This study controls for high street experience through two sets of variables: leisure and community land uses, and to some extent, the design of the space ie. its typomorphology.

Deloitte (2021, p.20) perceive a recovery for the high street that involves a smaller retail footprint as "surplus shops are demolished or repurposed to level up the balance between retail and other uses" that are desired by locals. But this study's findings show this change of use should not be geared towards office creation, since office visits are vulnerable to shocks (both to lockdown, and economic shocks which may lead to unemployment and hence a reduced number

of office workers). The office may become obsolete because of the success of working from home, the new patterns of convenience that have developed, and the high rents that corporations must continue to pay even as offices remain closed. If more offices are to be built on the high street, they must be adaptable such as in the form of internet cafes (Deloitte, 2021). These are some of the uses which are projected to replace retail.

Leisure uses are particularly thought to protect from the long-term crisis of online shopping by creating a high street experience that is unlike the online realm. Secondary centres in particular "have experienced a 'shift' towards increased leisure and service provision" (Findlay and Sparks 2014, p.18). A 1% increase in leisure to address ratio on the high street increased footfall by 5.73% overall, and by 10.81% during lockdown. Although retail uses were limited to essential shopping, Londoners could exercise outside for 1 hour a day during lockdown, thereby allowing the use of the following leisure land uses: outdoor amenity and open space and allotments and city farms (MHCLG, 2006, see table 3).

For every 1% increase in community space to address ratio on the high street, there was 3.30% increase in footfall overall, but only a .79% increase during lockdown. This is logical as most community centres were closed during lockdown, although a few did provide food aid during the pandemic. Hypothesis 2.B is therefore rejected in the case of leisure ratio's impact on footfall, which did increase instead of experiencing the expected decrease. However, in the case of community space, the hypothesis is substantiated.

Typo-morpohology of the high street

The dataset is highly skewed towards the main street typo-morphology, with 33 out of 36 high streets fitting into this category. Perhaps, there is a correlation between the locations of footfall sensors and streets that are accessible for vehicles, due to sensor maintenance requirements. It would be interesting to locate sensors on a wider variety of high street types in order to better understand the effects of design on high street performance and perceive significant results, which this study cannot claim to have due to the limited nature of the dataset on this matter. The results do however suggest that the plaza typo-morphology had a -72.49% effect outside of

lockdown, but a positive 99.21% effect during Lockdown. Indeed, this may be an interesting hypothesis to investigate since the plaza typology allows for the social distancing of a greater number of people than the street typology, and particularly the main street, where pedestrian access is narrow. Plaza typo-morphologies are also optimal for outdoor markets, which were allowed for parts of lockdown.

In 'Towards a fine city for people' (2004) Jan Gehl studies the design of the pedestrian environment and classifies walking into three categories: 1) necessary: for shopping and commuting, 2) optional: recreational or for sightseeing, and 3) social: sitting, reading, talking. The design of London's streets, he suggests, does not promote activities 2 and 3, as seen by footfall which is relatively constant from day to day, showing a lack of "promenading on good days." Providing lively open spaces such as plazas leads people to partake in activities 2 and 3, thereby increasing footfall beyond necessary walking. Open spaces also promote accessibility for those with mobility impairments, as they face less obstacles. Area-wide issues of streets include pavements that cannot adequately accommodate the volume of users and this issue is only heightened in the context of social distancing. Indeed, plazas allow the 'comfortable carrying capacity' limit of 13 people per minute (Gehl 2004, p.82) (see photograph 1). Furthermore, Gehl links active streets to high street revitalisation through the implication that if people are likely to linger, they may be more likely to shop. Finally, making streets more accessible to the mobility impaired also widens the potential customer base for retail units.

As seen in Photograph 2, the Market Place in Romford (the case of a plaza typo-morphology in this study) provides benches allowing for people to linger, thereby improving the shopping experience: a feature that has been noted as increasingly important for high street resilience (Coca-Stefaniak and Carroll, 2014).

Photograph 1. Photo showing the Market Place, Romford (plaza typo-morphology) (Author's own)

It must again be noted that, as this typo-morphology only concerns the Market Place in Romford, other variables may have contributed to high footfall on this site, leading this typo-morphology to perform well. For this reason, it is crucial to place more sensors on high streets matching a diversity of typo-morphologies in order to produce conclusive findings.

Photograph 2. Photo showing the Market Place, Romford (Plaza typo-morphology) (Author's own)

V. Conclusion

Summary of Findings

The structural shift in working and shopping patterns that has emerged due to lockdown has placed high streets in an ideal position to reinvent themselves (Deloitte, 2021). In the past, the high street has continuously demonstrated its capacity to adapt despite constant changes to the economy and lifestyles (Ruiz-Apilanez et al., 2015). However, such generalised statements overlook the differential resilience of high streets, which, as demonstrated previously, has been highly dependent on their relative location and compositional and spatial attribute of the street. This research highlights that the future of the high street is turning away from offices and towards retail and residential uses. Indeed, Deloitte (2021, p.16) predicts that services that typically surround office workers in city centres will 'follow the money' and be replaced by grab and go food outlets, stationers, printing services, and local IT support services. There may be a widening geographical distribution of workspaces, as centralised offices become redundant, potentially taking the form of internet cafés ie. spaces for workers who wish to avoid commuting but also wish to work outside of their homes occasionally (*ibid*). According to Deloitte (2021), the Local Data Company (2021) counted 1,961 internet café openings between 2016-2021. Since the attraction power of these spaces is linked to their proximity to residential uses and not to any specific skillsets of workers (as with regular offices), they can be expected to locate near residential areas and areas with low rents, (since workers are paying to use these spaces).

In rejecting Hypothesis 2.B, the results suggested that the experience of the high street has remained an important factor of performance throughout lockdown, though the presence of leisure spaces. Indeed, the literature had already indicated that is not the retail offering but rather "the type and quality of the overall town centre experience that is becoming key to visitor engagement, satisfaction and local resident loyalty" (Coca-Stefaniak and Carroll, 2014, p.2). Furthermore, no conclusive findings could be asserted regarding typo-morphology, leading the hypothesis to be neither rejected nor accepted. However, suggestions were made for potential future study of typo-morphology, focusing on the interesting case of the plaza during lockdown.

Projected impacts of (and on) Permitted Development and Change of Use

Due to decreasing demand for office space in Central London from the effects of the pandemic, developers may drive a trend towards the conversion of office to residential near the CBD: a process which has been allowed without planning permission since the changes to Use Classes in September 2019. These changes to the classification scheme may therefore be beneficial as they allow high streets to adapt to demand and remain flexible (Deloitte, 2021), in a context where underused space above the ground floor of, and around high streets, creates a need for quick adjustments to redundant space (Findlay and Sparks, 2014). However, particularly in the case of office to residential conversions, Clifford et al. (2018) warn against permitted change of us, as it creates inadequate interior and amenity space, and inhibits the ability to strategically plan for, and fund, the services required to accommodate additional residents. The deregulation of conversions may therefore have positive impacts on footfall but negative impacts on quality of life for high street residents.

In this context, the public sector may wish to ensure high street vitality and resilience as well as quality of life through the creation of codes for housing above the high street. If conversions are to be allowed without planning intervention, they should meet particular criteria such as space standards and EPC ratings. The GLA (2019) also highlights that a main barrier to having residential uses near and on the high street is noise pollution. If noise complaints will lead to reduced opening hours for retail, and particularly restaurants and pubs, then additional residential units on the high street may defeat their purpose of creating additional footfall. Acoustics codes should therefore be created for above-shop residential units, or new strategies should be thought of to mitigate this problem.

Additionally, since the 26th of September 2020, the High Streets Fund has been endowed with £830M to deliver a strategic vision on the high street through the purchase of key sites. Public investment has already taken place on sites such as The Galleries in Wigan, Greater Manchester. When this site was facing high vacancy rates under private ownership, it was bought by the local authority and was revitalised through public investment. Whilst this story was a success, planners should be wary of the contradiction between this push for public sector involvement in land use

designation on high streets and the deregulation of change of uses, which transfers this power to developers. The tensions between these approaches to town centre and high street revitalisations are worth considering and investigating.

Implications for urban design and policy-making

One of the primary tensions in controlling development on high streets is the restrictions on new locations for retail development, which creates a lock-in of the urban retail hierarchy and preserves inefficiencies in retailing (Findlay and Sparks, 2014). Shocks to the urban system lead to changes in behaviour, and in the case of COVID-19, changes in travel and work behaviours require a change in the locations of investment for retail: closer to residential locations, further from offices and the Central Business District, in areas with lower city-wide accessibility, and potentially towards plaza morphologies that allow more flexibility, accessibility and higher quality urban realm. Additionally, typomorphologies of high streets can be expected to retain their form for decades or centuries, so undesirable patterns will create negative path dependency (Sharifi, 2019a). Therefore, resilience thinking must be integrated into urban form at the earliest possible stage of policy-making in order to avoid undesirable trajectories (Feliciotti et al. 2017).

Overall, this study finds that land uses should be diversified and dispersed, but this dispersion should take the form of multiple neighbourhood centres, where residential uses can be located within walking distance of high streets. The shift away from offices and towards retail and residential has implications on urban form, due to the high concentrations of land uses in London, particularly in relation to the CBD. As offices located in the centre become lesser drivers of footfall, high streets on the peripheries benefit, leading us to ask: ‘Are city centre residents adequately provided for?’. The pandemic has exacerbated the importance for all to live within walking distance of food retail, green space, healthcare services, schools and childcare (HSTF, 2020).

As was once the case for the 2008 economic downturn, crises can be an opportunity to reflect on the importance of high streets in London within the larger national policy emphasis on Localism (Localism Act, 2011). Indeed, Deloitte (2021) foresee the effects of lockdown as

consolidating localism, which has already been a buzzword for a decade prior to the pandemic, by seeking to relocalise planning practice to the local scale. In this vein, the emerging trend of 15-minute cities is spreading quickly and globally, and is actively promoted by C40 cities (2020) as a framework for urban recovery from lockdown. This study's findings are aligned with 15-minute city principles, described in the literature review, since resilient high streets during lockdown have been focused on their local catchment and connectivity at the local level instead of the city-wide scale.

In London, as in most cities whose streets were formed before the rise of the automobile, a 15-minute radius of active travel from the home is a realistic achievement to strive for (O'Sullivan and Bliss, 2020). However, in the American or Australian context for instance, the catchment radius of retail accessibility is much wider, leading to 20 or 25-minute city strategies, such as in Melbourne. Issues of residential proximity are therefore highly dependent on the national infrastructure context. However, planners must consider that strategies seeking to increase proximity of housing and work may be classist. As stated in the analysis of Hypothesis 1.C income, qualification level and skill-level greatly influence who is able to work from home (Reuschke and Feldstead, 2020) and furthermore, many neighbourhoods rely on low-income workers who make long commutes from elsewhere in the city, or even beyond. Such strategies may therefore benefit wealthier neighbourhoods of the city, where workers can choose to work from home, but disregard lower income neighbourhoods where workers, who are often essential workers, must continue to carry out in person work in other areas.

The extent of the application of findings in other contexts

As noted by Sharifi (2019b), it is not possible to recommend optimal combinations of resilience factors that are generally applicable in different contexts. She claims that "more context-sensitive research is needed to explore how the interplay between different urban form elements and their combined effects impact urban resilience" (p,12), a goal that I have sought to achieve in this study. I have sought to understand how the changes in behaviour, led by the conditions of lockdown, have changed the demand for high street forms, compositions and locations. It must be acknowledged that spatial, geographical, or compositional factors are not the only variables

influencing high street user behaviours, both outside of and during lockdown, as seen by the explanatory factor of 66.44% of the regression model. Whilst this is a relatively high R Squared, it implies that many other factors are still to be considered, such as many of the KPIs in Table 2 of the literature review, which were considered outside of the scope of this study. Furthermore, outcomes from this research cannot be assumed to apply in all cities in the UK, nor even in all large metropolises throughout the world.

There are long term threats to our cities that require local retail to be resilient and accessible. For instance, findings from this research may apply to shocks that are not directly related to pandemics, but that indirectly impact the ability to travel. Indeed, a lockdown situation is not unlikely nor unique to epidemics, as it can be caused by terrorist threats or other national security threats. And above all, climate change will certainly increase the occurrence of disasters, but it will also cause intangible, cumulative and long-term threats to cities, forcing humans to stay inside. For instance, this could take the form of low air quality and visibility (the latter of which would make vehicles unsafe modes of transportation) or increased sun damage from holes in the ozone layer. During the great fog in London, the city was at a standstill due to lack of transportation options, for instance. For this reason, the results of this study should not be taken to be purely reflective of a one off event, but may be considered informative for many other forms of shocks that may befall cities. For these reasons, it is important that planners and policy-makers understand where high streets should be located for optimal resilience and accessibility, which in turn allows for a greater societal resilience to threats.

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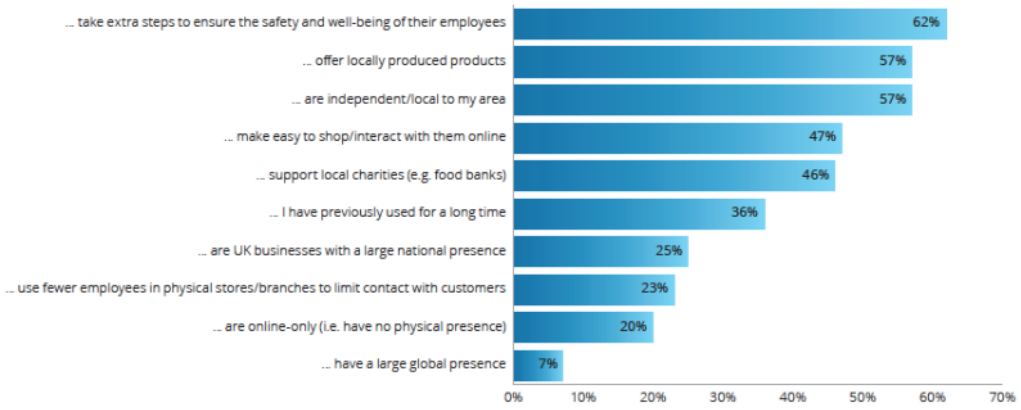
Appendices

Appendix 1. Graph showing shoppers' concerns when choosing businesses to shop at during the pandemic (Deloitte, 2021).

Figure 3. Following the original lockdown, respondents have been more likely to spend money at businesses that ...



Appendix 2. Beginning on the next page is the user agreement signed by the author and the CDRC, demonstrating all ethical considerations and limitations to the analysis of the data required by the CDRC.

CONSUMER DATA RESEARCH CENTRE

USERS AGREEMENT

THIS AGREEMENT IS MADE BETWEEN

LILI PANDOLFI whose address is Flat 8 Electric Lofts, 9-11 London Lane, London, UK E83PR, a registered Student in the Bartlett School of Planning at University College London ("Student");

UNIVERSITY COLLEGE LONDON, Gower Street, London, WC1E 6BT ("Institution"); and

UNIVERSITY OF LEEDS, represented by the Consumer Data Research Centre of Leeds, LS2 9JT ("CDRC").

INTRODUCTION

The Consumer Data Research Centre is an ESRC Big Data initiative, bringing together world-class researchers at University College London, and the Universities of Leeds, Liverpool and Oxford to harness the potential of consumer-related data to benefit social science researchers, businesses, government and society at large.

The CDRC requires potential users wishing to access safeguarded and controlled data services for research purposes to submit project proposals for approval by the Research Approvals Group (as defined below).

Once a Student is notified that their Project has been approved by receiving an Approved Project Notification, prior to being issued download instructions and password or site specific instructions for the assigned Secure Lab, the Student and their Institution must sign this CDRC User Agreement, including all Schedules hereto (the "Agreement"). The Agreement demonstrates that the Student and their Institution understand the seriousness of the undertaking, and that the Student and Institution understand the penalties that may be imposed for breaches of security or confidentiality, or any other breach of this Agreement.

DEFINITIONS

"Academic Supervisor" means the academic supervisor named in the Project application.

"Approved Project Notification" means the notification from the CDRC to the Student that their application to CDRC to carry out the Project has been approved, and shall set out any additional Stipulations that CDRC and/or a Data Partner may require the Student and their Institution to comply with under this Agreement, and which is annexed to this Agreement at Schedule 2, and may be updated from time to time by written notice from CDRC to the Student.

"Confidential Information" means information belonging to a Data Partner that is identified by the Data Partner as confidential in the Approved Project Notification and may include CDRC Data or Controlled Data.

"**CDRC Data**" means any combination of data which may be either Controlled or Safeguarded Data, and which may be subject to Stipulations.

"Controlled Data" means data which must be held under the most secure conditions with stringent access restrictions, including data which is Personal Information, and/or data that is considered commercially sensitive, and may also be subject to Stipulations.

"Data Partner" the organisation with whom the CDRC has entered into an agreement to provide Safeguarded and/or Controlled Data to the CDRC.

"**DPA**" means the Data Protection Act 1998 and any subsequent legislation or regulations.

"**End Date**" means the end date of the Project as set out in the Approved Project Notification.

"Institutional Signatory" means a signatory who is validly authorised to enter into contracts on behalf of the Institution.

"**Output"** means a pre-approved Project output as described in the Project.

"**Output Request and Release Process**" means the multi-stage Output approval whereby CDRC data scientists may check that Outputs to be released from the Secure Lab are compliant with the Approved Project Notification and are adequately non-disclosive.

"Personal Information" means personal information as defined by the DPA.

"Project" The particular research project proposal approved by the CDRC Research Approvals Group and approved in the Approved Project Notification, and which is annexed to this Agreement as Schedule 1.

"Research Approvals Group (RAG)" means the independent research approvals group whose role is to approve proposed project applications to use CDRC Data.

"Safeguarded Data" means data to which access is restricted due to licence conditions, but where data are not considered "personally-identifiable" or otherwise sensitive.

"Secure Lab" means the secure laboratory facilities within the CDRC, which comprises three secure laboratory facilities at UCL, the University of Leeds and the University of Liverpool. Each lab has its own site specific terms and conditions which Students and their Institutions may also be required to sign in order to obtain access to CDRC Data through each respective Secure Lab location.

"**Start Date**" means the start date of the Project as set out in the Approved Project Notification.

"**Stipulations**" means Project specific terms placed by CDRC and/or a Data Partner, as notified to the Student and their Institution under the Approved Project Notification with which the Student and Institution must comply in their use of the CDRC Data under this Agreement.

IT IS HEREBY AGREED:

1. Use of Data

A. If required within the Approved Project Notification, the Student must, and their Institutions must procure that the Student has satisfactorily completed a CDRC approved accredited safe researcher training course within the specified time period.

B. The Student shall be responsible for processing all CDRC Data in accordance with all applicable laws and all regulatory standards applicable to such CDRC Data.

C. The Student will ensure that any Stipulations as specified in the Approved Project Notification are adhered to.

D. Access to the CDRC Data is being provided for the statistical analysis and research as detailed in the Project and as further outlined in the Approved Project Notification. The

CDRC Data shall not be used or processed for any other purpose without the prior written consent of the CDRC and the Data Partner(s).

E. The Student shall not disclose nor compromise any of the CDRC Data from the individual records obtained or produced from the CDRC Data to anyone other than (i) those approved for the same Project and (ii) CDRC staff involved in the review of the Outputs.

F. The Student shall ensure that no attempts are made to link the CDRC Data to any other files in order to relate the particulars to any identifiable individual person, business or organisation unless such data linkage exercise has been explicitly approved by the CDRC as part of the Project.

G. On termination of the Agreement for whatever reason, all access to the CDRC Data related to the Project shall cease forthwith, and electronic access be denied. The Student must permanently destroy/delete or erase the Safeguarded Data that is in their possession within seven (7) days of the end of this Agreement, together with all hard or soft copies of the same and certify such destruction in writing (which may include email) to the CDRC.

H. The CDRC reserves the right to monitor, record, and audit, or to request a written report from the Student regarding, the use and activities relating to the use, of the CDRC Data by the Student during the lifetime of this Agreement.

I. During the lifetime of this Agreement and six months thereafter, the Student agrees that, and the Institution shall procure that, the CDRC will have right of entry to any premises where the CDRC Data is accessed in order to monitor, record or audit the use and activities relating to the use of the CDRC Data, upon the provision of reasonable notice to the Student.

J. Any incidents of unauthorised access to, processing of, or disclosing of, the CDRC Data must be reported immediately to the CDRC.

K. The Agreement is subject to review and without limitation whenever a change in the law, contracts for services with third parties, other procedures or other relevant circumstances takes place.

2. Output Release for CDRC Data

A. The Student must not reproduce, to any extent whatsoever, any CDRC Data, original datasets or copies or subsets of any CDRC Data.

B. Students are responsible for, and their Institution must procure that the Student ensures that rules and regulations for disclosure risk analysis as specified by statistical disclosure guidelines (explained during accredited safe researcher training) are applied prior to submission of analytical outputs for clearance and release.

C. No Outputs may be removed from the CDRC Secure Lab by the Student or before the Student satisfactorily completes the follow the Output Request and Release process.

D. The CDRC reserves the right to release in whole or in part, an amended version or not to release at all, as the CDRC deems appropriate, the proposed Output produced by the Student pursuant to this Agreement.

E. The Student, and the Institution agrees to work with the CDRC to meet the requirements of the Output Request and Release process. In the event that the CDRC decides not to release the proposed Output, if feasible the Student may, at CDRC's sole discretion, be allowed to revisit the Secure Lab to rectify the problem. The final decision to release an Output rests with the CDRC.

F. No CDRC Data shall be used for any commercial purpose whatsoever.

3. CDRC Data, Copyright and Publication Protocol

A. The CDRC Data and related documentation shall at all times be and remain the sole and exclusive property of the CDRC and/or the Data Partner, as the case may be. This Agreement pertains to the use of the CDRC Data and related documentation to produce a pre-approved Output for research purposes and nothing contained herein shall be deemed to convey any title or ownership interest in the CDRC Data or the related documentation to the Student.

B. Copyright in Outputs may be held singly or jointly by the Student(s) that created them, their Institution(s) or their funder(s) according to the Student's funding and Institution's agreements.

C. Any publications in connection with this Project (including but not limited to draft versions, final versions, abstracts, presentations, meetings or seminars) may only be published upon receiving written approval from CDRC. The procedure to obtain approval from CDRC shall be that the Student shall submit any proposed publication to CDRC via publications@cdrc.ac.uk strictly in accordance with the timescales specified in the Approved Project Notification. If CDRC and/or the Data Partner, at their sole discretion, determine that the proposed publication contains any Confidential Information, it shall notify the Student to ensure that such Confidential Information is deleted. Following any such deletion, CDRC shall notify the Student in writing that they may proceed with the proposed publication. CDRC and/or the Data Partner may also request that the Student delay the publication if the CDRC and/or Data Partner reasonably believes that the CDRC Data has been used outside the scope of the Project or the Approved Project Notification and the Student will make reasonable attempts to amend the publication to the satisfaction of the CDRC and/or Data Provider.

D. The Student shall comply with any further Stipulations in connection with publications as may be specified in the Approved Project Notification.

4. General

A. This Agreement shall commence on the Start Date and shall end on the End Date, subject to any earlier termination in accordance with clause 4.B or clause 4.C. Where the Agreement is due to terminate under this clause 4.A and provided the CDRC is free and able to do so, the parties may agree in writing for the continuing use of the CDRC Data in relation to the Project for a specific agreed additional period of time. The terms of this Agreement shall continue to apply to any such continuing use.

B. Without prejudice to any other right or remedy, if the Student and/or the Institution shall commit any breach of, or fail to comply with, any of their obligations under this Agreement, become bankrupt or any judgment is made against either the Student or the Institution and remains unsatisfied for seven (7) days, CDRC shall be entitled to terminate this Agreement forthwith on written notice.

C. The CDRC reserves the right to terminate this Agreement with immediate effect on written notice in the event that the Data Partner terminates the agreement to provide CDRC Data to the CDRC.

D. The Student and Institution acknowledge that any disclosure of CRDC Data other than in accordance with this Agreement may cause irreparable harm to the CDRC and/or a Data Partner. The Student, and Institution hereby agree that CDRC shall, in accordance to any

other rights or remedies to which it may be entitled, have the right to seek and obtain equitable and or injunctive relief.

E. CDRC does not warrant the accuracy or completeness of the CDRC Data, nor its fitness for any particular purpose. The CDRC Data is provided to Student "as is" and CDRC does not warrant that the CDRC Data will enable the Student to achieve the objectives of the Project, or that the CDRC Data is suitable for use in any report or for academic or research purposes.

F. The Student and/or Institution as the case may be are required to bring directly to the attention of CDRC any matters or events that may affect any of the obligations under this Agreement immediately as awareness of the matters or events may arise.

G. No failure or delay on the part of CDRC to exercise any right or remedy under this Agreement shall be construed or operate as a waiver thereof, nor shall any single or partial exercise of any right or remedy preclude the further exercise of such right or remedy.

H. The Student, and the Institution acknowledge that the CDRC may hold and process information submitted in the Project for validation and statistical purposes, and for the purposes of the management of the service and may also pass such information to other parties such as Data Partners.

I This Agreement is made under English law and the parties submit to the exclusive jurisdiction of the English courts. Notwithstanding the preceding sentence, CDRC may at any time bring proceedings for an injunction in any court of competent jurisdiction.

J. By signing this Agreement, the Student and Institution represent and undertake that: the information supplied in the Project and any supporting documentation is accurate to the best of their knowledge, and that they have read and understand and shall obey the conditions specified in this Agreement.

[SIGNATURES ON FOLLOWING PAGE]

Signed by:

STUDENT

Signature Lili Pandolfi

Name (PRINT): LILI PANDOLFI

Date: 09/11/2020

INSTITUTION: University College London

Signature: DocuSigned by: David McCarthy FB388554F66245F...

Name (print): David McCarthy

University College London

Date: 19 November 2020

UNIVERSITY OF LEEDS

Signature: DocuSigned by: Oliver Mansell 3EAE55EBFBE54A1...

Name (print):

[Institution Name]

Date:

READ AND ACKNOWLEDGED BY THE ACADEMIC SUPERVISOR:

Signature: Jung Won Sonn

Name (print): Jung Won Sonn

[Institution Name] University College London

Date: 12 November, 2020

Consumer Data Research Centre

An ESRC Data Investment

Schedule 1: Approved Project Proposal

CONSUMER DATA RESEARCH CENTRE

Safeguarded Data
Project Proposal Form

For office use: Ref 589-01

Consumer Data Research Centre

An ESRC Data Investment

INTRODUCTION

This form should be completed by those wishing to access the Consumer Data Research Centre's (CDRC) safeguarded data collections. You should consult the ***CDRC Data Service User Guide*** before completing the form. A CDRC data scientist will be assigned to you who can provide support in the application process.
Once submitted your proposal will be forwarded to the CDRC Research Approvals Group (RAG) for independent assessment. Projects will be assessed based on the criteria listed in Appendix 1.
Approval to access data will not be granted without evidence that the applicant has acquired ethical approval for the research through their institution, or supplied evidence that this is not applicable. For non-academic projects, where there is no approval process in place, the CDRC will assist the applicant in acquiring this.

PART A. PROJECT DETAILS

1. Contact Details

1.1. **Lead applicant:** Lili Pandolfi
Department and Institution: Bartlett School of Planning, UCL
Address:
Email:
Telephone:

1.2. **Initial Proposal Form Reference:** 589

1.3. **Title of Project**

Spatial factors associated with varying post lockdown recovery rates of high streets in Greater London

1.4. **Access Details**
Access requested from[1]: 20/10/2020
Access requested to (Date): 20/07/2021

2. Project Proposal Details

2.1. **Abstract**. Appropriate for a general audience. This may be used by the CDRC for reporting and publicity purposes.

On the national level, Centre for Cities' (2020) research on 62 cities in the UK has shown that average footfall on high streets has fallen to 22% of pre-lockdown levels on average. But there are significant variations hidden behind that average; high streets in small towns (Blackpool, Aldershot, Basildon) have recovered up to 57% of their footfall whilst larger cities (London, Manchester, Bristol) have only recovered 11-16%. This is likely to be

[1] Please note the RAG review process takes approximately 4-5 weeks.

correlated with a reduction in the share of people coming from outside the city. "Those places best able to pull people in from beyond their city boundaries are the ones that are also furthest away from a full recovery."

Out of town customers can refer to either commuters from nearby towns or tourists. Whilst I expect that tourism will somewhat return to normal once travel restrictions are lifted, particularly in cities like London and Cambridge, lockdown's effect on commuting patterns may be longlasting. As workers continue to work from home, high streets located near workplaces but not near residential areas will struggle to recover. I have selected London in particular because house prices are so high in the CBD that there are stark spatial variations between where people can afford to live and where their offices are located.

In light of this, I want to investigate what factors have made certain high streets recover more quickly than others from closures during the pandemic. More specifically, I want to study the relationship between the proximity of residential areas vs. offices in the recovery rate or high streets.

2.2. Project description. A detailed description of the project, documenting the motivation, scope and aims of the intended research as well as the methods you will use in the proposed research.

This research will analyse the recovery rates of high streets according to their location in inner vs. outer London boroughs and their proximity to areas with high or low residential density. It will discern what lessons can be learned about the resilience of the high street, and how these can be applied to the planning system. The data from SmartStreetSensors will be analysed visually through ArcGIS and then statistically through Strata or SPSS.

2.3. Research Category:

2.3.1. Is this request for an Undergraduate, Masters project? U'grad ☐ Masters ☒

2.3.2. Is this request for a PhD project? PhD ☐

2.3.3. Is your project funded, commissioned or sponsored by a funding body or any other organisation? Yes ☐ No ☒ Funding application in progress ☐

Please include the name, postal and web address of your current or prospective funder, and your grant/project reference number (if applicable).
N/A

2.4. Project Impact. Please describe the anticipated scientific and societal benefits of the project and the ways in which you intend to maximise those benefits.

My hope is that this research will help planning academia and planning practice to understand how we can best plan our cities for resilience to shocks. For instance, if my research finds a correlation between a high ratio of residences on the high street and its footfall during lockdown, then high streets should be located as close to possible to residential hubs in London.

This would reinforce the case for mixed use planning, and particularly vouch for polycentric planning (when cities are planned to have multiple centres instead of a single one).

2.5. End Users. Who are the main end users of this research (academic research, central government, consultancy, industry, local government, NHS, public sector, third sector? List all that are applicable.)

This project falls under academic research and its end users are therefore my dissertation advisors and members of the academic community at the Barltett. Please see below the information provided by UCL regarding the potential publication of the dissertation:

'It is standard practice that all dissertations achieving a grade of distinction (70% or above) are submitted to the UCL Library. We now have the opportunity to also submit this work to UCL's open educational repository, OpenEd@UCL. This will make your dissertation available to be viewed online, providing a much wider platform for you to share your research and acting as a great educational resource for future students.

In order for us to share your dissertation via the open repository, we must have your consent, which is given by completing the questionnaire below. ***You are not obliged to give you consent!*** *We will not submit any work for publication without the express permission of the student via the questionnaire below. We would, however, encourage you to share your dissertation in this way. Research relies on an open exchange of information and ideas, and you have doubtless benefited from other people sharing their research when undertaking your own research. Sharing data helps advance knowledge and in some cases can prevent repeated requests to organisations for the same information.* ***Important:*** *one of the questions in this consent form relates to the copyright of third party content in your work.'*

2.6. Outputs and Publications. What are the intended outputs or publications arising from the use of these data? (For example, journal articles, PhD thesis, report for government department, policy documents for a local authority, White Papers, new software or other tools, etc.)

This research will not be shared in any publications. As mentioned above, however, it may be published and added to the UCL Bartlett Library if deemed of an exemplary standard. I do not expect it would be read by policymakers or be used for policymaking purposes.

2.7. Research Team

Please list the names, affiliation and email addresses of all known members of your research team who are requesting access to the CDRC safeguarded data. If you are a student please include your academic supervisor.

Consumer Data Research Centre

An ESRC Data Investment

To access some of the CDRC safeguarded data products it is necessary for users to have successfully completed a safe researcher training course. Please see the terms of use information for the particular dataset.

For office use: Ref 589-01

Consumer Data Research Centre

An ESRC Data Investment

Research Team *(including lead applicant, add more rows if required)*

Title, Name	**Department/ Institution**	**Institutional email address**	**Completed a safe researcher training course. If yes, please specify course and date of completion.**
Ms. Lili Pandolfi	Bartlett School of Planning, University College London	lili.pandolfi.19@ucl.ac.uk	No
Dr. Jung Won Sonn	Bartlett School of Planning, University College London	j.son@ucl.ac.uk	No

For office use: Ref 589-01

Consumer Data Research Centre

An ESRC Data Investment

2.8. Ethical Approval

2.8.1. Have you sought or are you seeking **ethical approval from an institutional ethical approvals panel** or any other appropriate body?

Yes ☐ No ☒

2.8.2. If *Yes*, please provide **evidence** of the status of the application or the outcome of the ruling issued. Please list what evidence you are enclosing below and return it as a separate attachment in PDF format when you return this application form. Feel free to add any comments below.

Click here to enter text.

2.8.3. If *No*, please bring this to the attention of the CDRC as soon as possible so that routes for ethical approval may be discussed.

At the BSP, the dissertation supervisor usually checks if further approval is necessary due to ethical problems. I will discuss the routes necessary for ethical approval if it is deemed necessary by the CDRC team.

2.8.4. If you believe that ethical approval is not required for your research, please provide justification for this below.

I am uncertain, and would value your opinion on this matter.

Consumer Data Research Centre

An ESRC Data Investment

PART B. DATA REQUEST

3.1. Data Required. Please provide the following information for each dataset requested. Please add more lines if required.

Data Partner	Data Set	Access to Full Data Set requested or specific variables (list)	Geographic Extent	Temporal Extent
e.g. SmartStreetSensor	*Research Aggregated data*	*Five minute counts, operation dates*	*London*	*2015-present*
Local data company - SmartStreetSensor Footfall Data	Aggregated Data And Research Aggregated Data	All available variables	Greater London	First recorded date - present

For office use: Ref 589-01

4. Data Linkage

4.1. Data Linkage. If your project will be linking more than one data source, describe which data sources will be linked and how the linkage will be done, including any specific variables that need to be linked (if known). If any of the data to be linked has identifying information as defined in the Data Protection Act 1998 or General Data Protection Regulations please provide details. Please note that no project that has the potential to re-identify individuals through data linkage will be approved.

Click here to enter text.

PART C: DECLARATION

By completing this declaration I hereby declare that the information included in this application form is true and correct to the best of my knowledge. I understand that any false or misleading information given by me in connection with my application may result in termination of the application process and/or other sanctions.

I also agree that I will be the single point of contact for progress updates and communication regarding the progress of the application.

I agree for my personal information to be used for the purposes of processing this application in accordance with the relevant data laws of the UK.

☒ I consent to my contact details being added to the CDRC contacts database so that the CDRC can send me notifications of CDRC related activities.

☒ I understand that forwarding this form by email constitutes an electronic signature.

☒ I understand that final approval for this project may require the additional submission of project approval forms.

Name: Lili Pandolfi

Date: 19/10/2020

APPENDIX 1: RAG CRITERIA FOR ASSESSMENT

The role of the RAG is to provide independent and transparent assessments of applications by researchers for access to data through both the CDRC Safeguarded and CDRC Secure services based on a set of standard evaluation criteria. RAG is independent to the CDRC and will include representation from the academic, big data, industrial sectors as well as the data partners concerned. For full Terms of Reference and membership see https://www.cdrc.ac.uk/data-services/using-our-data/

Criteria for Approval

- **Scientific advancement –** how the project has the potential to advance scientific knowledge, understanding and/or methods using consumer data;
- **Public good** – how the project has the potential to provide insight and/or solutions that could benefit society;
- **Privacy and ethics –** the potential privacy impacts or risks, and wider ethical considerations relating to the project
- **Project Design and Methods –** how the project will be conducted and who will be involved with a focus on demonstrating project feasibility.
- **Cost and resources issues –** what impact the project is likely to have on CDRC resources**,** including CDRC staff time and use of infrastructure, as well as any data acquisition costs. Resource requirements should be justified.

Schedule 2: Approved Project Notification

Approved Project Notification

Project Reference Number: 589-01
Project Title: Spatial factors associated with varying post lockdown recovery rates of high streets in Greater London
CDRC User(s): Lili Pandolfi
Institution: UCL
Proposal Accepted: 02/11/2020

Stipulations imposed by CDRC, including those from RAG members and Data Partner(s)

1. CDRC

1.1. The CDRC User(s) must only use the data for the purpose of research as described in the approved Project Proposal 589-01.
1.2. Approval for use of the data for this purpose is from the Start Date 02/11/2020 until the End Date 20/07/2021. If the CDRC User(s) requires access to this data beyond the End Date a request for an extension may be submitted to the CDRC with an explanation on why this is required.
1.3. By the end date the data and all copies of the data must be deleted. Notification must be sent to the CDRC by email to info@cdrc.ac.uk within 7 days of this date to confirm that the deletion has been completed.
1.4. There is no requirement to complete safe researcher training to access safeguarded SmartStreetSensor footfall data.
1.5. The academic supervisors of student CDRC Users are required to ensure that their students adhere to all the stated stipulations.
1.6. The project must have received appropriate ethical approval prior to commencing and evidence of approval provided to the CDRC.
1.7. There is no requirement when accessing this dataset to submit for review a copy of any proposed publication (including reports, abstracts, or presentation to a journal, editor, meeting, seminar or other third party) to the CDRC prior to submission for publication or presentation.
1.8. Users are required to deposit copies of working papers, peer-reviewed journal articles, logs of impact and other publications for access with the CDRC site wherever copyright permits. Where a proposed publication has been produced using more than one dataset, the User should adhere to the partner stipulation which has the longest review period. Where this is not possible, full references to research outputs are required for CDRC audit purposes. Please email publications@cdrc.ac.uk when publications are ready for deposit or logging.
1.9. Published outputs must include an acknowledgement stating "The data for this research have been provided by the Consumer Data Research Centre, an ESRC Data Investment, under project ID CDRC 589-01, ES/L011840/1; ES/L011891/1".
1.10. Users are requested to provide a brief case study of the supported work to be included in the Research Outputs section of the CDRC website https://www.cdrc.ac.uk/research/

On behalf of CDRC: Nick Bearman 

Date: 02/11/2020

Ethical Clearance Pro Forma

Ethical Clearance Pro Forma

It is important for you to include all relevant information about your research in this form, so that your supervisor can give you the best advice on how to proceed with your research.

You are advised to read though the relevant sections of UCL's Research Integrity guidance to learn more about your ethical obligations.

Please ensure to save a copy of your completed questionnaire BEFORE hitting 'submit' (you will not be able to access it later).

Page 1

Submission Details

Page 2

1 * Please select your programme of study.

MPlan City Planning

2 * Please indicate the type of research work you are doing.

- [ ] Dissertation in Planning (MSc)
- [x] Dissertation in City Planning (MPlan)
- [ ] Major Research Project

3 * Please provide the current working title of your research.

High Streets in Lockdown: Studying the effects of composition and morphology on high street performance d

4 * Please select your supervisor from the drop-down list.

Son, Jung Won

Research Details

5 * Please indicate here which data collection methods you expect to use. Tick all that apply.

- [ ] Interviews
- [ ] Focus Groups
- [ ] Questionnaires (including oral questions)
- [ ] Action research
- [ ] Observation / participant observation
- [ ] Documentary analysis (including use of personal records)
- [ ] Audio-visual recordings (including photographs)
- [x] Collection/use of sensor or locational data
- [ ] Controlled trial
- [ ] Intervention study (including changing environments)
- [ ] Systematic review
- [x] Secondary data analysis
- [ ] Advisory/consultation groups

6 * Please indicate where your research will take place.

UK only

7 * Does your project involve the recruitment of participants?

'Participants' means human participants and their data (including sensor/locational data and observational notes/images.)

- ○ Yes
- ◉ No

Page 3

Appropriate Safeguard, Data Storage and Security

8 * Will your research involve the collection and/or use of personal data?

Personal data is data which relates to a living individual who can be identified from that data or from the data and other information that is either currently held, or will be held by the data controller (you, as the researcher).

This includes:

- Any expression of opinion about the individual and any intentions of the data controller or any other person toward the individual.
- Sensor, location or visual data which may reveal information that enables the identification of a face, address etc. (some postcodes cover only one property).
- Combinations of data which may reveal identifiable data, such as names, email/postal addresses, date of birth, ethnicity, descriptions of health diagnosis or conditions, computer IP address (of relating to a device with a single user).

◉ Yes ○ No

9 * Is your research using or collecting:

- special category data as defined by the General Data Protection Regulation*, and/or
- data which might be considered sensitive in some countries, cultures or contexts?

*Examples of special category data are data:

- which reveals racial or ethnic origin, political opinions, religious or philosophical beliefs, trade union membership;
- concerning health (the physical or mental health of a person, including the provision of health care services);
- concerning sex life or sexual orientation;
- genetic or biometric data processed to uniquely identify a natural person.

◉ Yes ○ No

10 * Do you confirm that all personal data will be stored and processed in compliance with the General Data Protection Regulation (GDPR 2018)?

◉ Yes
○ No

20/06/2021 Ethical Clearance Pro Forma

○ I will not be working with any personal data

Page 4

11 * I confirm that:

☑ The information in this form is accurate to the best of my knowledge.
☑ I will continue to reflect on, and update these ethical considerations in consultation with my supervisor.

You **MUST** download a copy of your responses to submit with your proposal, and for your own reference. To do this, use the print screen function of your web browser, and print to PDF in order to save.

Close this window

Risk Assessment Form

RISK ASSESSMENT FORM
FIELD / LOCATION WORK

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 **BARTLETT SCHOOL OF PLANNING**

LOCATION(S) **LONDON**

PERSONS COVERED BY THE RISK ASSESSMENT **Lili Pandolfi**

This research utilises a GDPR protected dataset. The CDRC has accepted my application and therefore found risks to be mitigated and anticipated. Whilst the mode of collection of the data contains GDPR risks, the data itself does not contain any information that could be linked to the identity of any individual. It only contains locations and footfall counts (Application to CDRC: Appendix 3).

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 ? 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
X	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 HandS 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

Low

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
X	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:

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 a possibility?	NO	If 'No' move to next hazard 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?		

There is no need to visit the locations as the study is quantitative. If a site is ever visited (for photographs for instance), it will be along with another person.

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
X	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
X	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? 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
X	OTHER CONTROL MEASURES: please specify any other control measures you have implemented: If it is ever necessary to visit a site for photographs, I will take care to wear a mask and maintain a 2m distance with others on the site to prevent the transmission of Covid 19.

TRANSPORT	Will transport be required	NO		Move to next hazard
		YES	X	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? Low: There is the potential for visiting the sites. They are all in Greater London.			

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

SUBSTANCES	Will participants work with substances	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any 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**	**X**	**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?	No
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
X	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: Dr Jung Won Sonn

FIELDWORK 5 May 2010