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Investigating the interplay of sustainability and resilience of the built environment

by

Elisabeth C Marlow

Submitted in partial fulfillment of the requirements

for the award of

Doctoral Thesis of Loughborough University

(2019)

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Acknowledgements

Passion for striving to make the world's urban development more sustainable and more resilient has led to undertaking the challenge of this doctoral thesis. It is a personal agenda influenced by working internationally in practice as a sustainability consultant.

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Abstract

Why are we not living in an urban environment that is sustainable and resilient? To find a response, this thesis considers the interplay of sustainability and resilience from their conceptual interpretations, measurement frameworks and application in the decision-making of the urban built environment. A multitude of challenges were presented and original thought was required to overcome them. To understand how the sustainability and resilience agendas intersect to influence decisions in cities has needed a broad methodological approach and diverse research design.

Theoretical literature on sustainability and resilience has been thematically reviewed to consider how both agendas relate to one another and found them to be generally mutually supportive. Three city case studies in the USA have been generated to provide descriptive context to consider the cities' decision pathways of policy, planning and design. Constructed from semi-structured interviews with built environment professionals has given decision-making insight and practice knowledge. Discursive interpretations, political and habitual behaviours and a foundation of Realpolitik have emerged as research outcomes.

Given the urgency of current global conditions, it is critical that better decisions are made to enable real change in the policies of the urban environments and facilitate the best of sustainability and resilience practice to become normal practice. Explanations have been provided by the use of decision-making interplay timelines and the cross case analysis provides patterns for consideration.

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List of Abbreviations

Abbreviations	Expanded
ACCCRN	Asian Cities Climate Change Resilience Network
AIA	American Institute Architects
ANT	Actor Network Theory
APA	American Planning Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
ASME	American Society of Mechanical Engineers
BEAM	Building Research Establishment Measurement
BEDRO	Building Energy Benchmarking Ordinance
BOS	Boston, Massachusetts, USA
BPDA	Boston Planning and Development Agency/ BDPA
BRA	Boston Redevelopment Authority
BRE	Building Research Establishment
BREAM	Building Research Establishment Environmental Measurement
CABE	Commission for Architecture and the Built Environment (UK)
CBD	Central Business District
CDP	City Data Portal
CEEQUAL	Civil Engineering Environmental Quality Assessment
CEQR	City Environmental Quality Review (NYC)
CHIC	Chicago, Illinois, USA
CIRIS	city inventory reporting and information system
CMAP	Chicago Metropolitan Agency for Planning
CME	Chicago Mercantile Exchange
CPC	City Planning Commission
COP	Conference of Parties
CO2e	Carbon dioxide equivalent (tonnes)
CRO	Chief Resilience Officer
CURB	Climate action for Urban sustainability
C40	C40 Cities
DDR	Disaster Risk Reduction
DETR	Department of the Environment, Transport and the Regions (UK)
DOB	Department of Building
DPD	Department of Planning and Development (Chicago)
DROP	Disaster Resilience of Place (Cutter, 2008)
DRR	Disaster Risk Reduction

ECI	Earth Charter Institute
EDIC	Economic Development and Industrial Corporation (Boston)
EIS	Environmental Impact Statement
EKC	Environmental Kuznets Curve (1955)
EO	Executive Order
EPA	Environmental Protection Agency, USA
FEMA	Federal Emergency Management Agency
GAR	Global Assessment Report
GDP	Global Domestic Product
GFN	Global Footprint Network (Rees and Wackernagel)
GHG	Green House Gases
GRI	Global Reporting Initiative
HK	High Knowledge with reference to Mendelow's matrix
HP	High Power with reference to Mendlelow's matrix
IBC	International Building Code
ICC	International Code Council
ICLEI	Local Governments for Sustainability
IEA	International Energy Agency
IEC	International Energy Code
IFRC	International Federation of the Red Cross
IGA	Illinois Green Alliance
IGBC	Interagency Green Building Committee (Boston)
IPCC	International Panel on Climate Change
ISO	International Orgainsation for Standardization
IUCN	International Union for Conservation of Nature
LCA	Lifecycle Analysis
LEED	Leadership in Environmental and Energy Design
LEED AP	LEED Accredited Professional
LEED BDC	LEED Building, Design and Construction v 4.0
LEED ND	LEED Neighbourhood Development
LEED-RELi	LEED- Resilience Design Framework
LK	Low Knowledge with reference to Mendlelow's matrix
LL	Local Laws in NYC
LP	Low power with reference to Mendlelow's matrix
LPT	Leverage Point
MA	Massachusetts State
MDG	Millennium Development Goal
MIT	Massachusetts Institute of Technology

MMCRC	Making My City Resilient Campaign by UNISDR
MWRA	Massachusetts Water Resources Authority
NACC	North American (Cities) for Climate Change
NAP	National Adaptation Plans
NEPA	National Environmental Policy Act
NAEP	National Associate of Environmental Professionals
NDRF	National Disaster Recovery Framework
NPCC	NYC Panel on Climate Change
NYC	New York City
NYC UGC	NYC Urban Green Council (a local Chapter of the USGBC)
OECD	Organisation for Economic Co-operation and Development
ODI	Overseas Development Institute
OLTPS	Office of Long Term Planning and Sustainability
ORR	Office of Recovery and Resiliency
PAR	Pressure and Release model by Wisner (2005)
PAS	Pre Application Statement
RABIT	Resilience benchmarking tool by Heeks and Ospina (2015)
RELi	Resilient Design Framework
RMI	Rocky Mountain Institute, Boulder, Colorado, USA
SBE	Sustainable Built Environment
SCAP	Sustainable Chicago Action Plan
SCEPA	Standard City Planning Enabling Act
SFDRR	Sendai Framework for Disaster Risk Reduction
SES	Socio-Ecological Systems
SDG	Sustainable Development Goals (2030 Agenda)
SZEA	State Standard Zoning Enabling Act
TAMD	Tracking Adaptation and Measuring Development by Brooks (2013)
TBL	Triple Bottom line coined phrase by Elkington (2001)
UN	United Nations
UBE	Urban Built Environment
UCCRN	Urban Climate Change Research Network
UNDRR	United Nations office of Disaster Risk Reduction (has replaced UNISDR)
UNFCCC	United Nations Framework Convention of Climate Change
UNISDR	United Nations Office of Disaster Risk Reduction supporting the Sendai Framework
USA/US	United States of America/ United States/ North America
USGBC	United States Green Building Council

U20	Urban 20. Urban 20 Mayors Summit
WCED	World Commission for Environmental Development
WDI	World Development Indicators by World Bank
WGBC	World Green Building Council
WMCCC	World Mayors Council on Climate Change
100RC	100 Resilient Cities by Rockefeller

Thesis Outline

Increasing recognition of the influence of natural hazard frequencies, social vulnerability and the impact of the built environment on health and climate change make it critical to achieve synergy between sustainability and resilience (Chapter 1). However, sustainability and resilience are broad-reaching with a spectrum of permutations of meaning, definition and applications and Chapter 2 reviews the themes in the literature of both concepts.

Given the global reach of these issues, there is a need to generate context in order to understand how sustainability and resilience interplay in decision making between policy and practice (Chapter 3). Three US city case studies have been generated and semi-structured interviews conducted to explore the relationships between policy, planning and design practice (Chapter 4). Chapter 5 provides insight from semi-structured interviews to construct an understanding of the reality of decision-making in the sustainable built environment with resilience. Chapter 6 discusses how the patterns in decision-making interplay and the emerging nuances between policy and practice, start to generate a case of Realpolitik (Section 6.4). From this valuable explanation, Chapter 7 concludes the research with Real Realpolitik (Section 7.1), key principles of action for built environment theory, policy and practice (Section 7.2), as well as considering limitations and further research. Informing this research position have been numerous sources, which are provided (Chapter 8) and further supporting work (Chapter 9).

Figure 1.1 provides a layout guide of each section of the thesis and colour codes the Chapters. These colours have been adopted for Chapter and main headings as follows: the introduction and conclusions are in dark green, the literature review and discussion are shown in green, the methodology in silver, data collection sections are shown in Gold.

Throughout the Chapters, key critical theme issues have been placed in boxes and some key quotes have been intensified within the narrative. However, in Chapter 5, collected quotes from the semi-structured interviews are used as illustrative examples. These quotes are in Gold text but not been labelled with a caption. Any further reproduction of this thesis should be printed in colour.

Thesis Guide	**Key words of critical components**
Chapter 1: Introduction	Definitions, outlining the issues and challenges encountered Interplay of sustainability and resilience in the built environment **Theoretical** landscape **Policy** landscape **Practice** landscape Research Approach Case study country- historical narrative of sustainability and resilience in the USA
Chapter 2: Literature Review	Sustainability and resilience in the built environment Themes of **interpretation of meanings** and measurement frameworks US Context of Leadership in Environmental and Energy Design (LEED) Decision- Making theory and consequences of **discursive use of interpretations in decision-making of policy, planning and practice in cities.**
Chapter 3: Methodology and Research Design	Broad approach to go to deeper levels of understanding **Inductive, Interpretative** and abductive Constructivism Qualitative **Research Design of 3 city case studies, semi-structured Interviews, thematic analysis and causal modelling** Limitations Appendix Documentation: 3.1, 3.2, 3.3 ,3.4, 3.5
Chapter 4: 3 Case Studies	Cross case examination of the meaning and measurement interpretations of sustainability and resilience along the decision-making pathway of: **city policy, city planning and city design practice in NYC, Boston and Chicago and d**ecision-making influences (Section 4.5) Case Studies of NYC (Section 4.6), Chicago (Section 4.7) and Boston (Section 4.8) Appendix 4.1- Critical timeline
Chapter 5: Results	**Practice interpretations** of the **meaning** of sustainable development and resilience in cities (Section 5.1) **Practice interpretations** of the **measurement** of sustainable development and resilience in cities (Section 5.2) **Decision-making interplay of policy and practice in three cities** (Section 5.3) Constructing an understanding of decision-making interplay (Section 5.4)
Chapter 6: Discussions	**Explaining decision-making patterns in cities**
Chapter 7: Conclusions	Real Realpolitik (Section 7.1) Principles for action in theory, policy and practice (Section 7.2) Research progression (Section 7.3) Research limitations (Section 7.4) Original contribution to knowledge (Section 7.5) Further work (Section 7.6)

Figure 1.1 Thesis layout guide

Chapter 1 Sustainability and resilience in the urban built environment

A sustainable built environment meets the needs of future generations by creating buildings that minimise ecological harm through passive design principles and renewable sources (Brundtland, 1987; McDonough and Braungart, 1992). A resilient built environment provides the sustainable built environment with the adaptive capacity to cope with changes from natural hazards and human induced threats (Folke *et al.*, 2002). Collectively the principles of sustainability and resilience create a systems approach centered on the global environment and the wellbeing of people (Meadows *et al.*, 1972; Senge, 2006). A sustainable and resilient built environment has a relationship with urban context which incorporates public realm, ecosystems and infrastructure. Ahern (2013, p.1203) identifies that transdisciplinary collaboration is necessary to build an urban landscape where sustainable cities become resilient by considering "*biodiversity; urban ecological networks and connec- tivity; multifunctionality; redundancy and modular-ization, adaptive design*". These conceptual meanings are further explored in Chapter 2 (Section 2.1).

The existing built environment is faced with multiple challenges (Section 1.1). Determining how to create a sustainable and resilient built environment has been met with discursive challenges in theory, policy and practice (Section 1.2). Foucault (1971), in '*The archaeology of knowledge',* builds on the *Order of things* (1966) about how the discourse of language can affect the formation of concepts, strategies and consequences. Introduced in Figure 1.2

are some critical junctures in the narrative of sustainability and resilience along a timeline, some of which hold historical significance (Section 1.2).

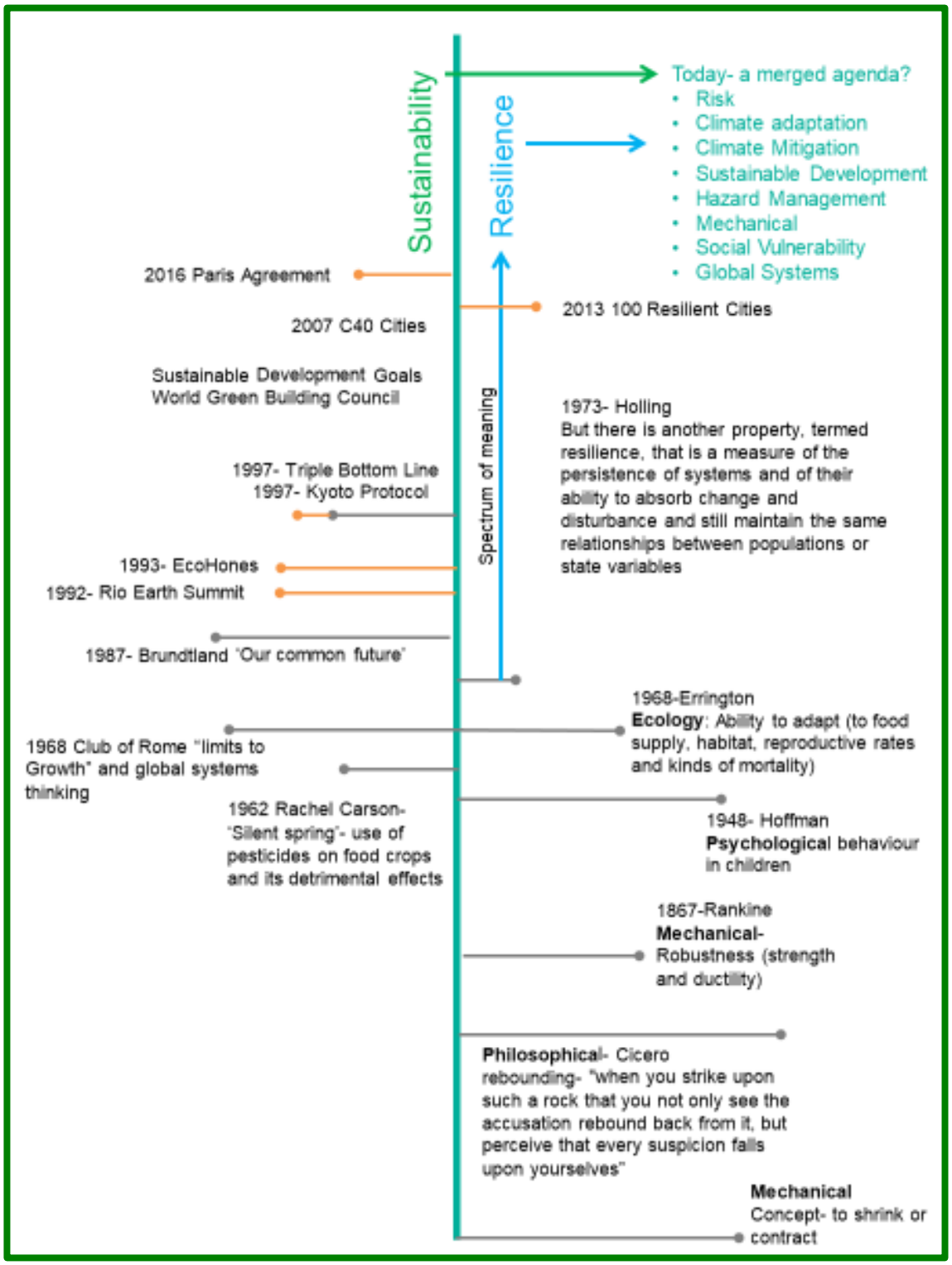

Figure 1.2 A timeline of critical junctures of conceptual interpretations created by Elisabeth Marlow

Indicated in Figure 1.2 are the origins of sustainability, which emerged from the environmental concerns of Rachel Carson (Lutts, 1985), economic principles set out by the Club of Rome (Meadows *et al.*, 1972) and “Our Common Future” (Brundtland, 1987). Over time, the conceptual interpretation has been captured in the global policy of 17 Sustainable Development Goals (SDGs) (United Nations, 2015b) which are grounded by the five pillars of sustainability: people, planet, prosperity, peace, and parternship (Sow, 2016).

Captured by Alexander (2013) is the etymological journey of resilience, who explains the origins of the term have mechanical meaning, but in modern times Holling (1973) translated the conceptual meaning into ecological behaviour of species populations. Today, the meaning has become stratified with lexical shifts and proximal meanings (Wang *et al.*, 2020) but there is a core understanding of Disaster Risk Reduction (DRR) and Natural Hazards (Wisner *et al.*, 2003; Wisner, 2018) (Section 1.2.1).

For the future of the built environment, owing to **discursive shifts in meaning** of the critical concepts, sustainability and resilience decision-making has been made challenging (Glavič and Lukman, 2007; Roostaie, Nawari and Kibert, 2019; Wang *et al.*, 2020) (Section 1.2.2). Gaillard and Jigyasu (2016) specifically outline how the interpretation of resilience has become an issue when trying to make a **decision about setting strategies and measurement targets** (Section 1.2.3).

To understand how the discursive shifts have influenced decision-making in the built environment, the issues need outlining (Section 1.2) and original context is required to build an explanation (Section 1.3). This need for built

environment context has been addressed in the research aims, objective and scope (Section 1.3). With the scope defined, the historical background of the US environmental movement sets the scene to frame today's issues of sustainable and resilient development (Section 1.4). The research design has led to some emerging findings that are outlined in Section 1.4, then fully discussed in Chapter 6 and concluded in Chapter 7.

1.1 What are the challenges in the Sustainable Urban Built Environment?

Unpacking the epitome of sustainability and resilience in the built environment is far from simple (Chapter 2). The Sustainable Built Environment (SBE) needs to consider the principles of sustainable development (McDonough and Braungart, 1992), the context of site and constituent relationships with its urban environment, building occupant and community lifestyles (Shove, 2003; Sullivan, 2012; Rydin and Turcu, 2014).

Many architects have explored this arena, Ken Yeang explored high rise living with increasing ecological value to create the bioclimatic skyscraper which considers the relationship of the building in its urban context (Yeang, 2007). Tim Smit explored the idea of reclaiming industrial sites to recreate ecological value with the Eden Project (Smit, 2016) and Winny Maas's 'the why factory' has started to explore cities of the future (Cavallo, 2020). Yet, considering the future of cities is not a new ideology, it is a recurring thought process and in modern architecture most notably explored by Le Corbusier with the Cities of Tomorrow (Stewart and Corbusier, 1971; Le Corbusier, 2000). However, today when considering the future of the built environment,

there is a focus on uncertainty, risk, threats, social migration, adaptability and vulnerability towards climate change (Folke *et al.*, 2002; Wisner *et al.*, 2003; Beck, 2009; Ahern, 2013; Cohen, 2014).

Historically decisions have been made concerning building and infrastructure practice, which have created ripples across the decades and which indirectly influence how society behaves within the urban environment (Berger, 1960; Hammond, Keeney and Raiffa, 1998; Vaughan, 2018). Within the next decade, 66% of the global population will live in cities generating urban growth, and the type of new development is an issue (Talen, 2003; Cohen, 2014; Meerow and Newell, 2019a). Globally, urban land cover is predicted to increase by 26% by 2030 from 58,000 km^2 to approximately 1,527,000 km^2 (Seto *et al.*, 2011). As urban development area increases in cities, there is a growing concern about existing building stock and infrastructure and its ability to cope with the expansion of society (Wisner *et al.*, 2003; Beck, 2009; Rogers *et al.*, 2012; Lloyds and University of Cambridge, 2015; Kohler, 2018).

Existing building stock has an increasing operational and insurance cost due to failures caused by not considering 'buildings in use', climate change and natural hazards (Linnerooth-Bayer, Mechler and Hochrainer-Stigler, 2011; Jahn, 2015). Dodman, Diep and Colenbrander (2017) have estimated the impact of the built environment on climate change and concluded that the existing building stock is globally responsible for approximately 40% energy, 25% water, 40% resources, and 35% GHG emissions. Chalmers (2014, p. 4) highlights that "*under business as usual, the energy use could double or even triple by 2050*". The International Energy Agency (IEA) considers that

urban areas are responsible for 71% of global energy and carbon emissions (IEA, 2016). These predictions reflect that sustainable design principles or lifestyles changes are not being effective in practice-why?

Currently, global governance manages resilience and sustainability separately between the UN Framework Convention of Climate Change (UNFCCC) and UN Disaster Risk Reduction (UNDRR). The C40 Cities (C40) network reports on how city mayors collaborate to enforce carbon emission reduction policies, and city resilience frameworks rate risk (Lloyds and University of Cambridge, 2015; C40 Cities, 2018a). Rosenzweig *et al.* (2010) outline that the World Mayors Council on Climate Change (WMCCC), established in 2005, has enabled cities to take responsibility and generate responses to climate change. Rosenzweig *et al.* (2010) expresses that cities' responses to the challenge were initially focused on agricultural systems. However, events like Hurricane Katrina highlight that over time urban development of cities have altered the adaptive capacities of ecological systems to provide natural defence to natural hazards events (Day *et al.*, 2000; Ko and Day, 2004; Olshansky, 2006). Lack of consideration of ecological systems in planning has created exposure and vulnerability of urban environments that policy makers need to address beyond carbon control (Day *et al.*, 2000; Ahern, 2013; Denton *et al.*, 2014).

Perelman (2017) has indicated that there are real conflicts between the concepts in policy and practice between infrastructure and the built environment which are a barrier in decision-making (Chapter 2). Understanding how to overcome this barrier is critical because the initial starting point of providing a sustainable built environment is a not mandatory

practice in many countries or cities despite the global policy of 17 SDGs (United Nations, 2015b). Providing a sustainable and resilient built environment needs urban context because providing better decisions is paramount (Section 1.3).

1.2 Interplay of sustainability and resilience in decision-making

Decision-making is complex (Section 2.3) but understanding which interpretation of sustainability and resilience is being mobilised between policy and practice needs further consideration (Chmutina, Lizarralde, *et al.*, 2014). To identify possible areas where the concepts provide collaboration and promote synergy in decision-making are important. However, areas where the concepts are considered individually or separately and promote conflicts in decision-making are important too. To consider this issue in the literature narrative, three themes of conceptual interpretation, policy and practice were considered to orientate the research landscape (Chapter 2). This section provides a summary of salient points established from the Chapter 2.

1.2.1 Concepts

Folke, (2016, p.13) has recently restated "*Resilience thinking is an integrative approach for dealing with the sustainability challenge".* Carpenter *et al*. (2001, p.2) discuss the systematic relationship of resilience with sustainability and summarise its measurement "*by the magnitude of disturbance the system can tolerate and still persist".* Achour et al. (2015) who investigated

resilience and sustainability in theory and practice has established that resilience was mostly associated with Disaster Risk Reduction (DDR) and sustainability with addressing carbon reduction policies.

When considering the shift in meanings of both resilience and sustainability from their origins (Figure 1.2), the theoretical literature concerning sustainability and resilience shows a mutual relationship between the two concepts (Walker *et al.*, 2004; Bocchini *et al.*, 2014; Chmutina *et al.*, 2016). However, resilience has multiple interpretations which indicate resilience has a separate identify from sustainability (Meerow, Newell and Stults, 2016; Wang *et al.*, 2020). **This theoretical fracture has created theoretical discrepancies in interpretations of sustainability and resilience**.

Theoretical differences start to appear when considering what resilience means and how it can be measured. Ayyub (2014) and Michel-Kerjan *et al*. (2013) suggest there is a need for quantification of resilience to reduce disaster risk and subsequent cost of recovery. There is also a fierce debate around whether it should be measured or not (Carpenter *et al.*, 2001; Wang *et al.*, 2020). **Positioning of 'which' terms should be quantified** are at a potential juxtaposition with **conceptual interpretations**, policy and practice.

1.2.2 Policy

Having identified that the cities are critical to delivering the benefits of sustainable and resilient development, how cities are now responding to global policy should be examined (Section 1.1). "Our Common Future" (Brundtland, 1987) was launched in 1987 and conveyed sustainability. Global political promises and international laws about changing the impact of human

behaviour on the planet were made in the Montreal Protocol (1987) (UNFCCC, 2019), the Hague Convention in 1989 (UNFCCC, 2019) and the Rio Declaration (UNFCCC,1992; O'Connell *et al.*, 2015). Primarily aims were to reduce carbon emissions to 400 ppm by 2030, but current levels now surpass this notional threshold (Jones, 2017). Climate change is an international legal issue (Taylor, 1998) and countries attend the COPs (UNFCCC, 2019) to discuss the commitments to these laws. COP 3 saw revised commitments to emissions and created the Kyoto Protocol in 1997 (UNFCCC, 1998). The International Panel for Climate Change (IPCC) (2012) continues to report increasing risks. However, the recent COP 21 in Paris discussed terms such as capacity building and adaptation, as well as the introduction of the Warsaw international mechanism for loss and damage (UNFCCC, 2016). There have been 24 COPs to date (UNFCCC, 2019).

The Sendai Framework for Disaster Risk Reduction (SFDRR) was established (UNISDR, 2015b). The 2015 Global Assessment Report (GAR) considers that "*60% of the area expected to be urbanized by 2030 remains to be built*" (UNISDR, 2015a, p. viii), which shows the significant opportunity for all development decisions to consider climate change adaptation, mitigation, natural hazards and human-induced threats (Dovers and Handmer, 1992; Handmer and Dovers, 1996; Folke *et al.*, 2002; Yohe *et al.*, 2007; Bosher, 2014; Denton *et al.*, 2014).

More recently, the 2019 GAR report (UNDRR, 2019a) outlines a 'Risk-Informed Sustainable Development' framework for all countries to work towards. This recent position is a shift from a focus on DDR (UNISDR, 2015b) towards a more cohesive interpretation of resilience and sustainability

in global policy. However, ‘what’ interpretations of resilience and sustainability have been adopted by recent city policies and practice is relevant because these could have long term impacts on buildings and infrastructure that create future problems (Hammond, Keeney and Raiffa, 1998; Day *et al.*, 2000; Talen, 2012). These sudden shifts in policy are timely for examining the relationship with built environment practice (Section 1.2.3)

Reducing the global impacts of human behaviour should mean employing the sustainability agenda and implementing the SDGs (Robert, Parris and Leiserowitz, 2005). However, increasing stochastic events, rising insurance costs and increasing social vulnerabilities are an issue (Beck, 2009; Linnerooth-Bayer, Mechler and Hochrainer-Stigler, 2011). Politically, the global achievement of the goals set by the SFDRR and the SDG are reciprocal, but only Goal 11 is specifically focused on Sustainable Cities and Communities (United Nations, 2015b). This makes some people question whether the SDGs are being effective (Peters and Tanner, 2016).

According to the European Commission (2015), 98% of global cities are experiencing impacts of climate change. Cities are starting to take more responsibility for their decisions. Established in 2005, was the C40 Cities (C40) network for city decision makers who have adopted this policy vision of “*large cities taking action to address climate change by developing and implementing policies and programs that generate measurable reductions in both greenhouse gas emissions and climate risks*” (C40 Cities, 2019). C40 now represents 96 cities across the world (C40 Cities, 2018a) and is actively monitoring and evaluating their performance as described in Box 1.1.

Box 1.1: Conceptual interpretation in the decision-making in cities identified in policy

C40 Cities (C40) works with the International Energy Agency (IEA) and has created the City Data Portal (CDP) to track issues (For Cities by Cities, 2019).

C40 can report that cities account for 70% of the global CO2 emissions and that 90% of the world's urban areas are situated in the coastlines and are at risk of the devasting impacts of climate change (C40 Cities, 2018).

C40 Climate Leadership Group and ARUP have recently published important studies on this topic such as *Deadline 2020: How cities will get the job done* (Hurst, Clement-Jones *et al*. 2016).

This is, however, only one challenge of many. Lloyds (2019) have created a city risk index, which identifies threats [1] and the threat-related cost of average annual loss of Global Domestic Product (GDP) for each threat. The index reports the total GDP at risk from threats and the recovery cost as US$4.6 trillion (Arup, 2017, p. 5). These predictions provide the context for future development decisions to consider climate change adaptation, mitigation, and natural and human induced hazards (Dovers and Handmer, 1992; Handmer and Dovers, 1996; Folke *et al.*, 2002; Yohe *et al.*, 2007; Bosher, 2014; Denton *et al.*, 2014).

Another city-led initiative called 100 Resilient Cities (100RC) was launched in 2013 for cities to apply and compete for funding to make their city more resilient. By 2016, there were 63 cities participating and work to support city decision makers started (Berkowitz, 2016). However, despite the prominence

[1] Recognised threats are: cyber-attack, drought, earthquake, flood, freeze, heatwave, human pandemic, market crash, nuclear accident, commodity price shock, plant epidemic, power outage, social unrest-interstate conflict-civil conflict, solar storm, sovereign default, terrorism, tropical/temperate windstorm, tsunami and volcano.

of these two city frameworks, there is little comparative evidence on whether the measurements are effective. The choice of which framework indicators are implemented and measured could have significant consequences for risk and sustainability in the urban context of a city as discussed by Hammond (1998), particularly for city planning and building design.

Consideration of the convergence of the sustainability and resilience agendas is paramount to decision-making of the built environment. The application of sustainability policies is broad and has a global effect. This research focuses on the urban scale of cities because of the emerging decision making practice and urban development issues (Ahern, 2013; United Nations Habitat III, 2017; For Cities by Cities, 2019).

1.2.3 Practice

In the Global Sustainability Cities Report, it is said that "*A major weakness of the new approaches is that they tend to focus more on process often at the expense of outcomes. They also place much emphasis on the directive aspect of the planning system and neglect the underlying regulatory system and how this links to directive plans. Planning is also weak in terms of how to deal with the major issues of the 21st century, such as climate change, resource depletion, rapid urbanization and informality*" (United Nations Habitat, 2009, p. 238). Given the global issues we are facing and the effect of international power transitions of the Paris Agreement (Rajamani, 2016), this thesis will consider the respective roles of sustainability and resilience in cities and how, in particular, they have been integrated into the decision pathways of cities (O'Connell et al., 2015).

This research shows that it is within the context of cities that the two agendas are applied together, and this also where conflicts and synergies arise. This surge of distinct measurement frameworks in practice starts to support a position that resilience has become too complex for quantification (Levine, 2014). Also, insurance costs and recovery from 'disaster' is getting more expensive, so planning for prevention needs more consideration, hence the need to measure risk in cities (Cole, 2014; Lloyds and University of Cambridge, 2015).

"*Cities need indicators to establish their baseline, and measure and evaluate their performance. However, existing indicators are often not standardized, consistent, or comparable over time or across cities. To address these challenges, a new series of International Standards is being developed to provide standardized indicators that enable a uniform approach to what is measured, and how that measurement is to be undertaken.*" (ISO, 2019).

Sustainability has been perceived as expensive as a result of activities such as the investment in renewable energy and improving building systems technology, but what is needed is real innovation to see beyond the targets and reduce costs (Dowson et al., 2012; Phillips et al., 2017). Sustainable development practice arguably suggests that there needs to be more transdisciplinary working; this argument existed in the 1990s with the UK's Rethinking Construction Report (Egan, 1998). This means more team working with fewer silos and more team responsibility from the outset to solve problems about risk and resilience and to promote systems thinking (Meadows et al., 1972; Senge, 2006; Meadows, 2008).

A way forward is to consider using existing measurement systems to consider life-cycles such as the Environmental Management Systems BS EN 14001 (British Standards Institution, 2015) to manage and unify the approach to ‘environmental’ measurement in practice. Strategic Environmental Assessments (SEAs) have also been advocated as a stretch target to Environmental Impact Assessments (EIA) (Balfors et al., 2018). SBE practice currently adopts the measurement frameworks of: Global Reporting Initiative (GRI), Environmental management (ISO 14001), Corporate Social Responsibility (CSR) (ISO 26000), Green Building Assessment Methods (from a micro scale of buildings to a macro of communities). However, The Overseas Development Institute (ODI) (2016) analysed 39 resilience frameworks for measurement; only three were found to operate at an ‘urban’ scale and only one measured system's ‘capacity’ (Section 2.2.4). If the urban environment is critical for both sustainability and resilience, then why is there not a greater focus on it?

Very recently two International Organization for Standardization (ISO) have been released: ISO 37123:2019- Sustainable cities and communities- indicators for resilient cities and ISO 37120 Sustainable Development in Communities- Indicators for city services and quality of life. However, with these new standards of measurement how will they be incorporated into city policy? (Section 2.3.5.3).

1.3 Research Approach

Understanding and providing an explanation to “why” the existing Urban Built Environment (UBE) is neither sustainable nor resilient, needs an original

approach to the methodology (Chapter 3). Many challenges have presented themselves (Chapter 2) which is why the aim of this research is to: critically examine the interplay of resilience and sustainability in urban environments to create a foundation for better decision-making in policy and practice. Five research objectives will address the overall aim:

1. To review, analyse and synthesise the literature concerning resilience and sustainability in urban built environments.
2. To evaluate how the concepts of resilience and sustainability are interpreted in policy and practice.
3. To examine three city case studies for causal relationships of decisions and identify patterns.
4. To theorise relationships of resilience and sustainability in city policy, city planning and city practice in order to provide an explanation.
5. To construct principles for action to support better decision-making of resilience and sustainability in urban environments.

Many resources regarding climate change, sustainability and resilience continue to be published in academic and grey literature. Climate change is a global issue, but the scope of this thesis focuses on sustainability and resilience in the urban environment at a city scale. City Risk Register(Lloyds and University of Cambridge, 2015) outlines that cities are at risk due to their location and effects of climate change, as well as representing the majority of the global population (Cohen, 2014). Case study cities provide contextual boundaries to allow the discourse of UBE to be observed, described and reified. Three North American cities have been determined for case studies (Section 3.3.1) because the USA has one of the greatest global carbon footprints (OECD, 2009, 2018) and some cities participate in the C40. The USA has a long standing history with environmental policies (Section 4.1 and

4.2) and sustainable hazard mitigation (Mileti, 1999) which are now being tested by shifts in presidential policies (Meadows *et al.*, 1972; Hays, 1982; C40 Cities, 2007; Baynes, 2019). To understand how decisions, impact the UBE, practice context is provided by specialists in each city.

Human behaviour in the built environment is complex as it relates to a range of cultural and societal issues combining themselves in communities, neighbourhoods and occupant behaviour in buildings. Sustainable building design and construction practice is an existing knowledge foundation (Ainger and Fenner, 2014; Green, Hope and Yates, 2015), and discussing how to increase building performance standards, improve building regulations or promote renewable energy targets are not the direct subject of this research. This research considers why best urban practice is not common practice and identifies possible barriers in decision-making (Chapters 4, 5 and 6). Synthesising how these agendas interplay in the UBE at city scale requires a narrative analysis of policy, planning and design documents to assess how decisions create conflicts and synergies for the agendas. It is here that causality of decisions can be brought into focus.

Sustainability is often referred to as the three pillars of sustainable development: social, economic and environment or the Triple Bottom Line (TBL) (Elkington, 2004), however the practice of sustainability in the UBE is also considered to be working towards sustainable development (Brundtland, 1987). Policy and practice are recurring themes and boundaries do get blurred between them. However, in this thesis, the term policy is considered as guidance, and practice is what is put into action.

1.4 USA's historical environmental narrative

Historical perspective is necessary to recognise political and habitual influences in decision-making. Setting the scene to the city case studies is important (Chapter 4). The case study cities identified through the research design (Appendix 3.2) are in the USA. There are critical junctures in USA environmental policy which must be acknowledged as they provide historical influence in decision-making. Hays (1982) articulates the history of modern environmental policies in the USA and discusses terms such as conservation and preservation (cf. sustainability and resilience) as under the environmental umbrella. Identified as important, was John Muir's natural environment development and Geoffrey Pinchot's approach to efficient development (John Muir Trust, 2020; Forest History Society, 2020). Despite the differences between conservation and preservation, both terms identified with the conservation movement to "*draw together the themes of natural environment lands and environmental protection"* (Hays, 1982, p. 16).

America's Modern Environmental Movement was mobilised by critical influencers: Rachel Carson (DeMarco, 2017), Eugene Odum (1959), Paul Ehrlichs, the Sierra Club of 1892 (John Muir, Gifford Pinchot, William Wordsworth and Henry David Thoreau), Friend of the Earth US, Greenpeace USA, Dennis and Donella Meadows, Hunter and Amory Lovins [2]. The combination of their environmental knowledge, coupled with the Lucky Dragon Disaster and Bikini Atoll (a nuclear incident) created a platform for USA Environmental Policy (Hays, 1982; Szczepanski, 2019). This led to the

[2] The Lovins founded the Rocky Mountain Institute (RMI), Boulder, Colorado. RMI is considered as a thinktank for policy makers and practice.

enactment of the National Environmental Protection Act (NEPA), Clean Air Act (EPA, 2019), Clean Water Act (EPA, 2019).

Eventually by 1993, in response to the Rio Declaration the environmental focus shifted onto built environment practice with the formation of the US Green Building Council (USGBC). The USGBC created the Leadership in Energy and Environmental Design (LEED) to create more environmentally responsible buildings and to measure sustainability. Today LEED operates as an international framework and is seen as a global leader (alongside BREEAM). LEED is a voluntary program but for some federal buildings it is mandatory, and its rules of implementation will vary per US state. LEED is a practice framework for the building design for a variety of building typologies. Currently LEED operates as version 4.0 for Buildings, Design and Construction (BDC) (USGBC, 2017) and has increased the scale to Neighbourhoods (ND) (USGBC, 2016a). LEED has expanded this decision-making platform by piloting a city and community certification scheme (which is only available for commercial use) (USGBC, 2019) and also including resilience with the introduction of LEED-RELi mandatory credits (Wilson, 2018; USGBC, 2019). At the same time, US cities have started to generate their own policies to ratify global policies as recognised by the North American Cities Taking Action for Climate Change (NACC) (Chicago Council on Global Affairs, 2018). These interpretative shifts between environmental policies of sustainability and resilience continue to create conflicts with practice and decision-makers which have become political (Chmutina *et al*, 2016).

1.5 Emerging Findings

Outlined in Chapter 3 is the abductive approach to this research. Three critical themes were initially identified in the sustainability and resilience narrative review: the discursive use of language with **conceptual interpretations, measurement frameworks and decision-making interplay** (Chapter 2). Yet, as the city landscapes of policy, planning and practice were explored (Chapter 4), these initial themes further identify decision-making consequences and data collected from the semi-structured interviews with building practice professionals provided decision-making feedback (Chapter 5). Decision-making influences from the cross case study were also established (Section 4.5, **Table 4.1**) and **themes of political behaviour, habitual decision-making and discursive use of conceptual interpretations that have become measured entities** became more relevant. As these themes were discussed, the role of the best performance standards of the LEED measurement foundation were seen as critical as a conduit to build better policy and making it mandatory practice (Section 5.3.7). However it was discovered that built environment practitioners would prefer codes of practice to recognise “passive-survivability” (Wilson, 2006), more regulatory updating of municipal codes so creating less conflicts between decision-makers (United Nations Habitat, 2009) and scope of works that incorporate sustainability and resilience long term outcomes.

Procedural knowledge of institutions of the built environment needs to be mobilised because current policies restrict best practice (Engineers without Borders, 2019). To support better decision-making, the role of planning is

pivotal in considering hazard scenarios as well as reducing social and financial inequalities and vulnerabilities (Mileti, 1999; Fainstein, 2005; Talen, Wheeler and Anselin, 2018; Vaughan, 2018). Collaborative transdisciplinary behaviour between policy, planning and practice is required to reduce political jurisdiction in decision-making to ensure better ecological systems management and deliver better sustainable and resilient practice.

Urban resilience and sustainability have started to dominate the built environment narrative (James *et al.*, 2013; Lloyds and University of Cambridge, 2015; Meerow, Newell and Stults, 2016). Social migration has led to the population in cities increasing (Ahern, 2013; C40 Cities, 2016b). Cities have increased their political leadership of sustainability with the C40 Cities Campaign and resilience with 100 Resilient Cities campaign (Section 2.2.3). The combination of these critical issues and proportional representation of city inhabitants globally has led to the creation of Sustainability Development Goal 11- Cities and Communities (Barnett and Parnell, 2016; Parnell, 2016). However, the city decision-makers have a limited voice at a global political scale which generates conflicts with global and national policies (U20, 2018) (Section 6.4). This situation demonstrates Realpolitik of cities where there needs to be unification on the discursive interpretations and measurement of sustainability and resilience decisions (Section 7.2).

Realpolitik is often defined as "*a system of politics or principles based on practical rather than moral or ideological considerations*" (Oxford Reference, 2020) but in this situation it is Bew's (2016) interpretation of Realpolitik that is most helpful because it considers reality, not just the ideological, *"the*

creation of the concept of Realpolitik was an attempt to answer a domestic political conundrum: how to build a stable and liberal nation-state in an unsteady and rapidly changing environment, without recourse to violent convulsion or repression" (Bew, 2016, p. 17).

Recognition of Realpolitik is a reflective finding of the research (Chapter 7). The cross case studies analysis and semi structured interviews provide historical evidence of decision-making interplay in cities which have indicated to systemic inequalities due to political and habitual behaviour of decision-making (Foot, 1985; Talen, 2003; Olivier *et al.*, 2016; Vaughan, 2018; Meerow and Newell, 2019b). Realpolitik remains a political conundrum that can be addressed through unification of sustainability and resilience in city policies. Further research of the causes and effects of Realpolitik is imperative because after four decades of climate change policy, our urban environment is neither resilient nor sustainable and many are vulnerable to the effects of poor decision-making (Section 7.6).

Chapter 2 Thematic narrative review of sustainability and resilience in the urban built environment

Goal 11 of the SDG outlines that sustainable cities and communities matter because of the increased predictions of the urban population on water, energy, sewerage, air pollution, health and social disparities (United Nations, 2020). More recently Goal 11 has been expanded to "*Make cities inclusive, safe, resilient and sustainable*" (United Nations, 2020). This shift in descriptive language still outlines the core concept of sustainable cities but now includes terms such as vulnerability, and adaptability to climate change and disasters. However, this shift in language is critical to how both sustainability and resilience are conceptually interpreted because Natural Hazards have been confused with creating disasters not necessarily the unsustainable development of the built environment (Chmutina, Meding and Bosher, 2019).

How sustainability and resilience are managed in the built environment have influences on many factors such as social, economic and environmental behaviours (Talen, 2003; Ahern, 2013). Figure 1.2 acknowledged the recent increase in discursive interpretations and subsequent new trends of both concepts. The new resilience trends have been recognised by Wang *et al.* (2020).

Understanding how to construct a meaningful narrative to explore the themes of conceptual interpretation, measurement and influences in decision-making interplay needed an early development of the research ontology and epistemology (Chapter 3). Braun and Clarke (2008) outline the process of a

thematic review which is a useful method (Section 3.3.4) to explore nuances in the theoretical landscape. Critical themes of conceptual interpretation, measurement, policy, practice, urban and cities were recognised. These themes have informed this Chapter in the following way: Section 2.1 outlines the conceptual issues in the UBE, then discusses the theoretical landscape and policy origins for both concepts. These themes are then synthesised in the urban context (Section 2.1.3). This is critical because as the concepts have been interpreted, different versions are being measured in policy and practice. Section 2.2 considers how both concepts have been measured and a range of frameworks is considered before focusing on what is being measured in cities. Section 2.3 considers the theory of decision-making, organisations, thinking styles and knowledge transfer before synthesising the themes of policy influence, urban and cities context, measurement and consequences. These are critical components for the case study narrative (Chapter 4).

2.1 Conceptual interpretations in urban built environment

Chapter 1 introduces sustainability and resilience in the UBE and outlines that these concepts vary with urban developmental scale from buildings, communities, neighbourhoods, infrastructure, open space and cities. McDonough and Braungart (1992) outline the Hannover Principles for sustainability in the built environment but these principles have become adapted over time and are often used to describe sustainable development (Section 2.1.1). A resilient built environment is more complex, as outlined by Hassler and Kohler (2014a). Initially descriptive terms used are robust,

redundancy, adaptable and transform, but ‘what’ is being made resilient is more of a pertinent question (Carpenter *et al.*, 2001; Meerow and Newell, 2019b). Resilience and sustainability have a social-ecological systematic relationship (Folke *et al.*, 2002, 2010) but as the context varies, the relationships between the constituents of sustainability and resilience shift and sometimes create conflicts and synergies in decision-making; these often get exacerbated by political and habitual behaviour (Bulkeley, 2006; Vale, 2014; Lizarralde *et al.*, 2015; Meerow, Pajouhesh and Miller, 2019) (Sections 1.5 and 2.3.5).

The Climate Reality Project (2017) provides examples of five sustainable cities: Copenhagen, San Francisco, Vancouver, Stockholm and Singapore. These cities provide energy efficiency, clean sources of energy to the power infrastructure and public transport networks. In doing so, the cities are increasing the ability to cope without fossil fuels and alternative ways of living in building and healthier societies; however, are the cities adaptable and transformative and meeting the needs of the next generation?

Whatever the scale of urban development, the principles of sustainability of creating small ecological footprints to meet future generations’ needs must be applied (Brundtland, 1987; Siemens, 2020). However, this mitigation approach also needs adaptation to meet future generational needs. Zolli and Healy's (2012) framing of resilience becomes relevant as it considers both ecological and sociological origins as “*the capacity of a system, enterprise, or a person to maintain its core purpose and integrity in the face of dramatically changed circumstances*”. Section 2.1.1 outlines these sustainability principles but they must also be resilient (Section 2.1.2) to meet the future generational

needs of the built environment (Section 2.1.3), then progress in decision-making can be made (Section 2.3.5).

2.1.1 Sustainability in the urban built environment

Principles of sustainability have evolved through the pioneering actions of Rachel Carson (DeMarco, 2017), the Club of Rome (Meadows *et al.*, 1972), James Lovelock (2003) and the broader Green Movement; all bringing attention to the loss of biodiversity and global warming. All considered the relationship between environment and society as fundamental. The movement eventually resulted in the enactment of environmental laws to protect global ecosystems and global policies on climate change (Hays, 1982; DeMarco, 2017).

McDonough and Braungart's (1992, p. 4) Hannover Principles associate sustainability with the need *"to combine concern for the well-being of the planet with continued growth and human development"* and adopt the definition: *"Meeting the needs of the present without compromising the ability of future generations to meet their own needs.".* The Hannover Principles have developed a sustainability matrix which outlines eight categories: **materials, land use, urban context, water, wastes, air, energy and responsibility**. Each category is provided with several characteristics with a positive and negative effect but it comes with an explanation too, that: *"**Designing for sustainability requires awareness of the full short and long-term consequences of any transformation of the environment**."* (McDonough and Braungart, 1992, p. 4). McDonough and Braungart (1992) also discuss within the Hannover principles whether sustainable development

is actually achievable, the many conceptual interpretations of sustainability, the linear thinking of measurement frameworks and the contradictions that lifecycle analysis bring to the built environment and quantification of environmental responsibility. These issues have become concurrent themes in the literature review narrative (Sections 2.2, 2.4).

What connects a building with its context is the understanding of its site, the connections with public realm, community and infrastructure (DETR and CABE, 2000; Retzlaff, 2009). Walker et al. (2004) and Weinstein (2010) describe the practice of the understanding the site as sustainability science which aims to "*understand the fundamental character of interactions between nature and society* " (Kates, 2001, p. 641). Sustainable science led design must consider the context of the mesoclimates, microclimates and the local environment to optimise passive techniques to minimise energy consumption, so that renewable technology can produce clean energy for the building and if necessary feedback into the power infrastructure. Ideally, embodied carbon relates mostly to construction materials, resources and waste. Reducing embodied carbon means constructing buildings from materials found within (or near to) the site and not produce carbon emissions in its construction, produce waste materials or have a negative impact on the site (Green, 2012; WRAP, 2013; Green, Hope and Yates, 2015). However, operational energy and sustainable lifestyles are even more complex, as people spend 87% of their lives inside buildings and using energy, using water and producing waste (Klepeis et al., 2001).

Yet, decision-making of operational and embodied carbon relate to building Life Cycle Analysis (LCA) and bring more issues into the process (Ibn-

Mohammed et al., 2013). Human interaction in buildings is about behaviour, lifestyle choices and sustainable consumption (Shove, 2003; Barr and Gilg, 2006). A sustainable lifestyle should seek to reduce demands of water, energy and waste by promotion of self-sufficiency, reuse and recycling to led to positive feedback in natural cycles (Evans and Jackson, 2007; Phipps et al., 2013). Building in passive design strategies through the reduction of operational energy increases the ability for buildings to become more adaptable and engaged with the building occupants (Bordass and Leaman, 1997; Batty *et al.*, 2012; Kummitha and Crutzen, 2017). Recently in the 2019 Global status report for building and construction (IEA, 2019), there is an indication that buildings emissions are continuing to rise and outline influencing factors to an increase in global population, floor area, climatic variation and demand for space cooling and appliances. What this suggests is that passive design principles are not being implemented and no adaptability or flexibility is being introduced into design-making of buildings. If these principles are not being applied at a building level, then the scalar effect or urban sustainability is difficult to achieve.

2.1.1.1 Discursive theoretical interpretations

Dovers and Handmer (1992) adopt Brundtland (1987) to support their conceptual interpretations and define sustainable development as an,

> "*umbrella concept under which a complex array of interrelated issues can be gathered*" (Dovers and Handmer, 1992, p. 264).

They consider that the desired outcome is not one sustainable society, but many different yet sustainable societies. Four years later their definition of

sustainability has expanded to "*the ability of a human, natural or mixed system to withstand or adapt to endogenous or exogenous change indefinitely*"; thus, demonstrating that "*sustainable development is […] a pathway of deliberate change and improvement which maintains or enhances this attribute of the system, while answering the needs of the present population*" (Dovers, Norton and Handmer, 1996, p. 485).

Sustainability became recognised in terms of three pillars or the TBL: **Social, Economic, and Environmental,** where they are often considered to have an **equal relationship** (Elkington, 2004). Carruthers (2001, p.93) considers that: *"sustainable development of today bears faint resemblance to its point of origin. The language of sustainability was once a discourse of resistance, fusing radical environmental consciousness with a critical rethinking of a failed development enterprise. It provoked challenging questions about scarcity and limits, affluence and poverty, global inequality, and the environmental viability of westernization. By* ***today, sustainable development has been transformed, stripped of its critical content, and reconfigured for compatibility***".

Through considering organisational needs the narrative starts to take an economic bias. Stern (2004b) provides a history of the economical measurement of the Environmental Kuznets Curve (EKC) which was introduced in 1955 by Kuznets. The EKC illustrates the relationship between the development of the degradation of the environment with global economic growth. Torras and Boyce (1998) expand on this by indicating that economic growth will lead to better environmental performance over time. However, the Political Economy of the Environment is eventually considered as a defunct

relationship (Stern, 2004a). This position means that countries will achieve their individual turning points (development) and then start to develop better policies to combat the environmental degradation. However, it must be recognised that political shifts can change projections. In the UK, the Stern Review (2004) on the economics of climate change is now on its fourth edition (2008).

Yohe and Tol (2007) are critical of the report's implications on climate change policy and classify it as a risk because it has based its argument on misguided facts to silence sceptics rather than influence policy. Their main concern is that there is a case for emissions reduction without considering adaptation (when calculating impacts on water resources or damages that could occur due to sea level rise), and the economic growth between the living standards of developed and currently developing countries.

Beg *et al*. (2011) explore the linkages between climate change and sustainable development to conclude that sustainable development in this setting is failing because "*climate challenge does not feature prominently within the environmental or economic policy*" (p.142). Raworth (2012) outlines a broad approach to growth economics (Figure 2.1), which seems to have been more accepted that Stern's view and it is advocated by Oxfam.

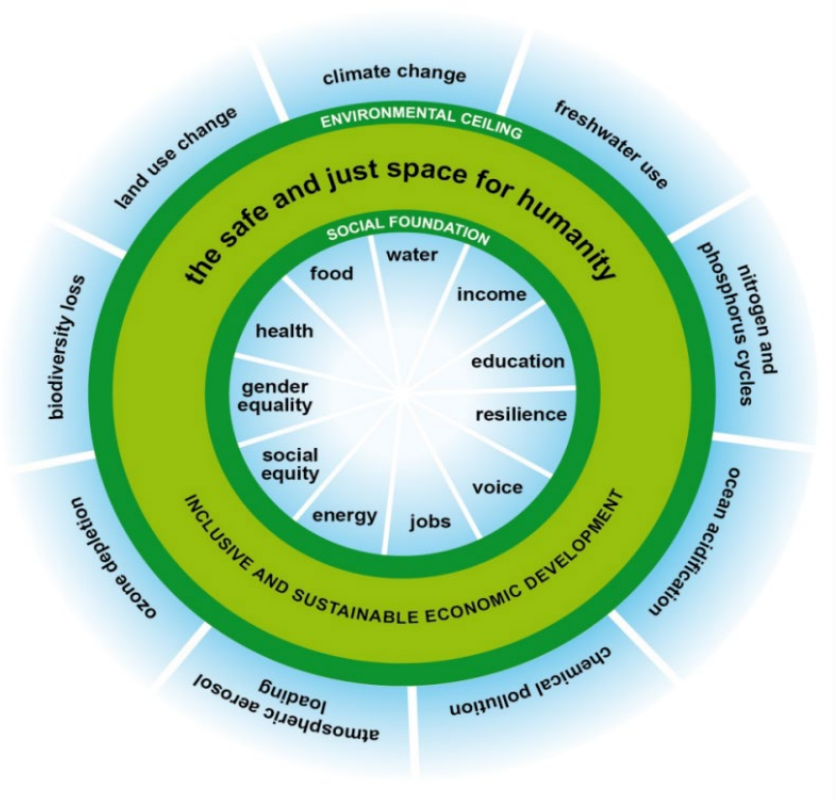

Figure 2.1 Oxfam's sustainability weighting (Raworth, 2012)

Raworth's coined phrase is the "doughnut" and places the social foundation at the centre, similar to Maslow's hierarchy of needs (Maslow, 1943), then with the environment (resources) marking the limit of the system. Anything that is on the outside edge of the environment is living beyond the earth's resources. This approach is unlike the Triple Bottom Line (TBL) that was promoted by Elkington (2001), who saw the equal relationship between social, economic and environment. Recently, the Forum for the Future, has expanded the sustainability definitions towards **five natural capitals: natural, social, financial, manufacturing and human** and the five capitals follow a systems model (Forum For the Future, 2019).2.1.1.2 Sustainable policy origins

The World Commission for Environmental Development (WCED) commissioned a report (Brundtland 1987) that outlined sustainable thinking to create a catalyst for change in global policies, which started with the Montreal Protocol (1987) and Hague Convention. Brundtland then synthesises the characteristics of sustainability (of the time) and consolidates the term sustainable development as,

> *"Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs"* (Brundtland, 1987).

In 1992, global leaders met at Rio de Janeiro to discuss the impact of economic development specifically on Brazil's rainforests. After many discussions, the United Nations created the Framework for the Convention of Climate Change (UNFCCC) which is also known as the Rio Declaration or Earth Charter (Sands, 1992).

Sustainability principles were outlined in the Earth Charter (ECI) and expanded by the Hannover principles (McDonough and Braungart, 1992; ECI, 2000). The ECI (2000, p.1) describes the global situation as follows, "*An unprecedented rise in human population has overburdened ecological and social systems. The foundations of global security are threatened. These trends are perilous—but not inevitable"*. Brandon (2002) called for more decisive action and definition when operationalising sustainability because past decisions have led to an unsustainable environment, thus creating a paradox. The paradox between sustainability and sustainable development has created decision-making conflicts between organisational management,

disciplines and sectors. In doing so, the need for frameworks that embed sustainable thinking into everything, was generated.

To focus the thinking about these issues, the **UN developed 8 Millennium Development Goals (MDG)** (United Nations Foundation, 2015), were expanded to **17 SDGs (comprising of 169 targets)**, framed within the 2030 Sustainable Development Agenda (United Nations, 2015b, 2015a). The goals are structured towards global, regional and national decision-makers. However, it is the challenge to reduce greenhouse gases to 80% of 1990 levels by 2030 that is a dominant message (Marchal *et al.*, 2012). In the document, it is specifically outlined that goals and targets will be followed up and reviewed using a set of global indicators (United Nations, 2019).

Twenty seven years later from the Rio Declaration, it is clear the SDGs are having some effect on carbon emissions but the global world is more polluted than ever before, as well as experiencing negative changes and needing to implement amendments to air pollutants with the Kigali Agreement (IPCC, 2014; Arneth *et al.*, 2019; UNEP, 2019). Although some declare the Paris Agreement a success (Rajamani, 2016), others consider political turmoil is still contributing to lack of good practice (Peters and Tanner, 2016). Barnett and Parnell (2016) express concerns about the SDG urban agenda not being significant enough because place-based policies are subjected to local power structures which can skew the advocacy of urban sustainable development, particulary in cities.

2.1.2 Resilience in the urban built environment

Recognising interpretations is important when considering the infrastructure of urban systems (Section 2.1.2.1). If an ecosystem has low adaptive capacity because it has less diversity then it is considered as being less resilient to disturbances, *"Ecosystems with low resilience may still maintain function and generate resources and ecosystem services- i.e. may seem to be in good shape - but when subject to disturbances and stochastic events, they may exceed a critical threshold and change to a less desirable state" (Folke et al., 2002, p. 34).*

When translating these principles into urban development, Folke *et al.* (2002) identify that many approaches are partial or short term and there is a need for adaptive management to build in capacities of Social Ecological Systems (SES) (Section 2.1.2.1). They consider that '*structured scenarios'* are a useful tool to provide active management in complex unpredictable systems. This critical observation creates a real tension between a desirable state of the SES that adapts to disturbances and slowly changing variables by pushing the system into a new state using efforts to reduce the risk of undesired shifts, fluctuations and disturbances (Smith and Pilifosova, 2001; Chelleri *et al.*, 2015).

Management of long term and short term goals needs to be carried out in tandem and at various spatial scales (Chelleri *et al.*, 2015; Platt, Brown and Hughes, 2016). Understanding whether adaptive capacity has been achieved requires dynamic monitoring of the system and provides opportunities for social learning.

> *"Flexible social networks and organisations that proceed through learning-by-doing are better adapted for long term survival than rigid social systems that have set prescriptions for resource use"* (Folke et al., 2002, p. 47).

Godschalk (2003) emphasised that everyone is vulnerable unless the infrastructure of cities and supporting systems are resilient too. Without resilient systems, cities cannot cope with severe shocks and that communities are an important part of coping during a stochastic event, *"community networks must be able to survive and function under extreme and unique conditions. If they break down, decision making falters and response drags"* (Godschalk 2003, p.2).

This interpretation of the term links to urban planning and infrastructure (Hassler and Kohler, 2014b), and resilience is frequently linked to an increase in adaptative capacity to climate change and hazard management (Klein, Nicholls and Thomalla, 2003). Klein, Nicholls and Thomalla (2003) define adaptive capacity as the ability to plan, prepare for, facilitate, and implement adaptation options. Subsequently, the term's meaning has evolved in practice as 'building things that last' (Goldstein, Peterson and Zarrilli, 2014; BRE, 2016a) and to be able to withstand a multitude of structural loading scenarios and survive hazard events. In recent times, the term "**passive-survivability**" (Wilson 2006) has emerged in building practice when considering how to manage extreme heat events and power failure in building air conditioning system design (Santamouris *et al.*, 2007; Baniassadi *et al.*, 2019).

Mileti (1999) discussed sustainable hazard mitigation and that infrastructure must be maintained and incorporated into planning decisions of the built environment. However, sustainable development must also consider how the world's resources are managed and used globally (Boyle, 2005; Ainger and Fenner, 2014). The technical literature has a broad spectrum of meaning, ranging from smart cities (Vanegas, 2003; Bătăgan, 2011; Domingue *et al.*, 2011; Batty *et al.*, 2012; British Standards Institution, 2014; Viitanen and Kingston, 2014; Kummitha and Crutzen, 2017), to building in efficiencies into infrastructure and making places prepared in response to disaster through the use of technology (Chang *et al.*, 2014; Institution of Civil Engineers, 2014).

2.1.2.1 Resilience theoretical interpretations

The interpretations of resilience are particularly convoluted and interpretations are various (Carpenter *et al.*, 2001; Reghezza-Zitt *et al.*, 2012; Wang *et al.*, 2020). Errington (1953) and Holling (1973) created the ecological interpretation of resilience, where Holling applied the term 'resilience' to ecosystems to consider how they manage uncertainties and since then, the definition of resilience has new meaning. Today, resilience theories have emerged into policy and centred on managing threats such as security and emergency management (Chmutina *et al.*, 2016).

Brand and Jax (2007) and Davoudi *et al.* (2012) discuss **that resilience has become a malleable concept, which is why many seek to define and quantify it** (Klein, Nicholls and Thomalla, 2003; Cutter *et al.*, 2008; Windle, 2011): 'Is something resilient?' is almost a semi-rhetorical question (Levine,

2014) and is often left open ended or undefined. There is a fierce debate about **what resilience means and there are theoretical fractures between its interpretations** (Bradley, 2016).

Chmutina *et al.* (2014) explore the reification of resilience and identify that the term has been largely **influenced by policy and decision makers**, rather than being a top-down consensual paradigm (Section 2.3). Chmutina *et al.,* (2014, p. 1) unpack the term to consider that "*resilience should not be seen as a consensual concept but rather as an unfolding ethical paradigm through which stakeholders create their own dynamic representation and meanings"*; they couple this notion with HB Kaplan's models of resilience in which he "*argues that resilience has generally been defined in two ways: a desired outcome, or as a process leading to a desired outcome*" (Chmutina *et al*, 2016, p. 71).

Levine (2014) and Carpenter *et al*. (2001) question **why we should even measure it, where others seek to determine indicators to support its measurement** (Cutter, Burton and Emrich, 2010; van de Ven *et al.*, 2016).

> *The United Nations has defined resilience as: "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management "* (United Nations, 2016, p.22).

Alexander (2013) adopts sustainability as a foundation for resilience by modelling 'social, environmental and social' concepts in the interpretation of resilience (Figure 2.2).

Figure 2.2 explicitly shows climate change, sustainability science, DRR, Hazards and risks together. This suggests a mutual relationship of adaptation and mitigation.

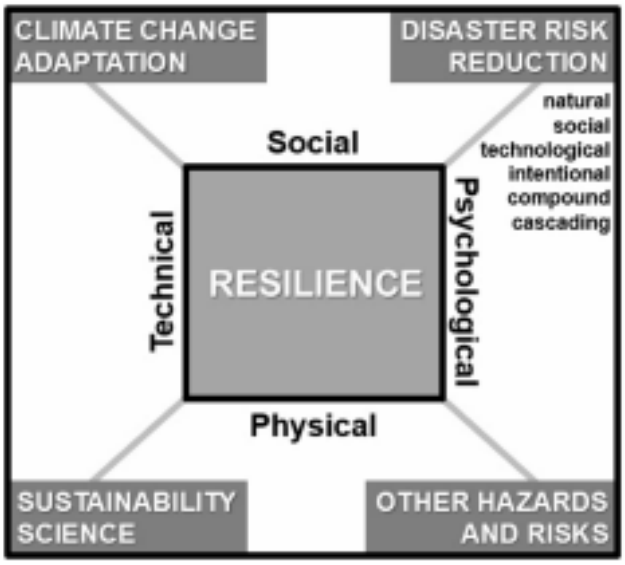

Figure 2.2 Diagrammatic relationship explaining resilience concept extracted from (Alexander, 2013).

Recognised in the theoretical literature are numerous permutations of the interpretation of resilience. Sharifi and Yamagata (2016, p.1) state resilience as "*a polysemic concept that has been defined differently in different disciplines and contexts*". This continued discussion leads to a theoretical contribution from Folke (2016) who has recently reaffirmed the original interpretation of resilience as described in Folke *et al.*, (2002, 2005, 2010), who declare that **sustainability and resilience have a coexisting relationship** and the theory has not shifted, and more importantly that it should not shift.

Handmer and Dovers (1996) introduced systems thinking to their understanding of the relationship between resilience and sustainability with reference to Lazslo (1972) and Von Bertalanffy (1968), stating that systems theory is relevant because it sets out a mutual relationship.

> *"recognition that any defined system will also be a subsystem is fundamental: that it is embedded in and related to a broader whole, and that a systems approach should not lapse into renewed reductionism*" (Handmer and Dovers, 1996, p. 486).

Dovers, Norton and Handmer (1996) also consider that to achieve the change in the system, an element of convergence and transdisciplinary behaviour is required and also expected because this demonstrates interdisciplinary response and common recognition,

> *"a systems approach thus demands recognition of interrelatedness and complexity, and an exploration and confrontation of what they might entail for endeavours in both science and policy"* (Dovers, Norton and Handmer, 1996, p. 274).

Handmer and Dovers (1996) express the change in the system as three resilience types, as summarised in Table 2.1. Type 1 claims that no action should be taken until evidence is presented. Type 2 adopts a political response and relies on a country's policies to change the system through sustainable development. Type 3 seeks a corrective response to deal with the root causes of the problems by changing the system to prevent or mitigate the effects of climate change and resource depletion. If resilience is interpreted to be open and adaptable, then there is high adaptability, low vulnerability, high preparedness and high mitigation occurring in the system (type 3).

Table 2.1 Resilience typologies (Handmer and Dovers, 1996, p. 496)

Resilience Type 1: Resistance and Maintenance	This is characterized by resistance to change. A management system of this type will do its utmost to avoid change and uncertainty, and enormous resources will be expected in maintaining the status quo. Threats will be identified, and anticipatory mechanisms put in place. Where proper reaction would threaten the status quo, appeals to ignorance are common: these are often expressed through calls for information, and an insistence upon inaction because of uncertainty. A society totally reliant on type 1 responses may be poorly equipped to deal with unexpected shocks of thresholds of change.
Resilience Type 2: Change at the margins	This is categorized by incremental change- change which does not challenge the basis of our societies, but which may lead to changes in emphasis at the margins. Where substantial change occurs, it usually serves the interests of the powerful elite, not necessarily those of the general population of the immediate environment, and rarely biosphere.
Resilience Type 3: openness and adaptability	This approach reduces vulnerability through a high degree of flexibility. Its key characteristic is an ability to change basic operating assumptions, and thus institutional structures, and adopt new ones. Of course, through history this has happened, but usually only in a slow and painful way. An adaptable society would be open to the possibility of moving in a new direction quickly and painlessly.

Considering typologies of resilience and systems thinking led to collaborative work of: Folke, Carpenter, Walker, Berkes, Kasperson, Holling and others for the world summit on Sustainable Development, which outlines SES thinking in '*Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformation'* (2002).

> *This collective group state the following: "Humanity has powerful interactions with biogeochemical, hydrological and ecological processes, from local to global scales. The complexity of social-ecological systems makes it necessary to abandon the perception of a global steady state. Instead, managing complex, coevolving social-ecological systems for sustainability requires the ability to cope with, adapt to and shape change without losing options for future development. It requires resilience- the capacity to buffer perturbations, self-organise, learn and adapt. When massive transformation occurs, resilient systems contain the experience and the diversity of options needed for renewals and redevelopment. Sustainable systems need to be resilient."* (Folke et al., 2002, p. 51).

From this thinking flow two consequences. Firstly, that the term SES encompasses human behaviour. Secondly, that sustainability and resilience 'coexist' in the same system. Consideration of resilience moves the discourse towards natural hazards and human-induced risk (Wisner *et al.*, 2003; Hood, 2005; Beck, 2009; Wisner, 2018). Consequently, resilience becomes the framework for managing risk and vulnerabilities as reflected in GAR 2015 (UNISDR, 2015a).

The literature refocuses on hazard management by anticipating risk in urban planning in order to eliminate uncertainty (Bosher *et al.*, 2007) or make it more secure (Chmutina, Bosher, *et al.*, 2014). This shift indicates that strategies to reduce the impacts of uncertainty and change should be developed (Beg *et al.*, 2002). This is not necessarily new thinking, as observed in 1996, "*At present our decision making systems tend to ignore uncertainty"* (Dovers, Norton and Handmer, 1996, p. 272) - and perhaps they still do. If consideration of uncertainty is to become a part of decision-making, the need for sustainability still exists;

> *"Managing for resilience enhances the likelihood of sustaining development in changing environments where the future is unpredictable and surprise is likely"* (Levin et al. 1998, Holling 2001).

Anderies *et al*. (2013) declare that sustainability is a mainstream subject and that sustainability and resilience are a combined framework. They outline the following for policy consideration and conclude that these concepts need to be aligned for global change,

> *"Resilience provides a framework to think about how multiple systems, each operating at their characteristic temporal and spatial scales, interact across scales. Finally, sustainability, as defined here, provides a framework to translate understanding of feedback systems into meaningful action through policy discourse."* (Anderies et al., 2013, p. 9).

However, it needs global policy to resolve conflicts in performance measures and practical implementation.

Multiple interpretations of resilience have led to a fracturing of the concept (Reghezza-Zitt *et al.*, 2012; Marchese *et al.*, 2018; Roostaie, Nawari and Kibert, 2019). Wang *et al.* (2019) outline that over 29 years of bibliometric data collected around the term resilience, it has seven modifiers of: Ecological, social-ecological, urban, climate, coastal, community and disaster but more importantly that each modifier is working independently because there is little recognition of shared references. With evidence growing in the resilience narrative that there is a wide range of interpretation, it is important that the meaning of the term is theoretically discussed widely but as an umbrella concept and mutually supportive to sustainable development (Folke *et al.*, 2010).

SES was introduced to the narrative and how SESs cope with threats also needs to be recognised because this how resilience and sustainability have been measured (Meadows *et al.*, 1972; Carpenter *et al.*, 2001; Walker *et al.*, 2004; Meadows, 2008; Quinlan *et al.*, 2016a). SES behaviour is frequently ascribed to a range of characteristics: **adaptive, adaptive capacity, vulnerability, uncertainty, sensitivity to transformation, and hazard mitigation, all of which can be considered**

part of the umbrella term resilience. Multiple interpretations exist around each term, for example adaptative capacity has been discussed in the following way:

Adaptive capacity can be increased through diversity; the greater the diversity in the systems, the greater the ability to cope with a high levels of disturbance (Folke *et al.*, 2002, p. 25). Holling (1973) outlines the principle that diversity relates to the number of functional groups and the overlapping of functions "*a resilient ecosystem contains functional groups with several species that perform a similar function, but respond in different ways to environmental changes*" (Folke *et al.*, 2002, p. 26). The adaptive capacity of the social component of an SES is considered as *" the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups"* (Folke *et al.*, 2002, p. 17).

Smit provides definitions of the characteristics of SESs where adaptive capacity is "*the potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects or impact*" (Smith and Pilifosova, 2001, p. 894). Therefore, to build resilience to a threat, the underlying characteristics need to increase their adaptive capacity to cope with uncertainty and stochastic events.

Yohe & Tol (2002, p.1) go further by developing a working definition of adaptive capacity without adopting a one size fits all approach; their method was designed to "*assess the potential contributions of various adaptation options to improving systems' coping capacities by focusing attention directly*

on the underlying determinants of adaptive capacity". Their quantitative SES approach has been developed with determinants and scenario settings and leads to a system that will respond to "*variability and extreme events before they respond to gradual changes in the mean*." (Yohe and Tol, 2002, p. 26). This would be a useful tool for the interpretation of resilience and sustainability in practice. Their model has eight determinants which are listed as follows: **1) Scale, 2) Resources - total cost and distribution, 3) Institutions - structure, participation and criteria, 4) Human capital, 5) Social capital, 6) Risk spreading, 7) Information - management and credibility, and 8) Awareness**. However, from reviewing the literature related to adaptive capacity, measuring remains challenging in an urban environment because it is so dynamic. However, Brooks, Adger and Kelly (2005) adopt this definition of **vulnerability**,

> "*Vulnerability depends critically on context, and the factors that make a system vulnerable to a hazard will depend on the nature of the system and the type of hazard in question*" (Brooks, Adger and Kelly, 2005, p. 152).

Smit and Wandel (2006, p.286) provide further description that vulnerability has a broad range of determinants "*vulnerability of any system (at any scale) is reflective of (or a function of) the exposure and sensitivity of that system to hazardous conditions and the ability or capacity or resilience of the system to cope, adapt or recover from the effects of those conditions*".

Walker *et al.* (2004) acknowledge that scenario planning supports 'transformations' in decision making. Their adopted meaning of transformability is summed up here;

> "*Transformability is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable*" (Walker et al., 2004, p. 1).

Folke *et al*. (2010) suggest transformations occurs in three phases: 1) **being prepared for change, 2) navigating the transition by making use of crisis as an opportunity for change, and 3) building in resilience**, which are similar to the hazard management temporal scales of change (Table 2.1), "*the very dynamics between periods of abrupt and gradual change and the capacity to adapt and transform for persistence are at the core of the resilience of social-ecological systems*" (Folke *et al*., 2010, p. 1). Changes to a system can be naturally ordered from full transformational change, adaptable change, incremental change and then merely maintaining the system. However, what creates the **change is created by the context or the complex systems,** "*a perturbation can bring the system over a threshold that marks the limit of the basin of attraction or stability domain of the original state, causing the system to be attracted to a contrasting state*" (Folke *et al*., 2010, p. 2).

If the system has high adaptive capacity and a low vulnerability state, then it can cope with minor perturbations, but as the perturbation increases to crisis, the vulnerability increases and unless the system has high adaptive capacity it will transform. If the use of scenarios are adopted as outlined by Yohe and Tol (2002) variants occur within the system "*to envision alternative futures and the pathways by which they might be reached*." (Folke *et al*., 2002, p. 9). This will assist with identifying which parts of the system need to be maintained and which need to transform and will assist with building in

adaptive capacity to reduce vulnerabilities. However what interpretation of SES has filtered into LEED-RELi and decision making of the built environment? (A response can be found in Section 5.4).

Devereux and Sabates-Wheeler (2004, p. 232) consider that achieving transformation in the SES is equated with, "*the need to pursue policies that relate to power imbalances in society that encourage, create and sustain vulnerabilities*.". Reducing or sustaining vulnerability is complex and Bahadur and Tanner (2014) also indicate that to achieve a transformative SES response, people, politics and power need to come to the forefront. They identify gaps, using an urban context, and state that resilience is often employed without reference to its subjects but what is most critical to recognise is that the absence of common resilience metrics compounds poor decision-making (Section 2.3.2).

Hazards and associated risks are critical variables when considering resilience; but it is also critical to recognise that human behaviour is influential in reducing the stress of increased carbon emissions.

> *"Resilience tends to treat stressors as generated by basically unpredictable forces in nature, such as storms, climate change or forest fires. A forest cannot prevent fires or stop climate change. Humans can."* (Swanstrom, 2008, p. 18).

Wisner *et al.* (2005, p. 5) state that "*the natural and the social cannot be separated from each other: to do so invites failure to understand the additional burden of natural hazards, and it is unhelpful in both understanding*

disasters and doing something to prevent or mitigate them. Disasters are a complex mix of natural hazards and human action."

Both Wisner and Swanstom indicate that human actions should also be treated as a risk to mitigate but how is this managed in social reality? The synthesis of hazards and risks is complex, as both create the disturbances that initiate changes in the system. Wisner differentiates a disaster by being triggered by a geophysical or biological event or a "*link in a chain of causes*" (Wisner *et al.*, 2003, p. 7) and hazards are linked to social vulnerabilities as outlined by the PAR Model (Weichselgartner, 2001; Wisner *et al.*, 2003).

Wamsler (2008) associates vulnerability with DDR of communities 'at risk' in less developed countries, which returns the debate back to climate change and sustainable development (Beg *et al.*, 2002; Lorenz, 2004; Eriksen and Kelly, 2007; Tyler *et al.*, 2013). This direction of the literature focuses resilience towards humanitarian aid to support those most vulnerable to Risk and Hazards. However, there needs to be transformation of the global system that addresses the root cause of vulnerabilities and associated risk in urban environments and this requires sustainable development systems. Cutter *et al.* (2008) relate communities to sense of place and create the Disaster Resilience of Place (DROP) model to support better decision making of hazard management. Then the discourse shifts to focus on reducing vulnerability through social interaction with communities and geographical context but vulnerability is a part of the system (Cutter *et al.*, 2008; Norris *et al.*, 2008; Cutter, Ash and Emrich, 2014; Cutter, 2016).

Chmutina *et al.* (2014) also question what is happening in the built environment stakeholders for hazard prevention and create an Integrated Security Resilience (ISR) Framework. Vanegas (2003) and Georgiadou, and Hacking and Guthrie (2012) explore the context in which the built environment industries are the custodian to the 'life cycle' in practice. Considering life cycles highlights that sustainability through its multiple guises has one area of consensus which is that "*The status quo is not sustainable long term, and consequently, to achieve sustainability it must be changed.*" (Vanegas 2003, p.5363). Vanegas does not use the word resilience but describes the life cycle of a built environment as,

> *"Worldwide, the AEC [Architecture, Engineering and Construction] industry continuously (i) develops new and increasingly more technologically complex facilities and civil infrastructure systems, in both greenfields and brownfields; (ii) rehabilitates the ones that are deteriorated; (iii) expands, upgrades, and retrofits some that are operational; (iv) recovers and reconstructs those damaged by natural or human-made disasters; (v) remediates serious externalities associated with their construction and operation; (vi) restores, reconstructs, and preserves some that have historical or cultural significance; and (vii) deconstructs, decommissions, and demolishes those that have reached the end of their service lives"* (Vanegas, 2003, pp. 5363–5364).

When considering sustainability and resilience as part of a life cycle, there are similarities with the resilience typologies (Table 2.1). Points i) and vii) deal with the transformation phase and points ii) to vi) the incremental phase of resilience type 2. However, life cycles also involve social decisions that relate on varying scales: on a human scale it is choosing what type of product (constructed from materials) but when considered socially, it can expand to smart technology and its applications. People's interaction with technology can have a positive effect because smart meters or 'smart'

technology can provide feedback on how much energy is being consumed (when constrained to building use) and help reduce carbon emissions inciting climate change (Rubel and Kottek, 2010). However, when expanded to smart cities (Viitanen and Kingston, 2014) the societal behaviour can help communicate risks and prepare cities for hazard events.

Smith and Stirling (2010, p.2) consider that "*technologies help us monitor and understand our effects for how we understand social ecological resilience*". Acknowledging the role of technology is important but this perspective starts to expand or fracture literature towards organisations, systems management and measurement of resilience. For the position of this research, the use of technology and its effects on occupant behaviour or its role in DRR is beyond the scope as it progresses towards psychology and health. Godschalk (2003) makes the point that sustainable development must meet the needs of future generations "*but it can not be successful without enabling cities to be resilient to natural hazards"* (Godschalk, 2003, p. 3). Cities and the urban context provide the sustainability and resilience agendas with a foundation to bring all the theoretical variables together but for some the behavioural social or human shift needs technology and resources (Section 2.2.3). All these different interpretations of resilience and its various subcomponents have actively been measured in policy and practice in cities (Section 2.2.3) but which interpretation remains an issue (Section 2.3.2).

2.1.2.2 Resilience policy origins

Resilience interpretations emerged in policy at the World Conferences on **DRR** in Yokohama (IDNDR, 1994), and again in Kobe with the launch of the

Hyogo Framework (United Nations, 2005). In response, countries have been encouraged to produce **National Adaptation Plans** (NAPs). Fifteen years later, the Hyogo Framework was revised and extended into an international strategy for DDR (United Nations-General Assembly, 2016). This led to the UNDRR launching the SFDRR (2015) to incorporate 'resilience' into decision making and sustainable development (UNDRR, 2018).

Achour *et al.* (2015) consider that many countries have developed strategies through sustainable building designs and that resilience has led to **disaster prevention plans**, and in doing so resilience has remained at a theoretical level and not implemented fully; "*resilience and sustainability are often approached as two separate issues, which led to predominance of sustainability over resilience*" (Achour *et al.*, 2015, p. 358). However, recently resilience has become a focus globally (Section 1.2, Figure 1.2) and its relationship with sustainability has shifted, yet the relationship between both concepts is critical for good decision-making.

2.1.3 Urban interplay

To optimise sustainability science in design, the sustainable built environment must reflect a relationship with urban context (Section 2.1). Over time, urban context has become more socially complex, as consideration of data connections, traffic congestion, air pollution, crime, power cuts, sanitation, social care, water supply, waste and many other factors all need attention (Kenworthy, 2006; Batty *et al.*, 2012; Cole, 2014; Vaughan, 2018). Delivering utopian ideas such as the City of Tomorrow (Dzwierzynska and Prokopska, 2017) becomes conflicted with its living reality; existing urban

morphology of cities include social, cultural, political and economic disparities (Talen, 2003; Brenner, 2009; Vaughan, 2018). As critical theory of urban planning becomes more relevant due to disparities, it was observed in the narrative that these issues are politically orientated (Brenner, 2009; A. Bahadur and Tanner, 2014; Vale, 2014).

Evaluating how influential political thinking has influenced the generation of a sustainable built environment is difficult and needs a full systematic review of policy at many decision-making levels (Chmutina *et al.*, 2016). Sustainable urban development has been recognised in global policy with the SDG 11 (United Nations, 2015b) which subsequently raises issues about how to reduce disparities and achieve low carbon cities (Thornbush, Golubchikov and Bouzarovski, 2013; Peters and Tanner, 2016).

Asking these questions, starts to point towards who translates urban policy into practice. Fainstein (2000) articulated that urban planning broadly has three categories 1) the communicative model, 2) the new urbanism, and 3) the just city; but most importantly, despite these typologies there is a greater issue to address in achieving widespread improvement in the quality of human life and that is with the planning process (Fainstein, 2005; Santander and Garai-Olaun, 2016).

> "*Differences among the types reflect the enduring tension within planning thought between a focus on the planning process and an emphasis on desirable outcomes……" (Fainstein, 2000, p. 452)*

However, urban morphology is also complex (Talen, 2003), and historically, most policies have not placed social responsibility or sense of place at the centre of decision-making (Mileti, 1999; Cohen, 2014; Angelo and Du Plesis, 2017; Vaughan, 2018). Socially, Cutter *et al.* (2008) identified the role of communities in decision-making and that the sense of place is critical. Childers *et al.*(2014) outline the challenges faced by delivering urban sustainability because it goes beyond sectoral thinking:

> *"Urban sustainability is rapidly expanding beyond interdisciplinary approaches to include transdisciplinary because human and biophysical structures and dynamics are inextricably linked in cities."* (Childers et al., 2014, p. 326).

Childers (2014) describe that **to advance urban sustainability there needs to be more inter-city comparisons, contexts and feedback in decision-making** *"(1) inter-city comparisons must represent different contexts of environmental change, different economic contexts, different social/cultural contexts, and therefore, different positions along a gradient of vulnerability and collapse, and (2) the concept of sustainability itself must be treated as a process, not a utopic terminal state, with feedbacks that account for "system learning*" (Childers *et al.*, 2014, p. 326).

Feedback in systems thinking is becoming more critical in the urban environment. Ahern (2013) outlines that to achieve urban sustainability there is a both a relationship with resilience and a requirement of strategic systems level thinking for planning and design, but this type of thinking contrasts fundamentally with fixed rules or processes.

> *"Resilience theory advances the discourse on urban sustainability in a non-equilibrium context by focusing on how cities build the capacity to respond to change and disturbance."* (Ahern, 2013, p. 1210).

It is not coincidental that there is a narrative shift from urban sustainability towards building capacity to cope with disruption, but as this shift occurs the breadth of meaning and interpretations of urban resilience expands (Ahern, 2011; da Silva, Kernaghan and Luque, 2012; Hale and Sadler, 2012; Stumpp, 2013; Wang *et al.*, 2020). Meerow *et al*. (2016) identify 25 definitions on urban resilience from different perspectives and their publication influences. Godschalk's definition (2003) was considered the second most influential definition from their collected data,

> *"A resilient city is a sustainable network of physical systems and human communities…[where]…"physical systems are the constructed and natural environmental components of the city" (*Godschalk, 2003, p. 137)*.*

Wang *et al.* (2019) describe that the term urban resilience is mostly linked to sustainability, complexity and vulnerability of urban systems. The SES resilience literature in an urban context starts to take on the character of a system or network of systems. The following two definitions have been considered,

> *"urban resilience refers to the ability of an urban system and all its constituent social-ecological and socio-technical networks across temporal and spatial scales to maintain or rapidly return to desired functions in the face of disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity"* (Meerow, Newell and Stults, 2016, p. 45)*;*

> *"The ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions (IPCC 2013)"* (Basyouni, 2017)

Further observed in the language discourse is that resilience is described in terms of "acute shocks" or "chronic stresses" and of direct and indirect impact (da Silva, Kernaghan and Luque, 2012; Rogers *et al.*, 2012; Collier *et al.*, 2014; Basyouni, 2017) which relates to the extreme and incremental phases of change identified. The following two definitions have been considered,

> *"Acute shocks - are the sudden sharp events that threaten a building, including earthquakes, floods and terrorist attacks. Chronic stresses - weaken the fabric of a building day to day. Examples of these stresses include impacts of both climate change and resources and energy scarcity."* (Basyouni, 2017, p. 482)*;*
>
> *"The direct impacts of climate change take the dual form of shocks, sudden impacts such as storms, typhoons and heat waves, and stresses, impacts that build gradually over time such as sea level rise, general temperature increase and changes in rainfall patterns. Such events will in turn generate a cascade of indirect effects, eroding the city's capacity to adapt as a result of significant disruptions in the socio-technical networks essential for city functioning"* (da Silva, Kernaghan and Luque, 2012, p. 126).

Chang *et al*. (2014) further discuss how to maintain infrastructure during a crisis, as infrastructure is required for access, water and sanitation, and to provide energy for warmth or cooling, and food security (da Silva, Kernaghan and Luque, 2012; Desouza and Flanery, 2013; Cole, 2014).

Examining design practice of sustainability and resilience in urban development is also critical because of the relationship with context (Section 2.1). El Basyouni (2017, p.482) identifies that if buildings are designed with a

sustainability focus then resilience can be an outcome to "*bridge the gap between disaster risk reduction and climate change adaptation*".

Collier *et al*. (2014) and Rogers *et al*. (2012) seek to 'build resilience' into the urban environment. They consider cities and respective infrastructure as multiple components of static and dynamic systems that are interconnected directly and indirectly on several levels. "*This means finding ways to prepare for an uncertain range of hazards and threats and increasing the ability of urban systems to cope with the resulting shocks and stresses*" (Collier *et al*. 2014, p.80). Thus, building resilience into the system must address one or more of three responses as outlined,

> *"Mitigation: The system will be affected by a particular shock or stress at a level that is able to be mitigated (e.g. a flood protection system stops any impact).*
>
> *Adaptation: The system will adapt to a particular shock or stress (e.g. the flood overwhelms the system, but the citizens are prepared and there is little impact).*
>
> *Disaster management: The system will be heavily affected by a particular shock or stress, and disaster risk management will be required (e.g. the system is overwhelmed, so disaster response measures are initiated)"* (Collier et al. 2014, p.82).

Perspectives of urban resilience with building resilience into cities and infrastructure may act symbiotically and benefit from system dynamic thinking and measurement in developing strategy. Bahadur *et al*. (2016) discuss that components of any city resilience strategy should be linked back to theory. Underpinning all the built environments are infrastructure systems; these, "*are essential for cities to withstand and rapidly recover from natural and human induced disasters, yet electric power, transportation, and other*

infrastructures are highly vulnerable and interdependent" (Chang *et al*., 2014, p. 416).

The literature on urban infrastructure and urban resilience promotes the idea that hazard mitigation, through planning for preparedness, and development recovery from a disaster, create an opportunity for sustainable development (Godschalk, 2003; Wamsler, 2008; Rogers *et al.*, 2012; Grinberger and Felsenstein, 2014). Wamsler (2008) discusses urban resilience in terms of the risk to those most vulnerable to natural hazards and disasters and seeks to achieve a better understanding of the underlying factors of risk and disaster occurrence in slums and their coping strategies. Grinberger and Felsenstein (2014) observe that **when cities respond to recovery, different urban processes rejuvenate at different speeds. Thus, there will be inherent conflicts between components of sustainable development and urban systems**.

Conflicts start to appear in decision-making because planning needs to be both proactive and reactive (Vale, 2014). The challenge starts with how to create better decisions because there are political conflicts in the decision making process between policy and practice, and conceptual conflicts in regards **to which version of resilience and sustainable development is being employed by policy and influencing practice** (Chmutina *et al.*, 2014; Vale, 2014; Lizarralde *et al.*, 2015). Not many consider the critical junctures of decision-making and why systems feedback is not being generated but it is imperative that this starts to happen (Ahern, 2013; Chmutina, Bosher, *et al.*, 2014; Capoccia, 2015).

When sustainability and resilience are truly understood, there are critical junctures everywhere; some fracture and some unite between use of language in theory, policy and practice (Chmutina *et al*, 2016; Chmutina, Meding and Bosher, 2019). When asking questions of how sustainability and resilience relate to one another, some may suggest that they are separate issues; where sustainability is about the measurement of sustainable development and resilience is wholly a DDR term, others will argue that one cannot be without the other as part of a system.

2.2 Measurement

As the narrative review was explored the theme of measurement was regularly repeated (Carpenter *et al.*, 2001; Magis, 2010; Béné, 2013; Levine, 2014; Quinlan *et al.*, 2016b). Frameworks have been built around conceptual interpretations of sustainability and resilience, which in turn support decision-making in the built environment (Section 2.3.5). **Which conceptual interpretation** of resilience is being measurement is a particular issue because there is a large variation in **what** is being measured (Table 2.2). This section considers the measurement of sustainability (Section 2.2.1) and resilience (Section 2.2.2), before considering the interplay of both concepts in cities (Section 2.2.3).

2.2.1 Sustainability

Providing explanations to the meaning of sustainability has led to the quantification of sustainable development. William Rees and Mathis Wackernagel pioneered a quantification system called ‘”Ecological foot-

printing" (Wackernagel and Rees, 1995; Wackernagel *et al.*, 1999). Despite its age, it holds relevance today because an ecological footprint calculates the human demand on the biosphere in terms of land required for energy, crops, grazing, forest, urban settlements, and fish. This quantification method has rapidly led to a creation of the Global Footprint Network (GFN), which aims "*to help countries, businesses and institutions operate within the Earth's limits"* (Wackernagel, 2009, p. 86) and to identify the impact of their lifestyle choices in footprint units of: 'how many planet earths?'. By being sustainable (living within the planet's limits) equates an individual's footprint to one planet or less. A standard for the calculation of footprint defined by responses to questions on food, shelter, mobility, goods and services was produced by the global ecosystems network in 2009 (Global Footprint Network, 2009).

Expedited by Brundtland's definition of sustainable development (1987) were the Hannover Principles (McDonough and Braungart, 1992). McDonough (1992) provides a platform to design for sustainability and expresses that,

> *"Sustainable design is the conception and realization of environmentally sensitive and responsible expression as a part of the evolving matrix of nature"* (McDonough and Braungart, 1992, p. 4).

The Hannover principles are: 1. Insist on rights of humanity and nature to co-exist 2. Recognize interdependence. 3. Respect relationships between spirit and matter. 4. Accept responsibility for the consequences of design. 5. Create safe objects of long-term value. 6. Eliminate the concept of waste. 7. Rely on natural energy flows. 8. Understand the limitations of design. 9. Seek constant improvement by the sharing of knowledge.

Within the built environment, quantifying the impact of development led to the Building Research Establishment (BRE) (1990) launching ‘EcoHomes’, the UKs first voluntary environmental assessment method. The Civil Engineering Environmental Quality Assessment (CEEQUAL) followed in 2003 for public realm and civil infrastructure (CEEQUAL, 2019). These schemes facilitate the professional design process to progress towards a sustainable solution.

Facilitating the aims of sustainable building design have become epitomised by ‘Building Environmental Assessment Methods’ (BEAMs) systems such as LEED (Section 2.2.5), Building Research Establishment Environmental Measurement (BREEAM) and Passivhaus (Green, Hope and Yates, 2015). The latter concentrates on a standard of performance that mobilises passive design approaches, such as low U-values of the thermal envelope, natural ventilation and daylighting to achieve zero carbon outcomes (Passivhaus Trust, 2019). How sustainable the outcome is, is then determined by the sustainable design approach supported by the BEAM and the credits that have been chosen from the measurement system.

To provide an example of a BEAM, EcoHomes uses 10 categories of credits (where a credit is a design choice leading to a building becoming a better than “normal” building) and weights them to their importance in satisfying the sustainable agenda in the UK: Management (12%), Health and Wellbeing (15%), Energy (19%), Transport (8%), Water (6%), Materials (12.5%), Waste (7.5%), Land Use and ecology (10%), Pollution (10%), and innovation (10%). The weighting of these systems influences design practice and policy (Hammond *et al.*, 1995).

In practice, BEAMs are used to define design targets and appropriate strategy (Green, Hope and Yates, 2015). They have "*contributed enormously to furthering the promotion of higher environmental expectations and are directly and indirectly influencing the performance of buildings*" (Cole, 2005, p. 456). Developments are driven by budgets, so 'quick wins' are targeted without considering a building's operational legacy and the people within (Abdalla, Maas and Huyghe, 2011; Bordass and Leaman, 2013; Green, Hope and Yates, 2015; Leach *et al.*, 2015).

> Cole (2005, p.457) also identifies that "*because of their success, building environmental assessment methods have dwarfed all other mechanisms for instilling environmental awareness within the building industry*" and ultimately have not led to diverse approaches of sustainable practice.

To achieve improved efficiencies, economies of scale and a sustainable outcome, sustainable building design and renewable technologies need to work in their context of place, thus the scale, e.g. a community, a city or ecosystem is important to consider (Fankhauser, Kennedy and Skea, 2009; UK Green Building Council, 2019).

The results of 'green building methods' have created a spectrum of "green" buildings where one end is considered to have sustainable or "zero" impact, and the other is a mild improvement on standard building regulations (Burnett, 2007). However, "*achieving sustainability in buildings is not primarily about absolute performance. Ultimately, sustainable design is more about adaptability, resilience and user understanding*" (Green, Hope and Yates, 2015, p. 8), suggesting synergies with the resilience agenda.

Measurement systems have evolved over 30 years and been adopted by developed and developing countries; they have shaped how sustainability as a concept has become a measured entity in practice (Marjaba and Chidiac, 2016). Box 2.1 outlines that the World Green Building Council (WGBC) has supported the development of BEAMs in 74 countries.

Box 2.1: World Green Building Council (WGBC) – nationalising the measurement of sustainable development

Created in 2002, the WGBC (World Green Building Council 2017) currently supports **74 countries in developing their 'Green Building' Practice** (USGBC, 2013) and provides a global network to facilitate buildings committed to supporting the UN SDGs. The 74 members have created **38 established building programs**, of which LEED, BREEAM, and Green Star are the most dominant ones, with the overall certification of 1.04 billion m^2 of green building space (World Green Building Council, 2016).

Established BEAMs are now able to assess the benefits of their impact (Armitage and Monchuk, 2007). BREEAM reports that in 25 years of operating (BRE, 2016a), it has certified 538,000 buildings but does not disclose what percentage have achieved an excellent or outstanding rating outcome. It has taken 30 years for design practice to embed sustainability into the UK's RIBA design process (Sullivan, 2012; RIBA, 2013). How the industry moves forward with sustainability embedded into its practice will impact other professionals and design methodologies, which will need to be revised.

LEED is a tiered rating scheme with a number of credits to be awarded across categories, where compliance with credit requirements leads to points being awarded. To achieve a minimum accreditation, the design team must meet the performance standards in the prerequisite credits, which achieves a

‘pass’ standard. The best certification standard is ‘Platinum’ where nearly all the credits are met, then below that performance is subsequently tiered as Gold, Silver and Bronze. LEED Accredited Professionals (APs) are qualified professionals who become custodians of LEED in the design, construction and operation process and provide appropriate advice on how to achieve certification.

The universal LEED requirements are provided in manuals, which are operating at ‘version 4.0’. The LEED Building Design and Construction (BDC) version 4.0 and LEED Neighbourhood Development (ND) version 4.0 have been considered as appropriate for this narrative analysis. LEED’s BDC categories are: ‘sustainable sites’, ‘water efficiency’, energy and atmosphere, materials and resources, indoor air quality, ‘innovation and design process’, and ‘regional priority’. LEED’s ND categories are: ‘smart location and linkage’, ‘neighbourhood pattern and design’, ‘green infrastructure and building’, ‘innovation and design process’, and ‘regional priority credits. Credits are chosen from these manuals by the LEED AP, bespoke to the project and then credits are targeted dependant on meetings with inter-disciplinary design teams.

Garde (2009) reports that the greatest benefits of LEED-ND come when gold or platinum certification is achieved, yet, planners need to develop local strategies to promote sustainable development to reduce limitations in decision-making of neighbourhoods. LEED-ND could have the potential to cross into zoning codes but there are political barriers to be overcome (Smith, 2015; Garde and Kim, 2017). LEED remains the most used global

framework for sustainable development, and the USGBC reports it is piloting city-based work (USGBC, 2019).

However, what BEAMs do not yet do is consider hazard mitigation, unless the LEED-RELi credits are operationalised (Box 2.2) (Matthews, Sattler and Friedland, 2014; University of Minnesota, 2015; Champagne and Aktas, 2016; Marjaba and Chidiac, 2016).

Box 2.2: Practice of resilience using LEED

The C3 Living project has already created a resilience framework and recently created draft compulsory **(RELi) credits for the LEED manuals** (C3 Living Design Project, 2019). However, despite LEED's international reach, it is only one rating system and countries would need to develop localised approaches. Then there is the spatial scale of application, there appears to be a huge gap; there needs to be a **city level assessment of how cities are delivering the sustainable and resilience concepts, but LEED cities and communities have only started to fill it** (USGBC, 2019).

The LEED RELi Credits are IPpc98: Assessment and Planning for Resilience where potential hazards needs to be assessed with location in mind; IPpc99: Design for Enhanced resilience where mitigation strategies are implemented for the top three hazards in IPpc98; and IPpc100: Passive Survivability and backup power during disruptions, which outlines the principle that a liveable temperature is maintained in the building for extendable periods of time without the use of active systems (USGBC, 2019). The development of LEED-RELi indicates that resilience can possibly be qualified using hazard scenario planning and quantified when using sustainable development measurement platforms (Section 2.3.5).

2.2.2 Resilience

Carpenter *et al.* (2001) described a position where resilience was unmeasurable because it has a cause and effect, and subsequently coined the phrase of ‘resilience of what; to whom?’’ In contrast, another argument for explicit quantification of terms developed (Eriksen and Kelly, 2007). Consequently, a debate about how to measure resilience ensued about which characteristics led to measurable entities. In determining which are measurable characteristics, Levine’s explanation that resilience does not mean one single thing (Levine, 2014) resonates because the concept is truly multifaceted and multi layered, or a process, an outcome or both. Wang *et al.* (2019) confirm how diverse resilience terminology has become, yet there are those who continue to measure it (Table 2.2).

Resilience policy is encapsulated by the SFDRR, which is geared towards managing vulnerability, adaptability and incremental risk from disasters (Section 2.1.2.2). It focuses on prevention and preparedness through better planning and communication. The common theme is that information sharing of multiple hazards needs to happen and prevention is generated through ‘warning’ systems. The understanding of the SES is enhanced through a focus on ‘hazards’, which entrains the social technological system and materials to link to sustainable organisation and measurement.

Chandler (2017) offers a neoliberal perspective that there needs to be consideration of social culture and the environment, which are not easy things to quantify or even change, but without them decisions to build in resilience (or even measure it) cannot be made. The issue is exacerbated

because "*solutions to urban problems are increasingly being sought at the local rather than the state or national level"* (Cohen, 2014, p. 78).

Box 2.3 outlines that there are more than 39 frameworks measuring resilience.

Box 2.3: 39+ Frameworks measuring resilience

The ODI (2016) inventory and analysis of **39 resilience measurement frameworks** incorporates varying scales of measurement including: household, community, national systems, and urban. The number of frameworks highlights that many approaches to resilience are being developed and not all relate to the NAPs. The variety and volume of frameworks, starts to follow the theme about too many definitions and meanings (Section 2.3.3) (Levine, 2014).

However, it is more critical to understand 'which interpretation' of resilience has been measured and whether sustainable development is included in the NAP, as it must be integrated with the response to resilience. Although there is a need for development markers to qualify and quantify measures of resilience in the built environment, such markers need encompass many global issues on a local scale (Adger *et al.*, 2013; Levine, 2014).

From the many measurement frameworks identified by ODI only three consider urban context or specific relevance to cities. Through further literature searches, 13 frameworks have been sourced and their brief descriptions outlined (Table 2.2). The two frameworks with greatest global recognition are discussed in more detail: C40 and 100RC (Section 2.2.3).

When examining Table 2.2, there are two main approaches to quantifying understanding of risks and vulnerabilities in present settings. Firstly, by ranking risks and vulnerabilities using such schemes as City Risk Indicators

and World Development Indicators (WDI) (Lloyds and University of Cambridge, 2015; World Bank Group, 2017). Secondly, by utilising local governance frameworks such as C40 and 100RC.

Table 2.2 Outline descriptions of thirteen frameworks at urban or city scale

Identified Frameworks or Indexes	Outline Description
100 Resilient Cities / City Framework (Da Silva and Moench, 2015),	Measured in 4 categories, 12 Goals, 52 Indicators and 156 variables. Four categories are: 1) Leadership & strategy, 2) Infrastructure & ecosystems 3) Economy & society and 4) health and wellbeing.
C40 Cities (C40 Cities, 2016a)	It is a collective group of 96 cities across the world and is actively monitoring and evaluating their performance. It has developed 7 initiatives: Adaptation and Water, Energy, Finance and Economic Development, Measurement and Planning, Solid Waste Management, Transportation and Urban planning and development
Making My City Resilient Campaign (MMCRC) (UNISDR, 2010)	Launched in 2010 this program is based on 10 essentials for Making Cities Resilient: A handbook for local government leaders' and assessment tools which include; local government self-assessment tools (LGSAT), city resilient scorecard- a tool for disaster resilience planning and new draft indicators for local risk reduction and resilience.
12 cities assessment (Buro Happold, 2016),	Derived by case study cities, it has produced a framework that results in a resilience rating to assist municipal authorities, private or public sectors in assessing their current and future resilience demands and capacities. The rating connected to a cost and benefit analysis of hazard impacts compared to the cost of inaction. It measures 3 groups with a total of 12 indicators.
Lloyds City Index (Lloyds, 2019)	Lloyds supported by Arup has produced a 'Future cities' report with the aim to "develop a new set of principles to guide planning, design and construction and operation of city infrastructure to improve resilience". Lloyds has predicted that "$4.6 Trillion of projected GDP of 301 of the world's leading cities is at risk from 18 threats over the next decade."(Lloyd's 2015, p.5)
ACCCRN (Asian Cities Climate Network, 2019)	Established in 2008, with Rockefeller financial support and Arup. An established group of 10 cities to manage regional resilience. The network's technical material provides advice through a series of 'design, construction and renovation' sheets for a variety of hazards which are geared towards 'low-income' groups. The cities resilience framework consists of 5 core elements to build resilience: 1. Engagement, 2. Assessment 3. Planning 4. Action and 5. Learning.
TAMD (Brooks *et al.*, 2013)	An operational framework for Tracking Adaptation and Measuring Development produced by Brooks ***et al***. (2013). It aims to support national and local policy decision makers using scorecards with 9 indicators that have associated credentials. The score is achieved through a 'yes', partial or no response.

Resilience.io **(Passmore and Schmidt, 2018)**	An integrated systems open source platform 'tool' to enter in data to understand a system's 'performance' and how to make better decisions regarding resilience and sustainability across spatial scales: City, regional, national, global.
Happy City Index (Happy City , 2019)	Established in 2010 due to the evidence of need from Public Health England and the office of national statistics (Lewis and Abdallah, 2016). *The framework creates personal wellbeing as the central purpose with six other domains:* economy, education and childhood, equality, health, place and social relationships). It provides 60 wellbeing indicators to create a thriving place.
Global Indicators by World Bank (World Bank Group, 2017)	The index ranks countries for their resilience to disruptive events. It considers natural hazards, social, political and economic events over a year and uses data from International Monetary Fund (IMF), the World Bank, the World Economic Forum (WEF) and the U.S. Energy Information Administration (EIA), the UN and Freedom House to calculate the rankings.
RELi **(University of Minnesota, 2015)**	A framework that provides an action list and credit catalogue (University of Minnesota, 2015) and was pioneered in 2014. The interpretation of resilience is considered as 'the resilience design pattern' described as metapatterns: resilience, restoration, regeneration, sustainability and wellness. (C3 Living Design Project, 2019). The credit list is grouped into 4 categories with sub categories which are listed as below (University of Minnesota, 2015): Panoramic Approach- planning, design, maintenance and operations; Risk Adaptation and mitigation for acute events- hazard preparedness, hazard adaptation and mitigation; Community adaptation+mitigation for a resilient present and future- community cohesion, social and economic vitality, Productivity, health and diversity, Energy, water and food, Materials and artefacts; Applied creativity and contextual factors for resiliency- applied creativity, innovation and exploration.
LEED Cities (USGBC, 2019)	Launched in 2019. *"A new way forward for resilient, green, inclusive and smart cities*" and connected to the LEED V4.1 for communities. The system is currently being used in 90 cities across the world. LEED provides both process and outcomes of performance standards of sustainable development.
Resilient Cities **(Barkham *et al.*, 2014)**	Provide a positional overview of resilience in cities and seek to measure resilience through interpreting vulnerability and adaptive capacity.

Design practice has developed the LEED framework, which aims to unite resilience and sustainability in project decision-making with the launch of LEED-RELi (Wilson, 2018). Some frameworks have not been adopted or developed beyond their original purpose because they are either too complicated or on further investigation of the complexities of resilience lead

to a belief that it should be only qualified not quantified (Brooks *et al.*, 2013; Barkham *et al.*, 2014; Williams and Clear, 2015; BRE, 2016a).

As understanding which definition of urban resilience is being measured between policy and practice is important. Table 2.3 has examined the frameworks that measure urban or city scale resilience. This has generated a range of KPIs but there are different approaches, and this makes a comparison difficult and increases the complexity of decision-making.

Despite the prominence of some of the city frameworks and their application, there is little comparative evidence on the outcomes. Until a further examination of interpretations and meanings in practice is assessed, it remains unclear whether it needs to be quantified to improve decision making because there is **lack of feedback** into the decision-making system (Cutter, Burton and Emrich, 2010; Constas *et al.*, 2014; Quinlan *et al.*, 2016b).

Recently, the 100RC has started to process what it has achieved with its cities and issued *Resilient Cities Resilient Lives: Learning from the 100RC Network* (100 Resilient Cities, 2019). Yet, the measurement interpretation of resilience and sustainability could have significant consequences with regards to managing changes as discussed by particularly relating to city planning and building design (Hammond, Keeney and Raiffa, 1998).

What becomes apparent in the drive for measurement frameworks is that more social interaction is required. Vale (2014) considers this axis of preventative and reactive thinking required in decision-making as a political challenge, because currently urban planning processes do not represent social behaviours accordingly nor the local environment, which needs to be

addressed (Alexander, 1977; Rosenzweig *et al.*, 2010; Frankenberger *et al.*, 2013; Rosenzweig and Solecki, 2014; Angelo and Du Plesis, 2017).

Table 2.3: Six frameworks main indicators grouped into themes and compared for KPIs. This table represents the KPIs from each framework, where some frameworks use numerical lables and others provide listed points.

Pathway Themes	TAMD Indicators	12 City BRE Indicators	City framework Goals	MMCRC Points	Resilience.io Groups
Governance	*2- Climate risk management coordinated across institutions;* *4- Knowledge development and Training of climate change issues;* *9- Risk spreading mechanisms*	*Leadership & Government;* *Security & Safety;* *Business & Trade;* *Skills & Innovation*	*Effective Leadership;* *Empowered Stakeholders;* *Integrated development planning;* *Sustainable economy;* *Comprehensive security and rule of law;* *Minimal human vulnerability; Effective safeguards to human health and life*	*1- DDR in City Vision or strategic plan* *3- Financial planning of resilient activities* *9- Ensure effective preparedness and disaster response through city planning*	
Society	*3- Local initiatives to seek funding;* *5- Use Informed Responses of Climate Change;*	*Community & Inclusion;* *Health & Wellbeing; Mobility & Communication;* *Sense of Place*	*Collective identity and community support;* *Diverse Livelihoods and Employment*	*6- Institutional change to strengthen gaps in resilience capacity* *7-culture of social connectedness*	*Human scale of resource inputs and outputs*
Ecosystem		*Structures & Infrastructure;* *Systems & Technology; Resources;* *Environment*		*5- safeguard natural buffers*	*Resource Flows of land use activities- human systems and natural system* *Service and Infrastructure Networks*
Design Action	*8- Climate change issues, risks and responses*			*8- Risk mitigating infrastructure*	
Planning Action	*1- Climate Change integration into planning documents and processes;* *6- Managing uncertainty* *7. Stakeholder engagement in decision making*		*Reduced exposure and fragility; Effective provision of critical service;* *Reliable mobility and communications*	*2- hazards and vulnerabilities risk mapped* *4- risk compliant building regulations* *10-Build back better*	*Land use identification and identification of building types*

Establishing a measurement baseline is clearly important to cities because it assists decision making with complex issues but can the indicators adopted be free from political bias, include social voice and not distract from the real issues faced by cities (Bahadur and Tanner, 2014b; Vale, 2014; Chmutina *et al.*, 2016)?

2.2.3 Cities interplay

As sustainability-resilience concepts have global responsibilities, the decision making process from policy into practice should be reviewed to determine how sustainability and resilience are being interpreted in practice (Section 1.2). Within the urban narrative (Section 2.1.3), there is a concentration of conceptual interplay on cities which has consequences in decision-making (Section 2.3.5.2). The main frameworks for cities are C40 Cities and 100RC and they are outlined as follows.

In 2007, city governance galvanised to create the C40 network, which is a voluntary network for cities to make better decisions for the UBE (Section 2.3.5.3). Since 2008, C40 has provided a policy framework for cities (C40 Cities and Arup, 2016), but it remains unclear how cities are prepared for future climate change, shocks and hazards, that are beyond the existing predictions. C40 is navigating their way through how to make transitions in decision-making to contribute to national targets, and the finance industry is measuring risk and security through indicators (Cole, 2014; Lloyds and University of Cambridge, 2015; World Bank Group, 2017).

C40 is a leadership network for city governance that comprises more than 96 cities and 650 million people (Box 1.1). C40 report that '*30% of all climate*

actions are being delivered through city to city collaboration". C40 reports equate action to the carbon dioxide emissions saved and seek to limit global temperature increase to 1.5 degrees C. It has developed 7 initiatives that represent the main issues for the C40 network as listed: Adaptation and Water, Energy, Finance and Economic Development, Measurement and Planning, Solid Waste Management, Transportation and Urban Planning and Development. A further layer of network support has developed a 'program area', which is listed as:

- Business, Economy and Innovation: City solutions platform
- Diplomacy: C40 City Diplomacy
- City Intelligence
- Direct Support: City Advisers
- Finance: C40 finance facility; financing sustainable cities initiative.

Deadline 2020 reports that cities are pivotal to 'unlock action' in the climate change agenda and delivering the Paris Agreement. This is to be achieved through 5 pathways: Urban Planning, Transit, Energy, Buildings and Waste. Determining the future action of the pathways will use the C40-Arup Partnership Climate Action Pathways (2CAP) Model (Figure 2.3).

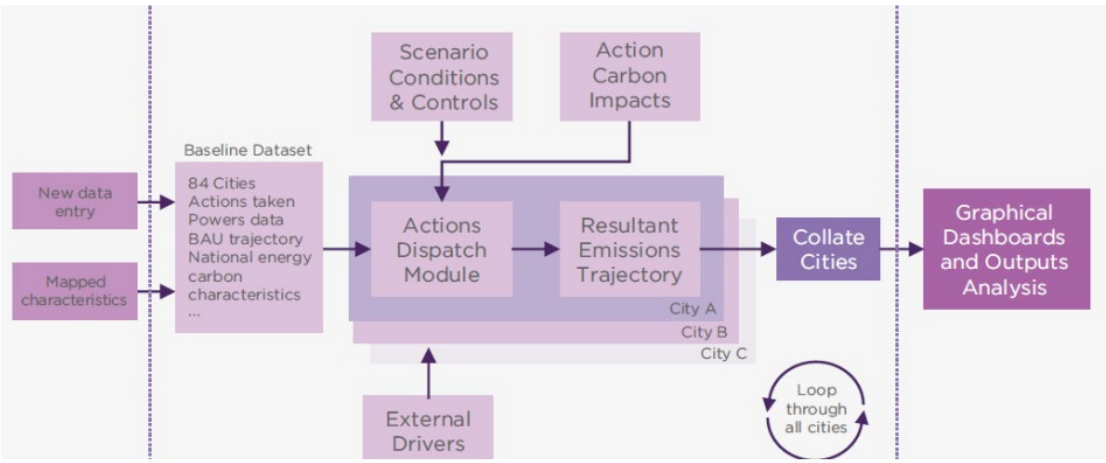

Figure 2.3 2CAP Model (C40, 2016b, p. 41)

The 2CAP model is a logic model that uses actions to predict how to reduce carbon emissions from using C40 data (C40 Cities and Arup, 2016, p. 106).

At present, C40 quantifies sustainability as ‘carbon emissions’ to reduce climate change risks such as heat waves, rainstorms, flooding, drought and extreme heat and cold through mitigation and adaptation. The C40 programme content does not directly refer to the specific concept of resilience, but in their interpretation the climate change risks targeted are linked to incremental changes in the resilience foundation.

In the C40 programme, resilience is more likely to be considered as a concept related to land use planning, food security objectives and reducing demands through sustainable green building measures (with behavioural change required for people to become more aware). For example, land use planning considers the following:

- Increasing density and containing urban growth
- Land preservation
- Land use policies for climate risks and adaptation
- Land policies and tools to increase housing and improve informal settlements.

The Building Pathway (C40 Cities and Arup, 2016) focuses on reducing energy demand both at individual dwelling and city scale by providing cleaner energy. Establishing energy codes with performance targets and with incentives or financial support to retrofit buildings to a high level of performance, *“Building retrofits that address energy efficiency can be designed to be highly complementary as adaptive measures. For example,*

green, brown or white roofs can reduce energy consumption, but also provide improved ability to deal with higher temperatures. Water efficiency measures can also reduce emissions, while at the same time improving the residents' ability to cope with drier conditions. More permeable surfaces and water recycling can also improve capacity to manage storms and flood. Additionally, there are opportunities to incorporate resilience measures while implementing emission reduction retrofits" (C40 Cities and Arup, 2016, p. 70).

The partnership relationship established in 2012 between C40, WGBC and USGBC has yet to mature, but their collective working could be captured in the LEED cities programme currently being piloted. C40 has been developed through the political governance of cities and the C40 Deadline 2020 publication concludes with 9 points, of which two capture the essence of the C40 agenda.

> ***Point 6 is*** *"As C40 cities age and grow they will need to invest in renewing and expanding infrastructure and working to enhance the lot of their citizens. From 2016 to 2050, over $1 trillion of this investment is required across all C40 cities to meet the ambition of the Paris Agreement through new climate action. $375 billion of this investment is needed over the next four years alone to take the climate action required"* (C40 Cities and Arup, 2016, p. 90).
>
> *Point 9 is "If all cities adopted the roadmap set out in this report for C40 cities, it would deliver 40% of the emission reductions required to keep temperature rise below 1.5 degrees: Action by C40 cities can have huge magnification. If all cities with a population greater than 100,000 adopted the ambition for C40 cities set out in this report, there would be the potential to save 863 GtCO2 globally by 2050. By 2100, they could have saved up to the equivalent of 40% of the reductions necessary for a 1.5 degree sc*enario." (C40 Cities and Arup, 2016, p. 90).

Cities are being framed by the C40 agenda to measure carbon to adhere to the Paris Agreement and that roadmaps must be written to achieve these goals and support the financial investment required. What is not clear is how there will be feedback on performance of the built environment, sustainability and resilience.

When considering how other frameworks measure resilience, the Cities Framework (Da Silva and Moench, 2015) was identified as the basis for many organisations. C40 and 100RC are currently involved with 90-100 cities worldwide. Each framework in Table 2.2 is based on difference measures of resilience, which may marginalize sustainability as a focus.

Established by the Rockefeller Foundation in 2013, the 100RC is a project to develop a network of 100 cities with the aim;

> *"not only to help individual cities become more resilient, but […] facilitate the building of a global practice of resilience among governments, NGOs, the private sector, and individual citizens" (100 Resilient Cities, 2019) .*

One core goal of the project is for each city to produce an 'urban resilience strategy' to unite people, projects and priorities. The program seeks to provide each city with the resources "*to develop a roadmap along 4 main pathways"* (Cities, 2018):

1. Financial and logistical guidance for establishing an innovative new position in city government, a Chief Resilience Officer (CRO), who will lead the city's resilience efforts
2. Expert support for development of a robust Resilience Strategy

3. Access to solutions, service providers, and partners from the private, public and NGO sectors who can help them develop and implement their Resilience Strategies
4. Membership of a global network of member cities who can learn from and help each other.

Four essential dimensions of urban resilience have been identified as: Health and wellbeing, economy and society, infrastructure and environment and leadership and strategy. A list of challenges has been created, which illustrate the wide variety of issues that need to be considered when becoming 'resilient'. Cities have been asked to develop city resilience strategies, which are then categorised by the following themes in Box 2.4:

Box 2.4 100RC Categories

Buildings	Information, Communications and Technology
Climate Change	Infrastructure
Disaster Risk Management	Natural Environment
Economic Development	Public Administration
Education	Public Health
Equality and Equity	Sustainability
Financing	Urban Planning

Each city has a bespoke response and is using the City Framework derived by Arup (Da Silva and Moench, 2015). Arup's City Framework is also recognised in ACCCRN (da Silva, Kernaghan and Luque, 2012), IFRC (2017), Prairie Climate Center (2017) and Mercy Corps, (2015). This framework has become a cornerstone for the measurement of resilience in cities, but other frameworks may offer other advantages towards scales of urban context (Section 2.3.5.2)

2.3 Decision-making

Recognised in the sustainability and resilience narrative (Section 2.1, 2.2) are two recurring sub-themes. The first is that there is an increased need for systematic '**feedback learning**' in decision-making of urban planning and building design in cities to create better UBE (Talen, 2003; Ahern, 2013; Thornbush, Golubchikov and Bouzarovski, 2013; Achour *et al.*, 2015; Capoccia, 2015; Zhang and Li, 2018; Meerow and Newell, 2019b). The second is that cities' **policies have become biased towards the quantification of carbon** (Section 2.2.1). Both themes are linked by the underlying process of decision-making because the feedback learning has yet to result in a more resilient-sustainable outcome (Chapter 1).

To provide the narrative with a foundation, an outline of decision-making theory (Section 2.3.1) and organisations is necessary (Section 2.3.2). Decisions are complex and a basic understanding of thinking styles (Section 2.3.3), the role of knowledge (Section 2.3.4) and how it affects decision-making interplay (Section 2.3.5) have been outlined. Decision-making in the urban built environment has consequences (Hammond, Keeney and Raiffa, 1998), and an emerging finding of this research has been Realpolitik (Section 1.5) which is outlined in more detail (Section 2.3.5.3).

2.3.1 Decision-making theory

Primarily, there is a philosophical foundation which is based on human motivation and consequences (Edwards, 1954; Howell, 2013). In understanding the theory of decision-making, Edwards (1954) outlines that

the philosophers such as Hume and Bentham consider that human motivation comes from pleasure not pain. From these hedonistic ideas, Bentham starts to construct the philosophy of utilitarianism which evaluates human actions based on their consequences and that "*the morally right action is the action that produces the most good*" (Driver and Zalta, 2014). This suggests that a decision always will lead to a positive consequence, but at some point there must be negative consequence because not everything benefits from utilitarianism (Foot, 1985).

What constitutes a decision is described by Slack, Byers and Thurston (2021) who convey that there are two groups of decision-making: programmed (repetitive and routine) and non-programmed (new and unique), and these have surrounding conditions such as certainty, risk and uncertainty. The approach to decision-making varies on whether it is an individual or a group. An individual will tend to consider a decision based on a rational or prescriptive approach (Archer, 1980) or bounded rationality (Simon, 1947), where a group or organisation will start to consider participation, coalitions and management science to achieve the best outcomes (Sylvester, 1974) (Section 2.3.2).

For an individual decision maker, Archer's (1980) definition of rational decision making is a starting point because it describes a decision process as a series of eight steps: 1) evaluate the decision, 2) implement the alternative(s), 3) select the best alternative(s), 4) analyse alternatives, 5) identify decision alternatives, 6) diagnose the problem, 7) define the problem, and 8) monitor the decision environment. This approach is linear and logical (Slack, Byers and Thurston, 2021). Simon (1955) outlines that decisions are

bounded by the capacity of knowledge and mental ability of those making them (Section 2.3.3), and that there is an economic reality that needs consideration (Section 2.3.5). Shepherd and Rudd (2014) progress bounded rationality by discussing that a decision strategy needs context (Section 1.3).

2.3.2 Organisations

Organisations or groups are more complex; Slack, Byers and Thurston (2021) outline that decisions often reflect an organisational strategy to fulfil a mission statement to achieve the goal(s). Organisations have structures which develop strategies towards output but how an organisation is constructed and how the strategies are developed relate to many factors. Mintzberg et al. (2012) describes organisation archetypes as: entrepreneurial, machine, professional, adhocracy, diversified, political and missionary. Mintzberg outlines that there a five parts of an organisation: operating core, strategic apex, middle line, technostructure, and support staff (Mintzberg, 1979). Each organisational part has a role and a method of coordination but the dynamics of organisational behaviour start to be affected by power (Johnson, Caporaso and Levine, 1994; Eisenhardt and Bhatia, 2017).

Organisational strategies can be developed through a multitude of strategical approaches that can include a PESTEL analysis that combines Political, Economic, Sociocultural, Technological, Environmental/ Ethical and Legal combined with a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis to understand the best outcome (Chartered Institute of Personnel and Development, 2020). However, the effectiveness of a strategy is also

affected by the relationship with power and how the organisation is constructed (Starkey, 1997; Mintzberg, Ahlstrand and Lampel, 2012).

Understanding organisational behaviour points towards Max Weber's organisational theory of rationalised decisions and *Verstehen* which considers that social action should be interpreted to arrive at a causal explanation of its cause and effects (Jones, 1977; Clegg, 1994; Bryman and Bell, 2015). Clegg (1994) describes that Weber and Foucault have similar origins of social interpretation but diverges from Weber on the concept of power. Weber considers power as a sovereignty or monolithic entity; where Foucault considers power in the context of social structure and knowledge which generates capillary power or networks, these have the potential to invert the powerbase of organisational hierarchies (Starkey, 1997). Foucault's interpretation of capillary power originates from Bentham's panopticon and considers that power comes from the collective human motivation where there are some strong voices (Starkey, 1997). From this overview of decision-making, it is clear that power is an influence in decision-making, and that a decision is complex

2.3.3 Thinking styles

Phillips *et al.*, (2016) provide a psychology perspective on thinking styles by outlining that a decision is either reflective, intuitive, or both, the description provided is that "*initiative thinking tends to be automatic, fast, preconscious, associative, autonomous and does not require working memory…[…]…reflective processing is slow, effortful, conscious, analytical, rule-based and requires working memory"*. Phillips *et al.*, (2016, p. 262) also

consider that "*Different types of decisions may also influence the association between thinking styles and decision outcomes*". Caretta and Faria (2020, p. 173) consider that reflective thought is eroded by the need to be efficient and "*produce easily measurable and rankable outputs*".

Achieving rankable outputs is goal-focused decision-making which relates to rational choice and can lead to the benefits of feeling good or human motivation (Aarts, Verplanken and Van Knippenberg, 1998; Driver and Zalta, 2014). Aarts, Verplanken and Van Knippenberg (1998) outline the theory of planned behaviour and how it has become predictable but in doing so, repetitive in its nature. This leads to the concept of habitual decision-making which means the generation of habits or automate decisions; this infers rational choices are being made towards goals, and in doing so, the opportunity to truly reflect on a decision is reduced.

2.3.4 Knowledge transfer

The understanding of sustainability and resilience vary diversely into all types of knowledge. Bloom's taxonomy (1956) outlined a method to understand knowledge and created six categories: 1) knowledge, 2) comprehension, 3) application, 4) analysis, 5) synthesis and 6) evaluation (Krathwohl, 2002). Krathwohl (2002) outlines a revised Blooms Taxonomy which includes four knowledge typologies: factual knowledge, conceptual, procedural and metacognitive where each knowledge type has its own characteristics: Factual describes the knowledge of terminology and specific details and elements that mainly relate to subject discipline knowledge; Conceptual considers the interrelationships to enable subject knowledge to function and

includes knowledge of classification and categories, principles and generalisations, theories, models and structures. Procedural knowledge is about how to do something, the criteria for using skills such as subject specific skills that relate to algorithms, techniques, methods and procedures. Finally, metacognitive knowledge is a type that emulates awareness of strategic knowledge, contextual, conditional and self-knowledge. From considering the trends in decisions, actors or influences can be identified.

Generation of new knowledge is described by Gibbons *et al.* (2006, p.1) as either Mode 1 or Mode 2 knowledge: Mode 1 is "*generated within a disciplinary, primarily cognitive context"* and *"Mode 2 knowledge is created in broader, transdisciplinary social and economic contexts*". This implies that Mode 2 can lead to build better decision-making between policy and practice and unify interpretations of sustainability and resilience between knowledge typologies (Section 1.2 and 3.1). The knowledge of how to build a more resilient and sustainable world exists, yet, the global policy targets of SDGs have shifted (UNGA, 2015), could it be that the decision-making process has become too complex?

Chmutina, Lizarralde *et al.*(2014), Chmutina *et al.* (2016) and Perelman (2017) all discuss how policy is generating conflicts with decision-making and that political agendas have shifted focus of delivering sustainable development and resilience in the urban environment. However, Wagenaar (2015) provides a perspective that interpretative policy analysis is hard to do because of "*the relation between theory and the practice of analytic inquiry is densely layered and fraught with the kinds of elusive contextual judgements*

that elude formalization in research methods or protocols" (Wagenaar, 2015, p. 8).

Wagenaar makes a further observation that "*the nonessentialist character of political identity; the insight that no higher principle or idea can escape this self-same interplay of antagonisms and power and can therefore not act to arbitrate political conflict*" (Wagenaar, 2015, p. 146). This statement has been considered to mean that the greater the discursive meaning, the greater the opportunity for political power to manipulate meaning; so if resilience meanings vary in theory (Section 2.1) their application can be used to the advantages of political shifts, which reinforces Chmutina *et al.* (2016) and Perelman (2017)'s perspectives.

Knoepfel *et al.* (2011) provide a pragmatic approach to their description of public policy analysis, their interpretation of policy is described

> "*to mean a series of decisions or activities resulting from structured and recurrent interactions between different actions, both public and private, who are involved in various different ways in the emergence, identification and resolution of a problem defined as a public one*" (Knoepfel et al., 2011, p. 39).

This introduces 'empirical actors' which can be taken, *"to designate an individual (a minister, Member of Parliament, specialist journalist etc), several individuals (constituting for example an office or a section of an administration), a legal entity (a private company, an associate, a trade union and so on) or a social group)."* (Knoepfel *et al.*, 2011, p. 39). They then proceed to outline "*affected actors*" whose behaviour is required to change as "*target groups, end beneficiaries and negatively or positively affected third*

parties" (Knoepfel *et al.*, 2011, p. 53). With actors considered, the agenda needs to be set and is described as a definitional process that "*may be interpreted as a power struggle whose main challenge is the recognition or imposition of an initial 'hypothesis of causality'. Which [sic.] (pre-) structures the development of the future public intervention*." (Knoepfel *et al*., 2011, p. 141).

Generating better decisions has led to the use of Game Theory because it supports understanding and explanation of how decision-makers interact (Sanfrey, 2007). McCain (2015) links Game Theory with Public Policy and discusses Social Mechanism Design, which leads to the fact that modelling situations are never real but can support consideration of policy implementation and evaluation of new policies. Meadows (2008) advocates systems thinking for providing feedback on policy systems because systems modelling considers that through

> *"the relationship between structure and behaviour, we can begin to understand how systems work, what makes them produce poor results, and how to shift them into better behaviour patterns"* (Meadows, 2008, p. 1).

The system provides feedback and therefore can locate responsibility for the decision-makers and ideally locating leverage points for changes within the system (Meadows, 1999). However, how can sustainable lifestyle changes be modelled effectively in urban built environments (Section 2.1)?

Determining which public policy theoretical approach is better at understanding the impacts of decision-making is not directly for this thesis,

but what is evident is that social behaviour is important to examine in decision-making in context. Also evident is that the conceptual relationship between sustainability and resilience, with its many interpretations, is at risk with its procedural and metacognitive knowledge or discursive meanings in action (Wagenaar, 2015; Wang *et al.*, 2020).

Discursive meaning of resilience in action has led to the Organisation for Economic Cooperation and Development (OECD) providing an assessment of the status of risk management, which outlined six areas: emerging systemic risks, risk assessment, risk prevention, emergency management, recovery issues, and future agendas (OECD, 2005). The report highlighted the need for a shift in hazard risk management because of the diversity of hazards, increased complexities and increased vulnerabilities.

2.3.5 Decision-making interplay

Transposing these theories of decision-making with organisational theory across the built environment is complicated. Coldicutt (1995) considers the processes of theory and organisational politics of decision-making in the built environment to outline that there are conflicts between the decision-makers with institution and theory; "*Built-environment theorists must also cope with the "what-will-be" as well as with the what-should-be. Because built-environment decisions include policy and built-environment theory. But theory about what the built environment should be is centrally concerned with design and in this way has a different emphasis or that theorised for policy processes*." (Coldicutt, 1995, p. 34). Sarkis, Meade and Presley (2011) discuss sustainability in decision-making frameworks and conclude that

future generations will be influenced by decisions made today and that LCA provides an intergenerational management framework for buildings.

Urban planning and practice in the built environment involves multiple design sectors which follow rational design processes often set out by institutions; for example in the UK the RIBA Plan of work includes seven stages that starts with strategic definition and finishes with building use (Architecture.com, 2020).

Even within this framework there is debate around its boundaries of use, particularly as the best sustainable outcome considers the operational use of social behaviours both in a building and community (Section 2.1), as well as how well decisions are made across design sectors in construction (Coldicutt, 1995; Egan, 1998; Sarkis, Meade and Presley, 2011). The interplay between decision-makers generates interpretative nuances between knowledge, power structures, policy makers, urban planners and design disciplines. These knowledge relationships between policy, planners and policy in the UBS have consequences along a decision-making pathway and need to be reflected in the methodology (Chapter 3).

2.3.5.1 Global Policy

The Rio Earth Summit is a critical juncture in sustainability policy (Section 2.1.1.2) but development trajectories seem off course (Section 1.1). Hecht and Cockburn (1992) outline the political discussions after this event as “Environmental Realpolitik” because countries were not in agreement about economic development (Section 1.5).

> *"The document was basically a diagnostic of the status of the world's resources and ecosystems and charted out the threats to them. It identified development processes that were a menace to ecosystems and emphasized three objectives of resource conservation that the* ***IUCN espoused****: maintenance of essential environmental processes, preservation of genetic diversity, and sustainable use of species and ecosystems, all very laudable aims."* (Hecht and Cockburn, 1992, p. 371).

Heller (1995) outlines that the contributing factor of Environmental Realpolitik related to the legal process of committing to mitigate GHG. Collectively, these views suggest that the economics and political actors have more influence over the conservation of the global environment.

SFDRR is a critical juncture in resilience policy (Wisner *et al.*, 2003; Beck, 2009; da Silva, Kernaghan and Luque, 2012; UNISDR, 2015b). Yet, after ten years of monitoring through the Hyogo Framework (United Nations, 2005), the SFDRR reports that,

> *"Over 700 thousand people have lost their lives, over 1.4 million have been injured and approximately 23 million have been made homeless as a result of disasters. Overall, more than 1.5 billion people have been affected by disasters in various ways, with women, children and people in vulnerable situations disproportionately affected. The total economic loss was more than $1.3 trillion. In addition, between 2008 and 2012, 144 million people were displaced by disasters."* (UNISDR, 2015b, p. 9).

The SFDRR was created on the basis that "*reducing disaster risk is a cost-effective investment in preventing future losses"* (UNISDR, 2015b, p. 8). The SFDRR lists four priorities: 1) understanding disaster risk, 2) strengthening disaster risk, 3) Investing in DDR for resilience 4) Enhancing disaster preparedness for effective response, and to "**Build Back Better**" in recovery,

rehabilitation and reconstruction (UNISDR, 2015b). Each priority specifies requirements for consideration at two levels: 1) National and Local and 2) Global and Regional. Understanding these levels of risk is central to developing the agenda in practice. However, there is distraction by further meanings and new knowledge, as resilience becomes quantified towards socially biased indicators or risk indexes (Table 2.3) (Cutter *et al.*, 2008; Cutter, Ash and Emrich, 2014; UNDRR, 2015, 2019b; Peters and Tanner, 2016).

The combination of the release of the SFDRR and the revised SDGs in 2015 provided a shift in direction of policy and practice (Aldunce *et al.*, 2015; Peters and Tanner, 2016). Contemporaneously with the SFDRR, the GAR 2015 report (UNISDR, 2015a) presented a number of key observations where theoretical and practical knowledge of resilience has evolved through "*decades of experience in managing disasters and reducing climate and disaster risk* [that] *have produced a wealth of knowledge and good practice*" (UNISDR, 2015a, p. 247). However, it also concluded that there had been too much focus on managing disasters, in contrast to sustainable development, with the resultant failure to address the underlying risks (UNISDR, 2015a, p. xiv). To redress this balance means galvanising development to do more to understand global systems:

> *"addressing them requires actions such as reducing poverty, planning and managing cities appropriately and protecting and restoring ecosystems"* (UNISDR, 2015a, p. xv).

GAR 2015 concluded that development itself needs to be transformed or risks will continue to increase. Pesaresi *et al.* (2017) model the global exposure to natural hazards in three dimensions of risk: hazards and exposure, vulnerability and lack of coping strategy. This is a different interpretation of modelling adaptive capacity and transformation (Section 2.1.2.1). However, the Atlas of the Human Planet (Pesaresi *et al.*, 2017) relates resilience in the context of the SFDRR and Sustainability with the SDGs, but there needs to be further explanation provided to how it could be incorporated into decision-making (Peters *et al.*, 2016; European Commission Global Human Settlement, 2019).

As countries progressed with the SFDRR and the development of creating NAPs not all has gone well. Woodruff and Regan (2019), in regard to the NAPs, conclude that planning, design and implementation of adaptation principles have institutional barriers that need to be overcome. It was observed in GAR 2015 that sustainable development was not part of the ethos as it was focused on DDR *"for and reduc*ing *disaster risk in order to more effectively protect persons, communities and countries, their livelihoods, health, cultural heritage, socioeconomic assets and ecosystems, and thus strengthen their resilience*" (UNISDR, 2015b, p. 9).

Parnell (2016) describes these game changing shifts in global policy, as necessary progress to establish SDG 11 and declares this a minor victory because historically there are political compromises that divert from the urban issues. Something that should be addressing all concerns (on both city and urban scales) is the New Urban Agenda (United Nations Habitat III, 2017). In parallel to the global discussion about Urban Settlements, City

mayors also created their own agenda by forming the World Mayors Climate Change Congress (2005) which was enabled by the Local Governments for Sustainability (ICLEI) (Rosenzweig *et al.*, 2010). The ICLEI have launched their own agenda titled “In the Urban Era- Our vision for a sustainable urban world” (ICLEI- Local Governments for Sustainability, 2019). It is too early to tell what this means until inter-city evidence can be generated (Section 7.4).

Creating sustainable UBE does not require new knowledge: the scientific and built environment practice community have both the modelling techniques and understanding of carbon emissions required (Burnett, 2007; Wilkinson *et al.*, 2011; Batty *et al.*, 2012; Jha, Miner and Stanton-Geddes, 2013; Jalaei and Jrade, 2015; Alhamwi *et al.*, 2017, 2018). Haughton (1997) outlines the problem of legal-jurisdictional boundaries that seem to protect politicians, where politicians and other decision makers seem protected from wider concerns such as environmental impacts.

However, policy and practice need to prepare for the disruptive events, but they also need to consider incremental influences, which may cause more stress over time. The criteria for both stochastic and incremental shifts needs all decision makers to discuss what level of stress is appropriate and how to manage extreme stresses or failures (Vale, 2014; Fiksel *et al.*, 2015; Grigoraș, 2018). Kohler (2017) discusses the benefits of sustainable development in the context of social-technical resilience, but what is not discussed is how the provision of sustainable development to high performance criteria reduces incremental risks alongside buffering disruption scenarios.

2.3.5.2 Urban and Cities

The UBE narrative starts to converge on urban resilience and sustainability (Lizarralde *et al.*, 2015; Zhang and Li, 2018). Yet, urban sustainability starts to concentrate on smart or eco-cities, or local communities and urban resilience (Tobin, 1999; Kenworthy, 2006; Bătăgan, 2011; Viitanen and Kingston, 2014). Also, the urban resilience narrative fractures towards city resilience and peri-urban resilience (Johnson and Blackburn, 2014; Gupta *et al.*, 2017). A pragmatic viewpoint is that cities are part of the global emissions problem and increase risks due to urban development, but because cities are at risk so is the global economy (Barkham *et al.*, 2014; Da Silva and Moench, 2015; Lloyds and University of Cambridge, 2015). Fractured or converging, what brings all into focus is how to deal with the impact of natural hazards and climate change on the built environment.

To create a more even landscape for UBE, the policies need to reflect cities and all scales of urban environments (Evans, 2009; Gupta *et al.*, 2017). Rosenzweig *et al.* (2010) outlines that city planners need to link climate change to broader agendas such as energy investment, pollution, water supply and waste, but to support better decision-making there needs to be more specific knowledge on cities.

> *Rosenzweig et al. (2010, p. 21) state that "What the world needs is the same science-based foundation for cities that the Intergovernmental Panel on Climate Change (IPCC) provides for nations" and created the Urban Climate Change Research Network (UCCRN).*

Yet, political resources and institutions have been steered towards making more resilience and sustainable decisions by the creation of the UN Habitat for Human Settlements. UN Habitat outlines habitual practice of decision-making in planning (Box 2.5).

Box 2.5: Recognition of habitual practice by the UN Habitat

United Nations Habitat (2009, p. vii) reports on Planning for Sustainable Cities, and in its introduction outlines that habitual practice of decision-making exists. "Planning schools should embrace innovative planning ideas, including the ability to engage in participatory planning, negotiation and communication, understanding the implications of rapid urbanization and urban informality, a*nd the ability to bring climate change considerations into planning concerns*".

2.3.5.3 Measurement

Rees and Wackernagel unfold a discussion about "why cities cannot be sustainable and why they are a key to sustainability" using their method of urban ecofootprints (Rees and Wackernagel, 1996). Rees and Wackernagel (1996) adopt a global systems approach towards their modelling and conclude that

> *"no city or urban region can achieve sustainability on its own. Regard-less of local land use and environmental policies, a prerequisite for sustain- able cities is sustainable use of the global hinterland."* (Rees and Wackernagel, 1996, p. 236).

From this understanding, an outline of the advantages of cities is discussed as: lower costs of waste infrastructure (water, sewers and waste), an opportunity for recycling, re-use, remanufacturing, high population density which reduces land demand, greater economies of scale of waste heat to cogenerate power, a greater potential to reducing fossil fuel consumption by

walking, cycling and public transit. However, for measurement purposes cities have a boundary and must be self-sufficient from their context, which means that their natural capital must be protected and enhanced to support city life and that there needs to be international agreement "*on the nature of the sustainability crisis and the difficult solutions that may be necessary at all spatial scales*." (Rees and Wackernagel, 1996, p. 245).

Handmer and Dovers (1996, p. 491) consider that "*we need decision-making and management strategies that can cope with, and readily adapt to, new or unexpected circumstances*" on the full temporal scale (short, medium, and long term). Driven by the need for understanding risk due to natural and human-induced hazards, particularly with respect to financial investments, organisations and institutions have started to quantify urban resilience (Barkham *et al.*, 2014; Da Silva and Moench, 2014; Lloyds and University of Cambridge, 2015; Bahadur and Pichon, 2016; BRE, 2016b; Buro Happold, 2016; FM Global, 2017).

The examination of measurement frameworks builds a case for increased indicators and measurement for multiple spatial scales of resilience and sustainability so better decisions can be made. There is a counterargument that this is too complex and needs many contributors to make a decision, so measurement becomes a hindrance (Davoudi *et al.*, 2012; Stumpp, 2013; Levine, 2014). Levine (2014) argues that measurement of resilience should not reside in a single tool because resilience is not a single 'thing'.

> *"far too little investment is being made in quantifying the impacts of policies and interventions in development generally, including in areas within the resilience agenda"* (Levine, 2014, p. 1).

Yet, a number of authors have sought to develop indicators to support measurement of resilience in the context of the urban environment or cities for adoption by city practice (Easterling and Kates, 1995; Yohe and Tol, 2002; Brooks, Adger and Kelly, 2005; Eriksen and Kelly, 2007). Shown in Box 2.6 are the Urban Planning Indictors included in the most recent ISO standards for sustainable cities and communities ISO 37123 and ISO 36120 (British Standards Institution, 2018, 2019).

Box 2.6: List of urban planning indicators in the ISO 37123 (British Standards Institution, 2019) **and 37120** (British Standards Institution, 2018)**.**

ISO 37123- Section 21 Urban Planning indicators
21.1 Percentage of city area covered by publicly available hazard maps
21.2 Pervious land areas and public space and pavement built with porous, draining materials as a percentage of city land area
21.3 Percentage of city land area in high-risk zones where risk-reduction measures have been implemented
21.4 Percentage of city departments and utility services that conduct risk assessment in their planning and investment
21.5 Annual number of critical infrastructures flooded as a percentage of critical infrastructure in the city
21.6 Annual expenditure on water retention measures as a percentage of city prevention measures budget

ISO 37120- Section 21 Urban Planning indicators
21.1 Green area (hectares) per 100 000 population (core indicator)
21.2 Areal size of informal settlements as a percentage of city area (supporting indicator)
21.3 Jobs–housing ratio (supporting indicator)
21.4 Basic service proximity (supporting indicator)
21.5 Urban planning profile indicators
21.1 Green area (hectares) per 100 000 population (core indicator)

An interpretation of what the indicators outline is continued habitual practice that the role of urban planning is constrained to thinking about land areas

(Section 1.2.3, 2.1.3), not necessarily advocating that urban planners have a social and environmental role in orchestrating shifts in policy and practice (Fainstein, 2005; Olshansky, 2006; IEA, 2013; Rosenzweig and Solecki, 2014). Alternatively C40 has recently reported a steer towards increasing biodiversity indicators and 100RC has developed strategies but started to retract its involvement with local governance (C40 Cities, 2020). The differences between theoretical practice and city policy in practice are starting to emerge (Section 6.4).

Recently, the GAR (UNDRR, 2019b) report indicates need for greater collaboration between resilience and sustainable development because there has been too much fracturing between them and their interpretations in knowledge. **GAR 2019 proposes to go forward with the definition as "risk-informed sustainable development"**. However, what procedural knowledge interpretations of both terms in policy and practice still need to be examined in an urban context (Chapter 4).

2.3.5.3 Consequences

As the nuances of interpretations of knowledge in decision-making have occurred, Realpolitik has consequentially been created between policy, planning and practice of the built environment between countries. When considering the origins of Realpolitik, there are references to Rochau's Foundation which is described as a liberal and socialist approach to promote political reform (Kelly, 2018). Bew's (2016) develops Hobbes and Machiavelli principles to build a modern interpretation of Realpolitik. This interpretation is most helpful because it considers reality, not just the ideological, *"the*

creation of the concept of Realpolitik was an attempt to answer a domestic political conundrum: how to build a stable and liberal nation-state in an unsteady and rapidly changing environment, without recourse to violent convulsion or repression" (Bew, 2016, p. 17).

Bew's (2016) historical perspective on Realpolitik provides a foundation to reconsider a reformation of Realpolitik, in which the ideals of sustainability and resilience can be transposed. Bew's (2016) foundation outlines eight recommendations of which five hold relevance and are outlined in Box 2.7:

Box 2.7: Realpolitik Foundation (Bew, 2016)

1. Real Realpolitik is based on Rochau's political analysis in which the three levels: existing power distribution within a state; the socioeconomic structures of society; and the cultural and ideological setting of the time; need to be brought together in political action.

2. Real Realpolitik is an enemy of habitual self-delusions and naively accepted catchwords. Rochau's Realpolitik is about a way of thinking, and to challenge others, and confront presuppositions and assumptions; where measuring, weighing and calculating of facts need to be processed politically.

3. Foundations of Realpolitik helps us understand political possibilities and that social and cultural considerations do need to be taken into account, "that is, to craft our political analysis around, and to anticipate, changing circumstances" (Bew, 2016, p. 302).

4. Ideas and idealism are important to the foundations of Realpolitik as forces of change and transformation, "Powerful ideas usually have social and economic weight behind them" (Bew, 2016, p. 303).

5. Foundations of Realpolitik asks for power, ideas, economics, and society at the same time to be considered as well as to identify the junctures and connections between them. "Realpolitik emphasized the importance of thinking synthetically and holistically, based on an assessment of all information before us" (Bew, 2016, p. 304) and what is meant by this is that it is important to identify how power, socioeconomic conditions, and ideas overlap and converge.

Practically, Realpolitik provides a foundation to discuss sustainability and resilience with politics and history in mind; it is an overarching approach. By

understanding the history of, and ideals behind, the agendas, it can be understood how and why they are currently formed in the way they are (Section 2.3). By understanding the various interpretations of terms used by decision makers, it can be understood how these choices influence decisions made (Chapter 4). By understanding the reality of decision making in context, it can be discovered how to make changes for the better that will last.

In the US, the Realpolitik of cities has seen city governance create their own sustainability and resilience policy frameworks (Chapter 4) and federal organisations generate funding streams towards flooding and recovery, but funds are being increasingly restricted as federal policy has shifted (Yin *et al.*, 2017). Given the recent recurrence of stochastic events in the US (Swanstrom, 2008; Wagner, Chhetri and Sturm, 2014), did resilience policy come to prominence due to disaster events and recovery funding?

Bew's (2016) foundations outline that ideals are possible in Realpolitik and that the socioeconomic conditions are of importance, and how they manifest themselves in the urban environment will be discussed in Chapter 6. However, Realpolitik's enemies are how ideals have been manipulated by politics and their use in language and place. In outline, the historical context will provide an understanding of the ideals that are and have influenced policy in cities, and then the use of language and various meanings of terms will be discussed because these are an integral part of the Realpolitik of cities and decision making in context.

2.4 Chapter Summary

Themes in the narrative have been recognised as discursive interpretations of meanings and measurement (Section 2.1, 2.2). Over time, the **discursive use** of sustainability and resilience has shifted and fractured the discourse from its origins of environmental and ecological needs of conservation. This **is an issue for decision-making** between theory, policy and practice (Section 2.3.5). However, previous definitions of terms have already been adopted to generate measurement frameworks and policies (Section 2.2.3). Critical themes that have been recognised in the interpretative narrative review are:

- Political bias (Box 1.1, Section 2.3.3)
- Interpretations of sustainability and resilience (Box1.1, Section 2.2)
- Measurement frameworks (Boxes 2.1, 2.3, 2.6)
- C40 cities as an actor (Section 2.2.3)
- The use of LEED and BEAMs (Box 2.1, Section 2.2.3)
- 100RC as an actor (Box 2.4)
- Decision-making factors (Section 2.3)
- Habitual practice (Box 2.5, 2.6)

What has also become relevant is the role of planning in decision-making, (Fainstein, 2000; Rosenzweig *et al.*, 2010) and is either part of the solution or part of the problem as it gets sandwiched between policy and practice. Understanding the thematic consequences of these decisions in the built environment needs further context (Chapters 3, 4 and 5).

Chapter 3 Generating interplay of decisions in cities

Chapter 3 describes the methodology that examines the discursive use of sustainability and resilience of the UBE to construct principles to improve decision-making (Section 1.3). Constructing an explanation to critically examine the interplay requires context and a diverse methodology. Figure 3.1 provides an overview to the developed approach. Section 3.1 and 3.2 outline the mindset and the methods are discussed in Section 3.3. Section 3.4 outlines each stage of the research design. Case studies and semi-structured interviews have been adopted to create understanding between policy and practice. Interview data has been collected, transcribed and coded in NVivo (Section 3.4.3) and secondary data analysis was carried out to establish causes and effects (Appendix 3.5). Known limitations are described in Section 3.5 but research limitations are also discussed in Section 7.4. Reliability and validity of the research design is provided by the quantity of three case studies (Chapter 4), which is verified by the process of thematic discussion and decision-making interplay between city policy, planning and practice (Chapter 4 and 5). This production of knowledge can support the establishment of discursive trends in conceptual and procedural knowledge which in turn supports the understanding of cause and effects in decision-making (Section 5.4).

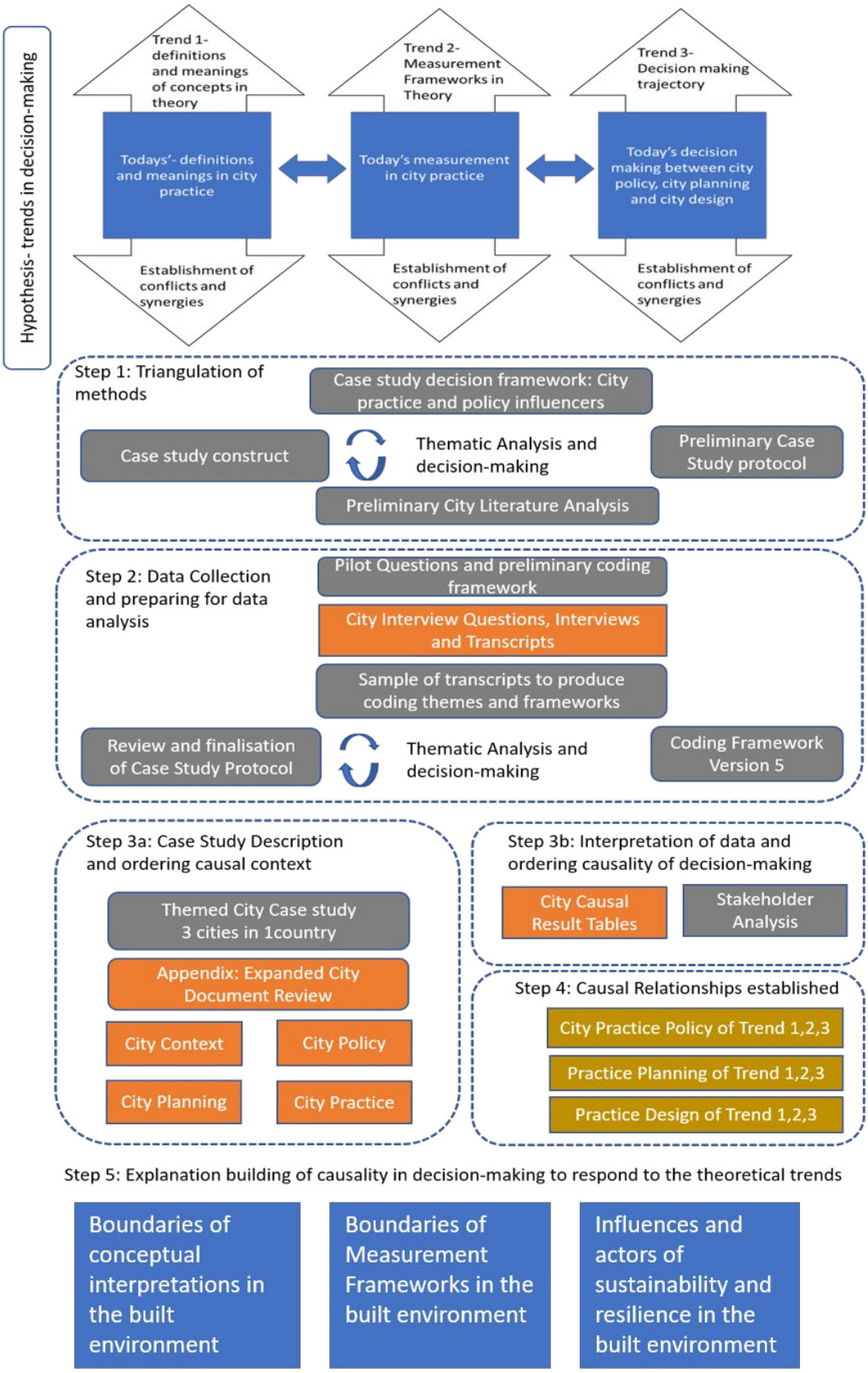

Figure 3.1 Overview of Research Design

3.1 Methodological Approach

Most recent research in resilience on a city scale has become longitudinal or sectoral, leading to a stratification of the concept (Folke, 2016), just as in the same context, sustainability has become eclipsed by green building measurement systems (Cole, 2003, 2005) and measured by carbon emissions (Davoudi *et al.*, 2012; Zero Carbon Hub, 2012). Broman *et al.*, (2013) call for 'systematic' leadership to reduce the silo mentality between disciplines, but this is not a new problem (Gibbons *et al.*, 2006; Senge, 2006; Peters and Tanner, 2016; Quinlan *et al.*, 2016a).

> *Barnett and Parnell (2016) call for epistemologies to consider "the divergent intellectual understandings of the urban question" and urge that new conventions are brought to the urban processes in policy worlds.*
>
> *The recent GAR Report (UNSDR, 2019, p. 8) also calls for a "break away from the prevailing practice of compartmentalized research, hazard-by-hazard risk assessment and management if we are to improve our understanding of complex systems and risk and collectively identify solutions".*

Levine (2014) and O'Connell *et al.* (2015) outline the principle of a 'decision-making pathway' as a way of thinking along the process to achieve both a resilience and sustainability agenda outcome. Fainstein (2000) cuts across planning theory and urges that the role of planning is given more priority in decision-making. Tobin (1999) discusses the role of planning in the relationship of resilience and sustainability through three pre-determined models and outlines the complexity of the relationship but does not consider the whole decision-making trajectory of the built environment. Mileti (1999)

considers the role of urban planning in sustainable hazard mitigation in the US and identifies several barriers in policy and the planning process. Bahadur and Tanner (2014a) consider the influence of actor networks, epistemic communities and policy entrepreneurs on the urban policy environment in India using a case study from the ACCRN programme. Their research approach includes semi-structured interviews and inductive approaches to narrative and discourse frameworks. Using the same case studies, in a different paper they continue to consider the role of politics in creating transformational changes and identify that building resilience has trade-offs spatially, temporally and that "*there remains limited understanding of how resilience thinking relates to prevailing politics, policy processes and how these factors play out in different institutional environments*" in trying to manage politics (Bahadur and Tanner, 2014b, p.204). However, neither paper considers the broader role of sustainability and existing measurement systems in the built environment (Section 2.3.5.3).

Underneath all these theoretical paradigms is the broader rhythm of decision-making in city planning and working with industry practice to complete the knowledge cycle (Rowley, 2001; Chmutina, Bosher, *et al.*, 2014). Section 2.3 outlines that decision-making is a complex process with widening applications which also needs curtailment and redefining, particularly with regards to policy (A. Bahadur and Tanner, 2014; Andreas, 2018). To understand the impacts of policy in practice, action research has a methodological role by working with multiple disciplinary teams and systems modelling is helpful (Senge, 2006; Meadows, 2008; Kohler, 2018). However to generate outcomes of action research, deductive processes and Mode 1

thinking are often employed (Gibbons *et al.*, 2006); so the broader depths of understanding are not considered because it is difficult and may not yield tangible outcomes (Miles, Hubermann and Saldana, 2014; Bryman and Bell, 2015).

Senge (2006) and Meadows (2008) outline that a systems modelling process is complex but necessary for global understanding of environmental issues. Currently systems modelling to enable better decisions is developing practice in the built environment (Passmore and Schmidt, 2018). Miles, Hubermann and Saldana (2014) suggest systems modelling is often used with deductive problem solving, so using it to consider interpretations of conceptual knowledge or how decision-making interplay generates conflicts and synergies is limited. Acknowledging these perspectives has influenced the methodological approach by ultimately steering towards a new theoretical foundation because the other methods are too longitudinal. Broader depths need to be considered. New research design approaches that consider multiple landscapes and their role in decision-making pathways are required.

3.1.1 Defining the Context Mindset - ontology and epistemology

Constructing knowledge to reduce discursive irregularities could be pragmatically assessed because of the subject diversity of social context;

> Howell (2013, p. 133) reflects on an interpretation of Corbin and Strass*: "People have an active role in shaping the world through interrelationships in terms of meaning, action and conditions the nature of experience continually evolved, which creates continual re-interpretation of phenomenon".*

However, to obtain Foucault's (1971) deeper understanding of the rhythms needs more of an open or inductive approach (Broman *et al.*, 2014). By observing multiple landscapes, the pattern of which characteristics of conceptual knowledge have overlapped in decision-making can be recognised.

Patterns and systems are entities that suggest connectivity and a relationship to other objects. Understanding these connections aligns with systems thinking *"to make the full patterns clearer, and to help us see how to change them effectively*" (Senge 2006, p.7). Resilience and sustainability both relate to change and the management of uncertain outcomes (Handmer and Dovers, 1996; Caputo *et al.*, 2015). This has led to examining how the concepts' characteristics have manifested themselves, which needs an open almost inductive approach that in turn needs interpretation to link back to what is known. The conceptual knowledge encompasses subjects that are classified by Short and Kim (1999) as uneven phenomena where wealth and global connectivity are interspersed with marginalised areas and population. Hopkins and Wallerstein (1996) consider the geo-culture of the world's system as complexes of processes within evolving structured frameworks. Given these descriptions, and the unevenness and dynamism of the concepts, interpretations need to be abductively made.

3.1.2 Interpretivism and causality

Howell (2013, p. 37-38) describes Hobbes's *Objections* (1641) principle of causation as "*knowledge as either effects developed though understanding general causes or causes determined through general effects*" and that there

are two types; "*efficient causes which bring about effects and entire causes which involved a combination of causes and effects*". Bryman and Bell (2015) consider that the term 'causality' as an interpretivists approach to understanding human behaviour and outline Weber's *Verstehen* rationale of providing causal explanations,

> *"Weber's definition seems to embrace both explanation and understanding, but the task of 'causal explanation' must refer to interpretative understanding of social action' rather than to external forces that have no meaning for those involved in social action." (Bryman and Bell, 2015, p. 28).*

Both perspectives need to be considered, and it reaffirms the epistemological position that this research is about the interplay of influences of decision-making in the built environment, but this requires explanations to describe the relationship of causal interplay (McClelland, 1975).

> *"Almost never are the fundamentals of practice and theory pulled together within the broader context of a methodological discussion", McClelland (1975, p.16).*

Lizarralde *et al.,* (2015) discuss the complexity of decision-making and policy in the UK and identify tensions and synergies between sustainability and resilience. Perelman (2017) has identified clashes in decision-making between policy and practice, but in the USA. Both references discuss how concepts have been interpreted and have resulted in conflicts of decision-making in practice. Whilst a debate around longitudinal responses of causation analysis could be developed (Ringer, 2002); this research is concerned with the interpretation of decision-making "actors and influences"

and “causes and effects” of the semantics of language (Morton, 1979). Semantics of language have already been identified (Section 2.2) in the theoretical foundation because of the repeated recognition that there are too many definitions of resilience (Wang *et al.*, 2020). When this situation occurs with language, McClelland considers that answers can “*be found in only one source: the reader’s own personal beliefs concerning the extrapolations justified by that experience*” (McClelland, 1975, p. 23). McClelland (1975) adopts a quantitative interpretation of causation and this method is often used to qualify quantitative relationships (Bryman and Bell, 2015, p. 174).

Explanations provide an approach to consider the interpretation of actors, which relate to context, yet the human behaviour needs interpreting to provide the knowledge of the cause and effect (Section 3.3.5). Morton (2004) outlines how causal modelling has facilitated the research into developmental disorders and uses descriptive terms. Disorder or disruption is a phrase that often connects itself with hazards (Chang *et al.*, 2014; Stuchtey, Enkvist and Zumwinkel, 2016). Morton's (2004, p. viii) research expresses that “*Human development can be seen as the unfolding of a particular pattern.*” and adopts the causal modelling approach as a tool to discuss cause and effect relationships of developmental disorder (in humans). This approach lends itself to supporting this research because of the unfolding nature and that patterns need to be identified (Section 1.5).

3.1.3 Using Abductive Reasoning

To decipher the various decision-making impacts and consequences of the interpretations of sustainability and resilience there is some known

conceptual understanding. Bryman and Bell (2015, p.27) outline that "*Abductive Reasoning involves the researcher selecting the 'best' explanation from competing explanations or interpretations of the data*". The literature synthesis on measurement frameworks (Da Silva and Moench 2014; BRE 2016; Governance *et al*. 2015) shows a range of interpretation of meanings, which increases its complexity or blurs issues, because there are specific viewpoints working at varying scales of approach, each trying to unfold the discourse and, in doing so, countering it.

Abductive reasoning is seeking not to quantify or qualify, induce or deduce, but to assess what is the best interpretation of resilience that is being progressed in operational measurement frameworks and whether this is actually 'the best' interpretation (Bryman and Bell, 2015). Dubois and Gadde (2002, p.5) consider the use of abductive theory in case studies to "*provide unique means of developing theory by utilizing in-depth insights of empirical phenomena and their contexts*", particularly when connections between the activities, the actors, and the resources not yet fully realised.

3.1.4 Adopting Constructivism

Foucault's (1971) "Rhythms", Alexander's (1977) "Patterns" and Meadows *et al.*'s (1972) "Limits to Growth" all consider the role of society and its impacts on their varying contexts. Decisions are made by people, so it is important to understand what conceptual knowledge has been interpreted into procedural knowledge by people (Bhaskar, 2008). Mir and Watson (2001, p.1172) consider constructivism as "*essentially products of different contexts, perspectives and making sense mechanisms*". Wells *et al*. (1995, p.24)

outline that adopting a constructivist's methodology with case studies led to the successes in their research, because it was not constrained by pre-determined values "*but represented contextualized cases*". Linking a constructivist's approach with context such as case studies design and practice knowledge will lead to an active process representing what is known at the time of the research (Sections 1.3, 3.5).

Sustainable development and resilience in decision-making in the built environment should evolve around communities and building users to meet their social components of their agendas (Magis, 2010; Bordass and Leaman, 2013; Peters and Tanner, 2016). Built environment processes centre on the decision-making interaction between planning procedures, design teams (practice) and compliance with policy (Section 2.3). Bosher (2007, p.1) identifies that to achieve an outcome of a resilient and sustainable future, "*Resilience should be systematically built into the planning and design processes rather than added on as an afterthought"*. A decision-making pathway between policy, planning and design would represent how decisions are made and socially constructed.

3.2 Qualitative Research Strategy

Chapter 2 outlines trends in narrative themes created by considering characteristics of resilience and sustainability over time by listing sources chronologically (Section 2.4). Despite the temptation to consider quantifying sustainability and resilience as a merged agenda, it was found that this had already been pursued by LEED-RELi framework (Section 2.2.3) and generating data for its use would be constrained as it is so new. Instead, this

research considers the discursive use of language in its applications of conceptual knowledge in decision-making that needs most attention (Section 2.3). Abductive reasoning and interpretation of knowledge requires a qualitative approach because of the need to know ‘why’ and ‘how’ decisions are being made and their consequences. To further examine the themes from the literature review requires context, the research methods consider how to generate understanding and create context, but the context needed framing (Section 2.4). Two decisions were made in parallel, the first was to adopt case studies and to decide about which cities to study; and the second to carry out a narrative review on city documentation (Section 3.3.2).

Causality is often considered as a quantitative and deductive approach to research, but here it is being used as a tool to rationalise interpretations of practice knowledge (Section 3.3.3) and understand the cause and effect relationship in decision-making (Section 3.3.5). .

3.3 Reliability and Validity of Research Methods

This section provides theoretical justification of the chosen methods and their application in this research project is outlined (Section 3.4).

Miles, Hubermann and Saldana (2014) outline methods to explore, describe, order and explain data. To explore and describe data, the case study method provides boundaries and context (Mir and Watson, 2001). Braun and Clarke (2008) outline that thematic analysis is a method that can cross boundaries and allow narrative to be dissected in a meaningful way (Section 3.3.4). Enlightened by Strauss and Corbin (1994), sustainability and resilience

practitioners' knowledge is required to explain and identify the reality of decision-making in cities.

Extracting knowledge from practice needs abductive interpretations of narrative and case studies to provide an explanation of causal relationships. To verify the reliability and validity of the preferred methods, the case study method (Section 3.3.1) with narrative review (Section 3.3.2), semi-structured interviews (Section 3.3.3), thematic analysis (Section 3.3.4) and causal and action networks were employed (Section 3.3.5).

3.3.1 Case Study Method

Providing context is critical; this points towards using case studies in which the researcher frames the context by virtual constraints. Case studies enable the ability to deal with a full variety of empirical evidence to explore the boundaries between concepts and their reality. Yin (2003) outlines how case studies support the aims of research; Table 3.1 demonstrates that verification, reliability and external validation of the research design can be achieved by the number of case studies.

This research will be reviewing multiple sources of evidence, and then identifying key experts to discuss the findings of the research. Triangulation of case study data is critical (Bryman and Bell, 2015). Internal validity is achieved through the empirical data generated by interviews with resilience and sustainability specialist stakeholders (Section 3.3.3.1).

Table 3.1 Adaptation of Yin's (2003) fig (2.3)

Tests	Case study tactic	Phase of research in which tactic occurs	PhD Design Response
Construct Validity	• Use multiple sources of evidence • Establish chain of evidence • Have key informants review draft case study report	• Data collection • Data collection • Composition	• How many case studies? • Thematic analysis • Pilot case study experts to review work.
Internal Validity	• Do Pattern Matching • Do explanation Building • Address rival explanations • Use logic models	• Data analysis • Data analysis • Data analysis • Data analysis	• Measurement frameworks • Causality data • Interviews
External Validity	• Use theory in single case studies • Use replication logic in multiple case studies	• Research design • Research design	Replication in multiple case studies- how many?
Reliability	• Use case study protocol • Develop case study database	• Data Collection • Data Collection	How many case studies?

The findings will be analysed for patterns in decision-making (Section 3.4.4). The replication of case studies will provide external validation (Section 3.4.1). The reliability of the data collection and analysis comes from the number of case studies and piloting the questions (Section 3.4.2 and 3.4.3).

Eisenhardt (1989) considers that using one case study compromises the replicability of the data and, as the research question might shift during the research, one study can not provide a comparison to verify the shift. Glaser and Strauss (1967) and Pettigrew (1988) suggest that two case studies can lead to polarisation, albeit that two polarised case studies may sharpen the construct. However, the process would benefit from a third case study to cross-reference with the pair of case studies and by further replication

confirm, extend and sharpen the theory to a concept. Therefore, three case studies are required to provide reliability, internal and external validation. Coincidentally, the logic of triangulation is also achieved with three case studies (Bryman and Bell, 2015, p. 647). It is at this point, how the three case studies are used as part of the strategy needs to be considered.

Yin structures a protocol in four sections: 1) An overview that includes project objectives, known issues and relevant readings of the investigation, 2) field procedures or general sources of information, 3) case study questions, and 4) a guide for the case study report. With a protocol the case studies outline 'how' the research will be carried out and the reliability comes from the repetition of the protocol's application. The case study protocol (Table 3.5) sets out how to conduct the research and validates the procedure of creating knowledge and database building (Yin, 2003).

3.3.2 Narrative Review

Narrative review becomes critical because of the inductive and interpretivist approach to discursive use of terms of sustainability and resilience. Bryman and Bell (2015) outline that with inductive research the theory is the outcome of the study and a narrative review provides a method in which to survey the topics of interest in literature and retain an element of flexibility. They continue to outline that the gap between systematic and narrative reviews is narrowing, so it is important to outline the procedure of the narrative research (Section 3.4.1). For this research design, the narrative review needs to inform both the case study but also the semi-structured interviews as it provides context for interpretation.

3.3.3 Semi-structured Interviews

Constructing knowledge from the social reality of how decisions are made in the built environment is imperative for this research (Carpenter *et al*., 2001). Bryman and Bell (2015) outline that semi-structured interviews provide a foundation to ask questions which can be interpreted by the interviewee and in doing so, reflect how the concepts are 'known' (used operationally). To increase reliability in data collection, the interviews could pursue structured or standardised questions because it would generate a reliable result to consistently asked questions; but this reduces interviewee interpretation and is less likely to expose gaps in knowledge.

The semi-structured interview allows the participants to explore issues that they feel are important and, through this verbal exchange, the social reality of 'how resilience and sustainability interplay' unfolds. Semi-structured interviews generate the empirical data and are the basis of the social construct of knowledge.

Bryman and Bell (2015) outline the role of interviews in qualitative research. Guided questioning should influence the asking of the initial question, so the interviewee has leeway in how to reply, thus gaining their insight into the practice knowledge. Semi-structured interviews ask predetermined questions but in practice are flexible and can be led by the interviewee. The researcher should aim to use similar wording between each interviewee and try to steer the line of questioning through the predetermined structure. The questions may change their wording dependent on the interviewee's response and variety of the 'kinds of questions' that need to be employed. Bryman and Bell

(2015, p.490) consider adopting open questions can yield more response, which is better for interpretation and reduces bias.

3.3.3.1 Identifying stakeholders

Understanding how to improve decision-making in cities must include representatives of policy, planners and design practice (Chapter 2). As both agendas are globally subjected to public scrutiny and debate, it is important to discuss intrinsic subject related knowledge with the people who make decisions concerning built environment policy and practice (Teigland and Wasko, 2009; Weichselgartner and Kelman, 2015). Key advocators in the built environment are normally architects, engineers, LEED practitioners, developers, clients, city planners, and city governance offices relating to environmental departments. Bryman and Bell (2015, p. 430) consider approaching specific knowledge groups as **a stratified purposive sampling approach,** which works with case studies and semi-structured interviews. Selecting the sample related to these built environment decision-makers meant using Linked-In as a search engine to find people in each city with 'sustainability' and 'resilience' expertise.

To maintain a quality of data reasoning, the number of people should not be limited (Bryman and Bell 2015, p.436) but it has to be accepted that not everyone can be found to talk to or be willing to participate, and that across case studies the data will start to saturate when themes start to reoccur in the analysis.

3.3.3.2 Ethical approval and consent

Miles, Hubermann and Saldana (2014) and Bryman and Bell (2015) outline that data protection and consent of people's responses are paramount both to the interviewee and the research. Ethical and risk assessments are subject to local institutional protocols and this research received approval, which was demonstrated by an email confirming the approach was compliant with Loughborough University's code of ethics (Appendix 3.1). The process of obtaining approval was initiated by preparing a participant's information sheet and explaining the ethical requirements. If the participant accepted these conditions, a consent form was signed and retained for data management, and the interview questions were sent to them. When arranging the interview, the participants were informed that the call would need to be recorded for research purposes and that their data would be anonymised. Data has been anonymised using a case study city code and an interviewee number.

3.3.4 Thematic Analysis Method

A "*thematic analysis should be seen as a foundational method for qualitative analysis*" (Braun and Clarke. 2008, p.78). The main advantage of using this method is its flexibility and compatibility with the constructionist paradigm; in some instances, it can also be use independently of theory (Braun and Clarke). To identify how the resilience and sustainability agenda has been interpreted the discourse must be dissected in a systematic way. Braun and Clarke (2008) outline a six-phased approach to a thematic analysis shown in Table 3.2. Phases 1-3 require data to inform the determination of the themes. Miles, Hubermann and Saldana (2014, p. 32) discuss that sampling

strategies can evolve during early data collection. For this research design, it has meant there has been an iterative cycle between the narrative review of documentation in each case study city and the interpretation of interview data to determine the precise themes. Four themes that were established through the case studies and initial code framework were: city context as this provides description, three levels of decision-making: city policy, city planning, and city design to represent the decision-making pathway.

Table 3.2 Phases of thematic analysis (Braun and Clarke. 2008, p.87)

Phase	Description of the process
1. Familiarizing yourself with the data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Once these themes were determined, it provided increased focus to the case study method and data management. For the case study method, the protocol was revised, and the case study report fully overlapped with phase 6 (Table 3.2) (Braun and Clarke, 2006). For data analysis, the themes are also used to collect data and analyse it (Ryan and Bernard, 2003; Braun and

Clarke, 2006). This approach to data collection "*provides the researcher with the basis for a theoretical understanding of data that can make a theoretical contribution to the literature relating to the research focus*" (Bryman and Bell, 2015, p. 600). When using themes in a coding framework (Section 3.4.3), the themes must become internally coherent, consistent and distinctive so that the themes can relate back to the original data set (Braun and Clarke, 2006). It is an interactive process as shown in Figure 3.1.

3.3.5 Causal networks and actor networks

Morton (2004) outlines that establishing a causal relationship adopts the categorisation of facts into levels of description, to allow the consideration of the external influences within the respective level of decision-making. Miles, Hubermann and Saldana (2014) discuss explaining causation by using causal chains or networks. They describe that causal chains can be used to "*study less constructive processes- sequences with negative outcomes*" (Miles, Hubermann and Saldana, 2014, p. 236). Causal networks can be achieved with inductive research as "*it has regularity and pattern; some things happen only when others do or don't. These things and the links between them acquire their own names or labels, and cluster into the probable influences and effects they appear to engender- and the analyst has a causal network*" (Miles, Hubermann and Saldana, 2014, p. 238). Rydin (2013) considers that Actor Network Theory (ANT) is critical in crossing boundaries between the planning community with professionals, public and civic voices. ANT provides an alternative to causal networks as it "*based on understanding the dynamic ways in which relationships between actants are*

forged, negotiated and maintained" (Rydin, 2013, p. 25) and considers shifts in relationships.

Whilst a casual network will not be constructed, it is important to recognise that decisions create cause and effects over time and that relationships along a decision-making pathway can shift too. For the purpose of this research, decision-making timelines have been created to track interplay along the pathway of city policy, planning and design practice. Each timeline generates a pattern in decision-making actors and relationships (Chapter 4).

3.4 Research Design Development

The strength of this research design is that it crosses theoretical and methodological boundaries to generate context that connects causality of resilience and sustainability, discursive rhythms, and decision-making in cities. Bahadur and Tanner (2014b) outlined that cities are critical to improving policy outcomes of the resilience and sustainability agenda (Chapter 1). City practice is representative of how decisions are made concerning urban development. Understanding a city's decision-making pathway is critical to generating empirical evidence. The pathway to be observed includes the following:

- Policy making is important as it sets the urban development targets;
- The sense of place is important because sustainable and resilient outcomes reflect their location;
- City governance is important because it translates the policy and set targets;

- City planning departments are the conduit between governance, land use and standards of city design practice (procedural, metacognitive and factual knowledge of the built environment projects).
- City design practice as it interprets measurement targets, practice standards and metacognitive knowledge.

The process starts with recognising the recurring trends in the literature (Section 2.2) and how they connect with city practice (Figure 3.2).

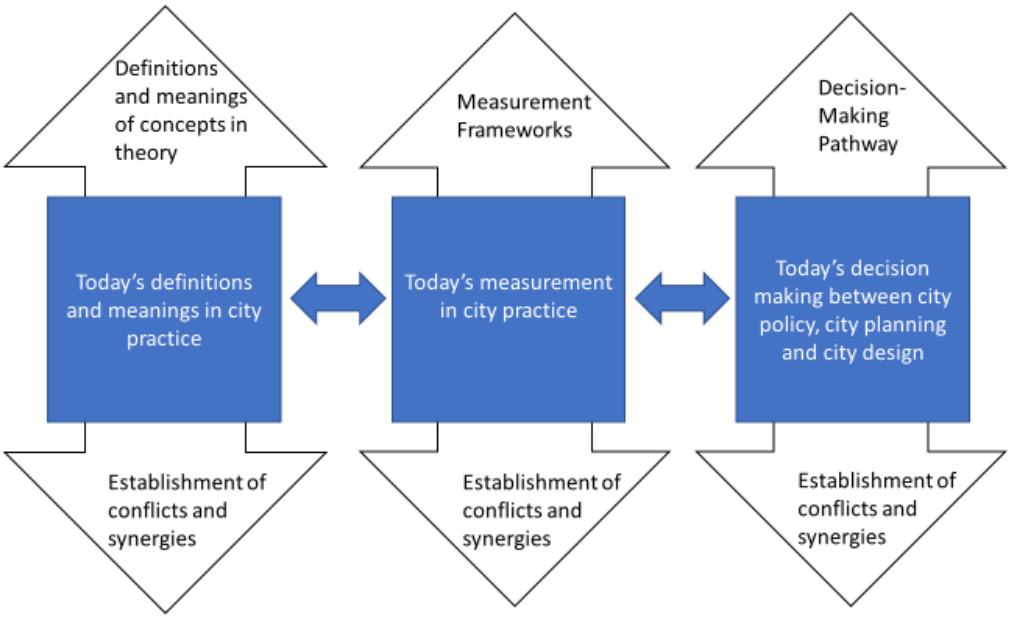

Figure 3.2 City practice knowledge and thematic analysis

The outcome of this research should lead towards identifying conflicts and synergies in interplay of sustainability and resilience in decision making (Section 1.5). The following sections outline how the research design has been created in five steps (Figure 3.1).

3.4.1 Step 1: Triangulation of methods

The research design relies on its methods because they have technical rigor, but each method is malleable in how it is used which supports interpretivist and inductive approaches. These decision-making pathway themes create the subject of the case study, and their relationship is illustrated in Figure 3.3.

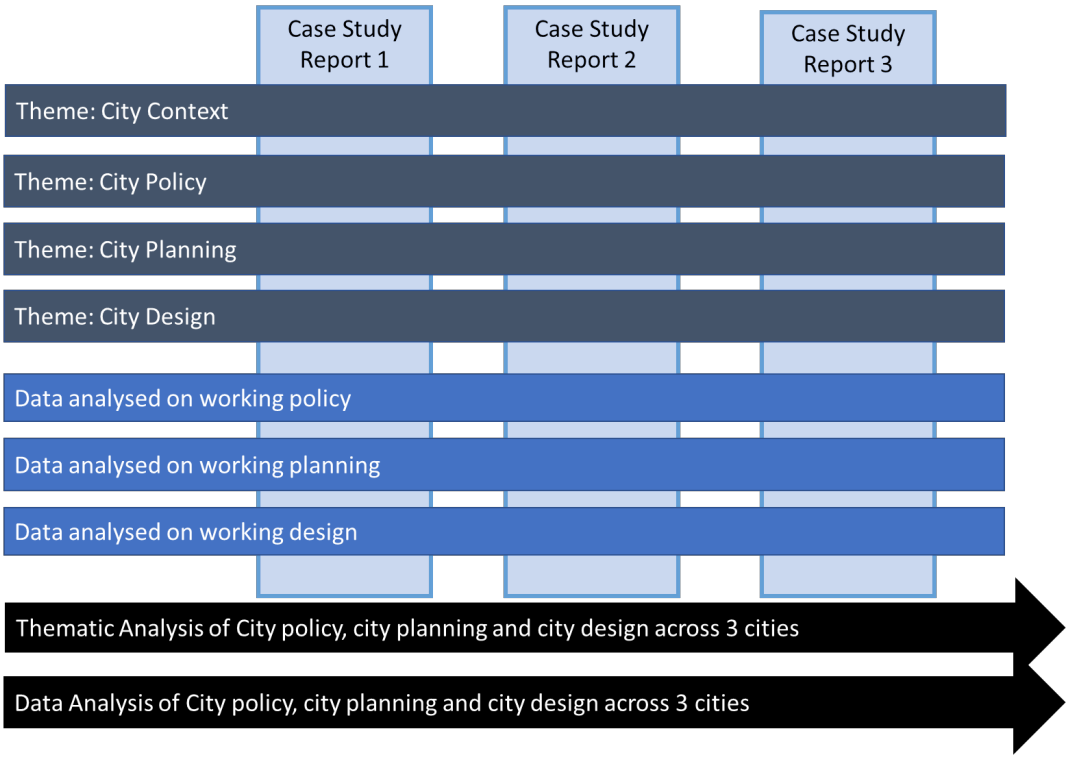

Figure 3.3 Meshing of themes and case study report compilation

With positioning how the case studies and thematic analysis relate to one another, the case study protocol can be finalised and the data collection process outlined (Section 3.4.2). The case studies, thematic analysis and semi-structured interviews produce a triangulation of methods to investigate how sustainability and resilience generate conflicts and synergies in use of language, measurement and decision-making.

For reliability and validity of the case study method, the number of three case studies has been determined (Section 3.3.1). The research trends recognised that cities are at risk with a measurement agenda and an increase in global population (Cohen, 2014).

Case studies are providing a context boundary and by accepting cities as the scale, the decision needs to be made about: which country?, which cities?, what data is available?, and who has city practice knowledge? This decision process is described as follows and recorded in Appendix 3.2:

A total of 175 cities across the globe were identified due to their participation in the global program of C40 and 100RC. A scoring structure was created for primary and secondary parameters which most relates to working knowledge (documentation in use) in policy, planning and practice (Table 3.3). The working parameters relate to practical issues of carrying out the research. The list of 175 cities was soon reduced to two countries that had three cities or more. Australia and USA scored highly and met the criteria (Appendix 3.2). Globally, the USA is the second largest country with a GHG problem (Moran, 2018) and the USA had 3 cities on a similar time zone, longitude and latitude. Further to that, the USA has historical practice of a sustainable building method (LEED), and the USGBC is a member of the WGBC. The cities selected were: New York City (NYC), Chicago and Boston.

With the location of the cities established, a preliminary narrative review of the three cities' primary sustainability and resilience city strategy documents were reviewed (Chapter 4).

Table 3.3 Decision criteria and scoring structure

Primary Parameters	Point Awarded	Rationale
Member of C40 Member of 100 RC Member of Making my City Resilient Campaign Governance- is there a mayor? Does the mayor have control over the buildings policies? Is the country a registered member of the World Green Building Council? Is there an Established BEAM? Have shocks and stresses been identified? C40 city advisor Chief Resilience Officer Available documents to review and assess	1 1 1 1 1 1 1 1 1 1	By the city being a member of one or more of the leading global campaigns, there is local governance support for the sustainability and resilience agendas. By participating in these campaigns, the shocks and stresses to the city have already been assessed. Green Building Guidance through planning and having a national BEAM will provide a benchmark in assessing conflicts and synergies in planning and design guidance. An expert such as CRO or a C40 city advisor.
Working Parameters		
Country- is there another city in the same country? Language (English) spoken and written (access to information) Known contacts Time zone		Can we communicate?
Secondary Parameters		
Is there a green building law? National Plan for sustainability or resilience? City resilience strategy? City sustainability strategy? Local Green Building code	1 1 1 1 1	Developed documentation to review

Typically there is one current city strategy document that includes the sustainability and resilience approach but each document has a history and also separate conceptual origins.

The most recent city strategy document (s) and previous editions were reviewed for the following information:

1. What does the document do (its purpose)?
2. What are the inherent ‘resilient’ risks identified?
3. How does ‘the document’ affect decision making?
4. Who does it facilitate?
5. Stakeholders were identified and connections to other documentation made.
6. What is its relationship to global regulation (Sendai & SDGs)?

Each city’s initial narrative review informed an understanding of how decision-making had evolved in relation to sustainability and resilience (Appendix 3.3). A further narrative review of secondary city sustainability and resilience documentation that related to localised policy, planning and design were also identified and then examined (Appendix 3.3). As the documents were assessed, it became evident that there had been a recent shift in city policy as there were multiple versions of city strategy documentation in a short time frame (around 2014).

However, which group of decision-makers were working to which version? These nuances in city documentation start to create inherited conflicts in decision-making. To consider the discursive interpretations over time, a set of further narrative search terms were generated for the thematic analysis of city policy, planning and design practice (Table 3.4).

Table 3.4 Narrative Questions

City Narrative Questions
• How does resilience and sustainability feature in city strategy documentation?
• Does the city documentation reference regional (and national) guidance? If so, what are the critical conflicts and synergies in planning and policy?
• How is sustainable building facilitated?
• What opportunities are there for LEED-RELi to manage resilience and sustainability better?
• What are the design 'issues' of scale exposed? (i.e. stormwater management) in planning documentation?
• What are the measurement frameworks employed and what were the outcomes?

Subsequently with reference to Eisenhardt's steps and Yin's case study protocol, the case study protocol (Table 3.5) was revised (Eisenhardt, 1989; Ryan and Bernard, 2003; Yin, 2003). The thematic analysis of the cities landscapes of policy, planning, and design practice was determined critical to consider explaining the effects of decision-making. The three cities case studies are represented in Chapter 4.

Table 3.5 Case study protocol based on Yin (2003, p. 68)

City Case Study Protocol
Introduction to case study and purpose of protocol
• Case study trends derived from critical analysis of literature: discursive use of conceptual knowledge, discursive use of measurement and their causal affects in decision-making. • Role of setting descriptive context in cities to ascertain how decisions are made in city practice by considering the pathway of local policy in city planning and city design practice of the built environment. City practice trends relate to narrative document review • Case study questions for each research question in each city
Data collection
• Stakeholder identification of practice knowledge and informing participants of ethical considerations. Consent forms to be signed by interviewee based on a description of the research • Preparation of questions and checked by a North American (NASA) Region Practice Leader of a global engineering consultancy • Data management and coding framework of semi structured interview transcripts • Systematic review of the city's landscape of policy, planning and design practice documentation that considers sustainability and resilience
Outline of case study report
• City context setting to provide a sense of place; review geography, microclimate, carbon emissions, historical governance and critical events relating to the city • City policy – what has historically happened and what is happening today with regards to the trends in decision-making of sustainability and resilience. Consideration of federal and local governance • City planning- what has historically happened and what is happening today with regards to the trends in decision-making of sustainability and resilience. Consideration of local planning laws and relative processes • City practice- what has historically happened and what is happening today with regards to trends in decision-making of sustainability and resilience. Consideration of professional conduct, codes of practice and specific procedural knowledge
Case study semi structured interviews
• Revision of pilot questions checked by North American (NASA) Regional Practice Leader of a global engineering consultancy • Questions relate to how decisions are made concerning sustainability and resilience in city practice
Evaluation
Each city case study acts to check reliability of data. Each case study provides description and ordering of events in city practice. All case studies and practice knowledge are to be thematically discussed and provide a cross-case assessment of cities that can be replicated for other cities and countries.

3.4.2 Step 2: Preparing for data collection and analysis

Section 3.3.3.1 recognises that there are multiple decision-makers in the built environment from city governance, policy-makers, planners and designers and beyond the city environment, there is a network of decision-makers (Section 3.3.5). In accordance with case study protocol (Table 3.5), pilot questions were created then tested with practitioners who have experience of decision-making across the landscape of city policy, planning and design practice. Their responses to the pilot questions were incorporated and informed the final questions, Table 3.6 shows the NYC questions. Then the same questions were then localised for each city case study because city documentation was different (Appendix 3.4). These were then checked by an experienced practitioner in the US for local language, terminology and interpretation. These responses also provided the starting point to develop the initial coding framework (Appendix 3.5.1).

Table 3.6 Semi structured interview questions for NYC

List of General Questions
Opening question: what is your job role and how do you define resilience and sustainability/ or how do you use its terms?
What are the goals, mission and objectives of resilience efforts in NYC?
What are the goals, missions and objectives of sustainability efforts in NYC?
How are projects (building and infrastructure) with resilience outcomes managed?
How are projects with sustainable outcomes managed?
What opportunities are there to manage sustainability and resilience together?
Should they be seen as mutually supported agendas or are they separate?
What measurement tools do you use? Are they beneficial or not?
What are the opportunities and barriers for both agendas?

Specific Role Questions:

If the person has a specific role or mentioned a reference point that was reflected in the responses, then questions were asked for their role category.

Theme: Planning and Design
• What are the obstructions in delivering sustainability and resilience in projects? (a 2015 housing plan update report specifically outlines design code updates and issues with FEMA) • How are the long term impacts of sustainability and resilience going to managed and monitored? • What are the design issues in the local building codes that needed updating? • What are the disparities in the FEMA documentation?
Theme: LEED/ Envision/ Green Building Assessors
• Are you aware of LEED-RELi? Have you used it? • Are you aware of envision? Have you used it? • Obviously major city projects on green infrastructure, housing, resilience and sustainability, how does this scale of project relate to your work? Does it affect the decisions that are made on the project? Does it enhance or negate the credit goals? • How does spatial and temporal scale of the decision affect the outcome? Can you provide an example? • Are the local green building codes comparable to LEED, how do they perform? • Where do you think there are the most gaps in design and planning buildings and infrastructure with local policy? • What changes would you like to see to implement LEED better?
Theme: Measurement (policy, strategy and resilience specialists)
• How do the one NYC targets affect your work at 100RC? • Do you think the targets set could be better supporting the sustainable performance of buildings, housing and infrastructure? • How is the relationship evolving between the 100RC strategy and One NYC with regards to resilience? • How is the relationship between the strategy outlined in Built to Last and Rebuilding together? • Do you agree with the NYC Climate change predictions? • How is vulnerability being measured? • How is the overall outcome of risk being measured? And how are these outcomes being fed back into meeting the OneNYC strategy?

Following Weber's protocol (Bryman and Bell, 2015, p. 299), the coding framework was initially set up to consider the interpretative interplay of the conceptual meaning of sustainability and resilience in decision-making on specific factors relating in practice and to identify a conflict or a synergy (Appendix 3.5.1).

However, when analysing the data the initial coding parameters were too stratified or specific and a broader approach was needed (Section 3.1). The expectation was that a decision-making conflict or synergy would be outlined by the interviewee but their responses provided reality and context. Conflicts and synergies needed a different style of recognition and the coding for "cause and effect" was created. The cause or effect relates to the themes (Section 2.4) and decision-making influencers and actors (Table 4.1). To decipher the causal relationship then required secondary analysis and a sample is provided in Appendix 3.5.3.

When applying the coding framework on transcripts, it was starting to become evident that resilience meant many things which represented Levine's (2014) position that resilience has too many meanings for quantification and coding nodes. A generalised and more open approach to interpretations was required to the coding and transcript analysis which lead to the code of "interpretation of sustainability and resilience". Section 2.2 outlines the broad range of conceptual meaning and measurement frameworks, so data needed to be collected for these two groups, however, decision-making was much more complex (Section 2.3).

As it is important to understand the role of metacognitive knowledge, a code for ‘job role’ was created because the professional experience of the stakeholders was considered important as this has shaped their interpretations of their definitions of sustainability and resilience.

Research themes have been identified in the narrative (Section 2.4) that relate to discursive use of conceptual interpretations and measurement frameworks in decision-making. However, to understand which conceptual definition has become procedural knowledge created the code “working: resilience and sustainability” but the context to the decision is just as important. This led to the code of “design”, “planning” and ”policy” to represent the level of decision-making. Procedural knowledge was considered as specific meta-cognitive understanding of measurement frameworks (Table 2.2) and sub codes were created for each framework (see Appendix 3.5). Metacognitive knowledge of each decision-maker was important to collect too, because this provides context to the cause and effect of the decision, this created the code for the level of decision. Appendix 3.5 shows the initial starting point. It took four iterations of the coding manual to understand that interview responses were discussing context and conflicts and synergies were not always rational but complex. The coding needed to be simplified to allow more context to be considered.

Table 3.7 shows the final coding manual which was pilot tested on the same three interviews before using it for the data analysis.

Table 3.7 Coding manual

Categories (the themes)	Coding Terms	Interpretation question
Conceptual knowledge in practice	Working Resilience Working Sustainability Job Role Interplay Design Issue Planning Issue Policy Issue Opportunity Network Building	What is the working definition? What is the working definition? Positional understanding How do they interplay? Pathway Issues- What is said as a conflict or synergy? Or is an issue identified? What do interviewees think works well? Is the interviewee highly knowledgeable for further evaluation?
Procedural knowledge in practice	Working LEED Opportunities for LEED Green Building References Measurement Frameworks Decision maker	Is LEED used? And How? Can LEED be used to support resilience? What other systems are being used? Which framework? Who makes the decision?
Level of decision in city design practice	Design Documents	What has been directly referenced?
Level of decision in city planning	Planning documentation	What has been directly referenced?
Level of decision in city policy	Policy documentation Local governance	What has been directly referenced? Who makes decisions?

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The coding framework (Appendix 3.5.2) was set up using NVivo software. NVivo is a computer assisted qualitative data analysis tool which allows transcript sources to be imported and analysed in accordance with the coding framework. For data recording, the NVivo coding framework was generated and titled “interplay of sustainability and resilience”. Coding stripes were used for each node and sub-node in each transcript.

3.4.3 Step 3: Data collection of narrative review, semi-structured interviews, and analysis of stakeholders and coding themes

Data collection was twofold: a narrative review of city documentation and conducting semi-structured interviews to generate transcripts with people in NYC, Chicago and Boston (Appendix 3.3).

Firstly, the narrative review was an extension of the existing cities case study documentation (Section 3.4.1). It also became apparent that national context was relevant in terms of professional institutions and legal history (Section 4.1). Documentation reviewed included specific city strategy documentation for resilience and sustainability, also references relating to the planning process and municipal practice references (Appendix 3.3). Section 2.2. has outlined that sustainability and resilience have multiple interpretations, sustainability in the built environment is often para-phrased as 'Green Building' and specific sections have been provided in the case studies (Section 4.6.6, 4.7.6, 4.8.6). Resilience has taken on multiple phrases too; mostly hazard mitigation and preparedness planning but the discursive language has tried to encompass as many terms as possible.

Secondly, selecting people to interview was a challenging process mostly because of the research being conducted in another country and across three different cities. Initially, there was no one to initiate the line of enquiry or connected person to approach. However, the Institution of Structural Engineers provided North American contacts as a starting point, and from the pilot questions the country expert was able to direct towards people in local governance. People were also found by using LinkedIn and the search terms:

LEED AP, ‘sustainability’ or ‘resilience’ in each city. Over 80 people were approached across the three cities, people were approached with a brief introduction and asked if they were willing to participate in research. If they were willing to proceed, they were sent the participants information document which outlined the research scope. If they were willing to be interviewed, they were asked to sign the consent form and a time for the interview was arranged (Section 3.3.3.2). Some practitioners were able to create a link to city governance and create the snowball effect (Bryman and Bell, 2015).

A total of 19 semi-structured interviews were conducted from April - October 2018. Due to location issues interviews were carried out remotely through Skype and were recorded to create an audio file. Interview lengths ranged from 30 - 90mins, lasted 49mins on average and in total there was 935mins of audio files. **The transcription process** involved listening to each audio file (file ending.av4) and using MS word formatting. Every word was typed out to compile a transcript of the interview (file ending.docx). The transcripts were ordered by city and stakeholder reference number. Albeit necessary, the transcription process was a time consuming and sometimes not every word was audible.

All the interviews were opened with an icebreaking question: what is your job role and either how do you define resilience and sustainability or how do you use its terms? Then the interview progressed with general questions (Table 3.6) concerning understanding of resilience and sustainability in operational terms, before progressing onto questions that considered more detailed components of measurement systems such as LEED (Appendix 3.4).

The NVivo analysis process is outlined by Bryman and Bell (2015) and the technique of selected text with coding stripes to assign it to a node was adopted. Once each transcript had been coded, data has been collected into the nodal groups of conceptual interpretations, measurement and policy, planning and practice issues (Table 3.7).

As the data collected was highly interpretative and very descriptive, a further interpretative analysis was required to understand the motivation of decision-making and consequences in policy, planning and practice. The coded data from NVivo was exported into an excel file for secondary analysis. The secondary analysis aim was to build connections with the themed literature of conceptual interpretation and measurement (Section 2.2), the city narrative (Chapter 4) and consider the cause and effect relationship (Appendix 3.5.3 provides an example of data interpretation). Due to the inductive approach adopted to the research, knowing whether enough data had been collected was an issue. Saunders *et al.* (2017) identify that when the interview responses start to become repetitive, it suggests that data saturation has occurred. With no set limit or target for interview numbers, when to stop carrying out interviews was governed by the researcher's interpretations of data saturation.

Adopting the total of 19 interviews, the stakeholders profile was examined for role and decision-making scale (Table 3.7) to ensure that there was enough breadth to the responses provided and whether there were established themes within them (Step 4). Data interpretation is subject to the researcher and when considering themes, sometimes it is important to remember what

providing an interpretation means. Bryman and Bell (2015, p.599) outline guidance on how to interpret data as listed:

- Repetitions: topics that recur again and again;
- Indigenous typologies or categories
- Metaphors and analogies
- Transitions: the ways in which topics shift in transcripts and other materials
- Similarities and differences
- Linguistic differences
- Missing data
- theory-related material

The interpretation of the data started to recognise common themes in theoretical understanding (Section 5.1) and measurement (Section 5.2), as well as cause and effects of decisions (Section 5.3).

Eight of the nineteen interviews represent NYC. The interviews were conducted during 2018 with built environment consultants (5), a local governance representative and the developer and head of property for a global bank. All these people work with design and planning of sustainability and resilience either on a local or global scale. The most notable responses come from the built environmental professionals mostly because they are restricted by institutional boundaries. After three interviews consistent messages were developing on themes of carbon emissions and emergency planning and reality of how decisions were being made.

Five of nineteen interviews represent Chicago. The interviews were conducted during 2018 with a regional planner, LEED and Energy specialists, an architect with local governance history and a built environment specialist. All these people work with design and planning of sustainability and resilience either on a local or global scale. The most notable responses come from the regional planner (who does not practice in the city) as they were able to project the planning context of the city and the resilience specialist with local governance experience, who was able to discuss local political shifts. Repetition in responses in Chicago, were similar to NYC and perspectives provided on political actors.

Six of nineteen interviews represent Boston. The interviews were conducted during 2018 with specialist built environment consultants (3), local governance (city planner) and a lawyer. All these people work with design and planning of sustainability and resilience either on a local or global scale. Responses in Boston developed positively, there was a notable coherency on what the issues were and how they were being managed. Themes on interpretations of meanings and how decisions were being made were similar to Chicago and NYC.

To position the expertise and knowledge, a stakeholder analysis was also carried out with relevance to Mendlelow's matrix (1991) (Figure 3.4). The knowledge component has been considered as: the participant's role, their knowledge discussed in the interview and their working practice. Stakeholders knowledge is important because it represents how concepts are considered with practitioners who have experience with sustainability and resilience through policy, planning or design issues. Table 3.9 provides an

overview of practitioners' knowledge components of the job role and their associated area (s) of practice of either city, planner or design practice. The sample size represents nineteen stakeholders but the job roles are not evenly distributed (Table 3.8).

Table 3.8 Job role description

Role	Description	Representation
Policy Developer	Someone who works with policy- either as an enabler, influencer or custodian.	4
Attorney	Works with policy, planners and designers with implementing principles and resolving conflicts	1
City	A position in city governance.	2
Specialist consultant	An experienced professional who advises others in planning and design.	5
Client	Work with practitioners and pay for their services.	2
Planner	works with planning COP	6
Design	Works with design COP	12

However, the stakeholders were extremely knowledgeable and many had experience with cross sectoral decision-making (Table 3.9). As this research is inductive, the outcomes are yet to be fully understood (Chapter 5 and 6) and the sample representation maybe a research limitation (Chapter 7).

Table 3.9 Stakeholder Information: Transcript code, knowledge, role and level of decision-making

NYC	LEED Experienced	LEED Aware	C40	100 RC	Role	City	Planner	Design
1			Y	Y	Government City Sustainability-Resilience Director	●		
2					Resilience Global Lead/ ASCE Past President			●
3					Water and Environment LEAD			●
4					Structural Engineer			●
5	Y	Y			Property Developer		●	
6	Y	Y			Structural Engineer			●
7		Y	Y	Y	Global City Consultant			●
8		Y			Head of Property- Bank		●	
BOS								
1	Founder Developer of LEED	Y			Architect-Resilience specialist			●
2	Founder Developed-RELI- Y	Y			Resilience specialist			●
3	Y	Y			Architect-Resilience specialist		●	●
4					Resilience and Sustainability Specialist	●		●
5		Y	Y	Y	Government-City Sustainability Planner	●		
6					Environmental Lawyer	●		
CHIC								
1					Regional Planner		●	
2		Y			Resilience Specialist			●
3					Passive Haus			●
4	Y	Y			Building Modeller			●
5	Y	Y			Previous Policy/now Specialist	●		●

With the stakeholders interviewed, an assessment was carried out to consider decision actors and influences per job role. Mendlelow's (1991) power-interest matrix groups types of stakeholders into power and knowledge categories (Figure.3.4).

Figure 3.4 An interpretation of Mendlelow's stakeholders

The power component relates simply to organisational position and working levels considered of interest were global and regional leadership, city and company leadership, specialist or team consultant.. Using the transcript ID allows an evaluation of which cities are using High Power (HP), Low Power (LP), High Knowledge (HK) and Low Knowledge (LK) people in decision making and an assessment of how the roles are positioned in the matrix.

Table 3.10 stakeholders' power: knowledge matrix

HK: HP	HK: LP
BOS 02 NYC 02 NYC 07	BOS 03 BOS 04 CHIC 04 CHIC 05 NYC 08
LK: HP	**LK: LP**
BOS 01 BOS 05 BOS 06 CHIC 02 NYC 01 NYC03 NYC04	CHIC 01 CHIC 03 NYC 05 NYC 06

This analysis highlights that the people in roles relating to the city were perceived to have the power to implement the knowledge and make decisions, when in fact it is the knowledge component which is more important. Designers were perceived to have high knowledge and low power, planners - high power and high knowledge as distributed in Table 3.8.

Each power: knowledge group has its own characteristics which were:

HK: HP: BOS 02, NYC 02 and NYC 07 all operate a leadership role within their respective organisations at least a regional power level, they are all in the 'design' category. They are aware of the resilience and sustainability systems at play.

HK: LP: BOS 03, BOS 04, CHIC 04 are either specialist consultants or specialists within a design practice. NYC 08 is a client, a client should have high power due to the position of business but when considered at a city level, the client is limited in its leadership role and has company guidance to follow.

LK: HP: The most mixed category with policy (NYC01 and BOS05), planning and design represented. It should be noted that NYC01 was highly knowledgeable, but the interview did not yield in the data coding. What it highlights is that you can have people in positions of power in policy, but they lose sight of the details and their knowledge is operationalised in a very specific way. CHIC 02, NYC 03 and 04, have sustainability and resilience knowledge because they are leaders, but their knowledge is used in a specific way that does not mobilise resilience and sustainability concepts

through the power that they have - is this because of working practice limits them?

LK: LP: This category represents a regional planner (CHIC 01) who has knowledge but limited power as they are not working in the city boundary.

From considering power: knowledge three critical gaps were identified. City Governance have people in positions for Boston and New York an interview has taken place with 'the' city's sustainability or resilience appointed representative in city governance. What they have not been able to project is how sustainability and resilience is managed from a building development side/ permitting perspective. Contact must come from within the organisation, as an outsider you can only contact the City's buildings department if you have a permitting issue to discuss. Clients have relevant knowledge but not necessarily an understanding of the meanings of knowledge interpretations. High level actors such as the Mayor may not be able to represent their knowledge due to political constraints and are likely to refer to their organisational experts. Public statements of intention are made on the mayors' ambitions for the cities.

All interviewees have been extremely high calibre: many are leaders for sustainability and resilience in their respective practice organisations but knowledge can be confined by political boundaries as recognised with the regional perspective. All responses represent issues experienced in decision-making. The stakeholder analysis also considered the power: knowledge profiles of the practitioners to ensure an even distribution of intrinsic knowledge where global leaders representing the 'high interest-high power'

group and the ‘low power-high interest’ were considered as the remaining planners and consultants. Interviews were analysed in accordance with the coding framework and interpreted to created secondary data compiled in cause and effect result tables (Appendix 3.5). Interpretations consider what has been said and whether it has created a conflict or synergy in decision-making or how conflicts and synergies are affecting decision-making. From this analysis data clusters occur on how sustainability and resilience related decisions were made concerning city policy, city planning and design practice.

Despite initial concerns that there is a not an even distribution sample across sectors (Table 3.8), this is purposive sampling where thematic interpretations of sustainability and resilience and measurement frameworks is paramount. When all roles were collectively considered for decision-making, the representation was considered acceptable because the literature (Section 2.2) and city narratives (Appendix 3.3) were not generating new evidence. It was considered that data saturation had occurred.

3.4.4 Step 4: Understanding Interplay

Generating understanding between the case studies and semi-structured interviews relied on the organisation of the collected data. Context was built through complying with the case study construct (Table 3.5). The three city case studies thematically discussed sustainability and resilience in the built environment across the decision-making pathway of policy, planning and design (Chapter 4). Chapter 5 considers the analysed transcripts for each city to discuss interpretations, measurement and decision-making.

Decision-making data was tabulated into context, cause, effect. In some cases, the cause was discussed, the other the effect and the researcher had to build the connection between the two components. An example has been provided in Appendix 3.5. Once the data across the cities was tabulated in this way, connections and patterns of decision influence, actor and conceptual interpretation in policy, planning and practice were generated. A pattern would come from a repeated phrase such as ‘tax revenue’, ‘the mayor’ as a decision-maker but the behavioural characteristics of human motivation were difficult to identify (Step 5). In some cases, the decision interplay led to synergy where the concepts have merged or are mutually supportive of each other. At other types the interplay has resulted in conflict, where there is a negative impact or clear distinction that there is different practice in managing resilience and sustainability.

Bryman and Bell (2015, p. p432) discuss data saturation as the point where there is no new data, the relationships are well established, and the category is well developed (Section 5.4). From the descriptions of decision-making pathways of cities, distinctive patterns emerged and conflated on the issues such as tax, political shifts, political jurisdiction, scope of works and out of date codes. It was also determined ‘how’ resilience and sustainability manifest themselves in city practice of policy, planning and design. Once evaluated, no new data was found to provide insight into the relationship between resilience and sustainability of city policy, city planning and city design. Data collected in the semi-structured interviews allowed to inductively deduce decision-making factors to further construct context to interplay in decision-making in city practice (as described in Chapter 5). Human

motivation of how a decision is made was not fully recognised until the historical context was considered and habitual practice revealed itself in what was being said and the transcripts were reviewed with habitual practice as a node. Beyond these determined factors, any further verification on data saturation would change the methodological approach to this research because it would become deductive towards validating specific terms of conceptual understanding through predetermination of closed questioning. Also, as the conceptual interplay is advancing in all cities, the data collected is in time with this research.

3.4.5 Step 5: Building interplay explanations.

With this research design (Figure 3.1), building causal explanations of decision-making across cities was the last stage of the research. The overall analysis provides pattern matching across the case study cities to consider root causes in policy, planning and design to create contextual understanding of how the conflicts in decision-making can be reduced and synergies promoted (Yin, 2003) (Section 5.4). Interview data also considers which interpretation and meaning of both concepts has been adopted by city practice and how the concepts are being measured (Section 5.1 and 5.2). Findings were ordered using tables that consider influences and actors with critical city documents across the levels of decision-making.

Decision-making knowledge was created through the city case studies (Chapter 4) and the causal interpretations (Chapter 5), which enable an interpretation of what is causing the effects of conflicts and synergies between resilience and sustainability in city practice (Chapter 6). Critical

themes for the case studies are outlined in Section 4.5. To anchor the themes between the case study narrative and semi structured interviews, text has been placed in **bold** font. Explanation building (Section 1.3) is subject to the researcher interpreting the case study descriptions and creating the cause and effect tables to construct causal explanations across three cities. Interplay timelines of knowledge create the basis of a causal network (Section 7.4).

3.5 Methodology limitations

This section provides limitations on epistemology and ontology and the research methods. The research paradigm followed an inductive (abductive) approach to interpreting and constructing practice knowledge. This required the researcher to personally connect with the data and provide a contribution to knowledge as the researcher “interprets”, whilst not certain on where the direction of the research will lead. Carrying out the narrative review with the case studies provided rigor to the interpretative process, and created results of abductive interpretation, as represented in the findings (Chapter 5). Practice knowledge represented in the findings demonstrates the reality of how decisions are made and what they are influenced by. At the start of the research process due to the inductive approach, the findings are unknown, but Realpolitik has represented itself through streamlining the causal explanations (Section 5.4). With the findings established, the component of causality of decision-making becomes an issue and reaffirms the position that causal knowledge is only understood at the end of the research process.

3.5.1 Thematic Analysis

The thematic analysis process has been an enabler to both the case studies and exploring interpretations, but the use of it in the research process does lead to iterations of verification until the themes get more repetitive. The iterations are probably more pronounced in inductive led research processes. This may become an issue if interview responses were numerous.

This work has been carried out remotely to the country and there have been restrictions on data access. For example, the case studies have historical material that can only be viewed in public libraries such as previous editions of the municipal codes in Chicago (Chicago Public Library, 2013). Chicago Journal of proceedings has not been viewed as part of the case study search, as awareness of the source has been subsequent to this research (City of Chicago Office of the City Clerk, 2020). However, for further research this source gap would need to be reviewed specifically along with other cities council meetings (Section 7.4).

3.5.2 Stakeholders

To construct causal relationships and understand how to create a new knowledge foundation that considers sustainability and resilience in its decision-making needed breadth. The limitation of how many interviewees was in control of the researcher and connected to the development of the methodological approach. Causality is highly interpretative, and the researcher makes a judgement on the content. From the number of stakeholders interviewed, it has given enough data on causal interplay. However, to extend causal interplay towards causal networks, the design

team role of participation groups could be considered towards interpretations and a more deductive approach to data collection on what has been interpreted.

When considering the role, power: knowledge and level of decision, there was a notable gap associated with local governance, urban planners and policy. NYC and Boston had a representative from local governance, but Chicago did not. It should be noted that during this research period, the 100RC programme had withdrawn its funding for the role of CRO, which reduced the opportunity to talk to people in local governance (Berkowitz, 2019). Also, clients were difficult to identify, but the represented from the perspective of a developer and building owner interviewed.

3.5.3 Semi-structured Interviews method

Semi-structured interview questions were prepared, but seldom did the interviewee follow the structure or necessarily have the responses to the questions. The responses from the interviewees were generated from a more open structure whilst trying to steer towards the semi-structured questions. There are other notable limitations which are listed:

- As part of the case study decision known issues such as time zones and language were considered. Interviews were carried out using Skype, telephone or a version of video conferencing, so any nonverbal language has not been recorded.
- Only one person has not provided consent, mostly because high profile people are busy and the researcher not being able to visit the place of work, communication relies on emails.

- There are now known stakeholder barriers, as the 100RC have withdrawn funding, job roles are no longer employed..
- Positions in local governance are held by a single person, although NYC and Boston have responded, Chicago did not yield any local governance response. This restricts a power based comparison assessment of decision-making.
- Requesting interviews with Local governance organisations is restricted because the initial contact is based on a specific enquiry, i.e. problems with sewer or planning permissions.
- Numbers of stakeholders per group (Table 3.5) are not an even distribution sample and bias of procedural knowledge may exist.

3.6 Chapter Summary

Broad qualitative approach to go to deeper levels of understanding has been developed (Foucault, 1972) with three recognised themes of interpretations, measurement and causality of decision making (Figure 3.3, Section 2.4). The research methodology is inductive, interpretative, abductive and constructs procedural knowledge (Section 3.1 and 3.2). Reliability and validity are provided by the triangulation of research methods: city case studies, semi-structured Interviews, thematic analysis and explanations provided by causal modelling (Yin, 2003; Braun and Clarke, 2006; Miles, Hubermann and Saldana, 2014; Bryman and Bell, 2015) (Section 3.3).

Outlined in Figure 3.1 was the research process which has been described in Section 3.4. The critical decision was how many case studies and which cities has been described in Section 3.3.1, Table 3.3 and Appendix 3.2. Table 3.5 outlines the case study protocol and ethical approval for the interviews has been achieved (Appendix 3.1). Built environment professionals with sustainability and resilience experience were identified as stakeholders (Table 3.9). The interview questions and coding table provided in Appendix 3.4 and 3.5 respectively. Known research method limitations have been outlined in Section 3.5 and further holistic responses provided in Section 7.4. The most critical limitation is this research design relies on the researcher to use narrative reviews to generate the case studies, as well as interpret the interviews to construct procedural knowledge. However, this research design strength is that it is not sectoral (Mode1) and steers towards a transdisciplinary (Mode 2) approach (Gibbons *et al.*, 2006).

Chapter 4 City Case studies

Decision-making interplay has been examined in three US city case studies: NYC (Section 4.6), Chicago (Section 4.7) and Boston (Section 4.8). However, the Chapter starts with an introduction to the country's context (Section 4.1), national laws and practice (Section 4.2 and 4.3) because they are critical influences on decision-making in cities (Section 4.4).

Each case study presents a city landscape narrative of policy, planning and design practice which has been abductively constructed from considering actors and influences in decision-making of sustainability and resilience in the built environment. Section 4.5 presents the cross case analysis of decision-making which includes the identification of influences and actors on the decisions (Table 4.1), as well as constructing a decision-making timeline which positions global, national and city policy and practice (Figure 4.1). The three case studies then provide a descriptive narrative of decision-making interplay.

4.1 Country Context

The measurement of GHG emissions was initiated in 1990 by the Organisation of Economic Co-operation and Development (OECD Stats, 2019), which ranks countries by their environmental impacts including the indicator of carbon emissions The higher in the ranking order (that starts with 1) the more polluting the country. In 2000, the USA was ranked 5th, but by 2014 the country was in 8th position (OECD, 2009) which suggests that the USA's environmental performance was improving.

Moran's (2018) Global Gridded Model of Carbon Footprints measured the carbon performance of 13000 cities worldwide. The case study cities were ranked as follows: NYC 3rd, Chicago 8th and Boston 55th. This data collected supports that cities have a significant impact on global carbon emissions (Rosenzweig *et al.*, 2010; IEA, 2013). Mileti (1999) also outlined a North American context for knowledge transfer of sustainable hazard design between decision making in policy and practice. Although a direct comparison between the case studies is not possible, institutional barriers were described with reference to the role of the planning process (Fainstein, 2000).

4.2. Key National Laws

A systematic review of federal laws has not been carried out, because the scope is targetted at city scale and that federal requirements should be incorporated into city scale decision-making. However, a positional statement about Environmental and Planning laws has been provided.

4.2.1 Environmental Laws

The US Environmental movement led to the National Environmental Policy Act (NEPA) which became federal law in 1969 (Gale, 1986) followed by the Clean Air Act of 1970 (EPA, 2019) and Clean Water Act of 1972 (EPA, 2019). However, the Environmental Laws of 1970s have not changed significantly since their origin. According to the Environmental Protection Agency (EPA), the last time these acts were reviewed was in 1993 with President Bill Clinton and Vice President Al Gore (White House, 2019). Box

4.1 describes the habitual behaviour of decision-making with the continuous non-ratification of key global environmental legislation exhibited by the USA.

Box 4.1 Habitual behaviour of non-ratification of policy by USA
The Clinton-Gore Administration had a further opportunity to revise laws by committing to the Kyoto Protocol, but a shift in presidency from Democratic to Republican led to non-ratification by the USA (Bohringer, 2003; Hovi, Sprinz and Bang, 2012). The ratification of environmental policy seems to be untimely with shifts in presidential office, as this pattern in behaviour was also repeated with the Paris Agreement (UNFCCC, 2015; Falkner, 2016; Rajamani, 2016). This pattern of policy cycles (Knoepfel et al., 2011) with decision-making is out of scope but needs further exploration (Section 7.4 and 7.5).

The Federal Emergency Management Agency (FEMA, 2019) was established in 1979 by Executive Order of President Carter which creates a federal responsibility to be"*preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made, including acts of terror."* In 2003, FEMA became a part of US Department of Homeland Security. During recent times, it has supported the crisis response to large natural hazard-related events, most notably Hurricane Katrina, the Florida and Miami floods. It was reported at the UN World Conferences on DRR in Sendai that until this moment USAID had provided $1.2 billion to support DDR (US Mission to International Organizations in Geneva, 2015). Despite this contribution, the USA did not sign the SFDRR and went on to create its own National Disaster Recovery Framework (NRDF) (UNDRR, 2016).

FEMA is a part of a Federal statute and therefore subject to political shifts at federal level. Since 2018, it is no longer functioning beyond a limited service due to President Trump's administration. This current administration has adopted a climate change sceptic position (Baynes, 2019) and ascertaining

how laws will be altered to reflect this shift is unknown because it needs to be actively tracked (Section 7.3). However, the National Centre for Environmental Information (2020) reports that the US Climate in 2019 was the thid warmest in a 125 year period, the coolest since 2014 and the second wettest year on record.

4.2.2 Planning Laws

Regulatory Zoning in cities was initiated by President Hoover who passed legislation called the State Standard Zoning Enabling Act (SZEA) and published it through the United States Commerce Department in 1926. It provides a model through which planning organisations can enact their own zoning enabling laws. A further law was passed two years later called the City Enabling Act by the same president and department (US Department of Commerce, 1928). The result was that Zoning in cities became standardised (American Planning Association, 2019). The standard city planning enabling act (SCPEA) in 1928 then set out six requirements, the first of which was the organization and power of the municipal planning commission, which was directed to prepare and adopt a master plan (US Department of Commerce, 1928). This requirement directly linked commerce to city planning which may be viewed as contributing to their commercial successes but lacked consideration of environmental protections.

4.3 National professional practice

Professional institutions are the custodians of industry practice. In response to the NEPA, the National Associate of Environmental Professionals (NAEP)

was established in 1975 to provide environmental leadership in delivering the requirements of the NEPA (NAEP, 2019). Compliance with NEPA means that environmental professionals are required to produce Environmental Impact Statement (EIS) on behalf of Proponents. The production of an EIS as part of the development consenting process represents the requirement on all developments to demonstrate environmental responsibility and compliance with federal environmental protection statutes.

In a professional institutional context, built environment design professionals are mostly represented by the American Institute of Architects (AIA), American Society of Civil Engineers (ASCE) and American Society of Mechanical Engineers (ASME). Each professional organisation adopts a standard of practice and promotes institutional knowledge relating to sustainability and resilience issues.

In relation to the environmental decision-making of the EIS process is the American Planning Authority (APA). The APA is a professional organisation that refers to the SZEA and provides policy guidance (APA, 2019). The APA policy of 'Planning for Climate Change' (APA, 2011) has been produced and more recently the Planning Advisory Service (PAS) has been discussing the issue of 'Building sustainability and resilience into Local Planning Agencies' (Feiden, 2018). Yet, given its previous work in these policy areas, for 2019 it is noted that the APA reports its policy agenda is prioritising on "*just, healthy and prosperous communities*" (APA, 2019).

4.4 Country policy influence on city policy

For the case studies to be placed into context, many influences may need to be considered, but to ensure comparability between other countries and a non-political bias, only data provided by the OECD indicators will be used.

According to the latest OECD report (2009), 74% of the US population lives in cities. The USA has wide geophysical and microclimate diversity (due to the country's size) and the cities all experience a variety of natural shocks and stresses. More recently, these impacts are starting to increase insurance costs and lead to rebuilding urban areas (Mills, 2005). Hurricanes Katrina and Sandy have started to shift how development is perceived in terms of recognising that there is a need to provide more hazard resilience (Rosenzweig and Solecki, 2014; Wagner, Chhetri and Sturm, 2014). However, the most significant shift has increased investments into infrastructure (OECD, 2019).

As costs increase to protect city systems and infrastructure, city mayors have taken more ownership of hazard impacts and created specific laws. This is exemplified by the example of recognising the Paris Agreement through the creation of the NACC (Chicago Council on Global Affairs, 2018). The attitude towards self- governance at a city level becomes more evident through the case studies.

4.5 Case study descriptions and cross case analysis

The case studies' role is to generate contextual understanding of resilience and sustainability in cities as described in the protocol (Section 3.4.1). A narrative review of city literature and procedural documents has been carried out for each city (Appendix 3.3). Documents have been assessed for their conceptual interpretation of resilience and sustainability, measurement and influence in decision-making and informed by the case study narrative (Sections 4.6, 4.7, 4.8). Individual design discipline codes and respective professional standards have not been specifically examined, as this would create an embedded case study and extend the research parameters.

Themes of interpretations, measurement and decision-making have informed the data collection and case study narrative (Section 3.4). Identified in the boxes of Chapter 1 and 2 have been critical themes of issues in decision-making and the recognition of themes continues in the case studies. The critical themes identified are listed below, and emerging themes are identified the text in **Bold** font:

- Political bias (Box 1.1, Section 2.3.3)
- Interpretations of sustainability and resilience (Box 1.1, Section 2.2)
- Measurement frameworks (Boxes 2.1, 2.3, 2.6)
- C40 cities as an actor (Section 2.2.3, Table 4.1)
- The use of LEED and BEAMs (Box 2.1, Section 2.2.3)
- 100RC as an actor (Box 2.4, table 4.1)
- Decision-making (Tables 4.5,4,6,4.7)
- Habitual practice (Box 4.1, Figure 4.1, box 4.11)

- Political shifts (emerging) (Boxes 4.5,4.7,4.9)
- Carbon and energy bias in policy (emerging) (Boxes 4.5,4.7,4.9)

All three case studies start with how each city has developed its built environment over time by reviewing environmental factors such as geology and geography before considering social and economic behaviours. This background context positions the knowledge of how sustainability and resilience has evolved in each city's built environment. To consider the discursive use of language and measurement, the case study construct outlines the city decision-making pathway of policy, planning and design practice (Section 3.4.2). Green building and LEED have a specific section to consider how city codes and strategies have adopted these terms.

To provide a cross case analysis, this section collates the critical components alongside one another for comparison of decision-making shifts in Table 4.1 (Section 4.5.3). For each city, decision-making timelines have been constructed (Figures 4.4, 4.9, 4.13) from the landscapes of city policy, planning, practice landscape and the Green building which provide descriptions of the events. Figure 4.1 provides a cross case timeline to consider patterns, shifts and intergenerational behaviour in the decision-making pathway (Berger, 1960) (Section 2.3). From the perspective of planning and design practice, each case study indicates that the greatest barrier has been policy (Sections: 4.6.4, 4.6.5, 4.7.4, 4.7.5, 4.8.4, 4.8.5).

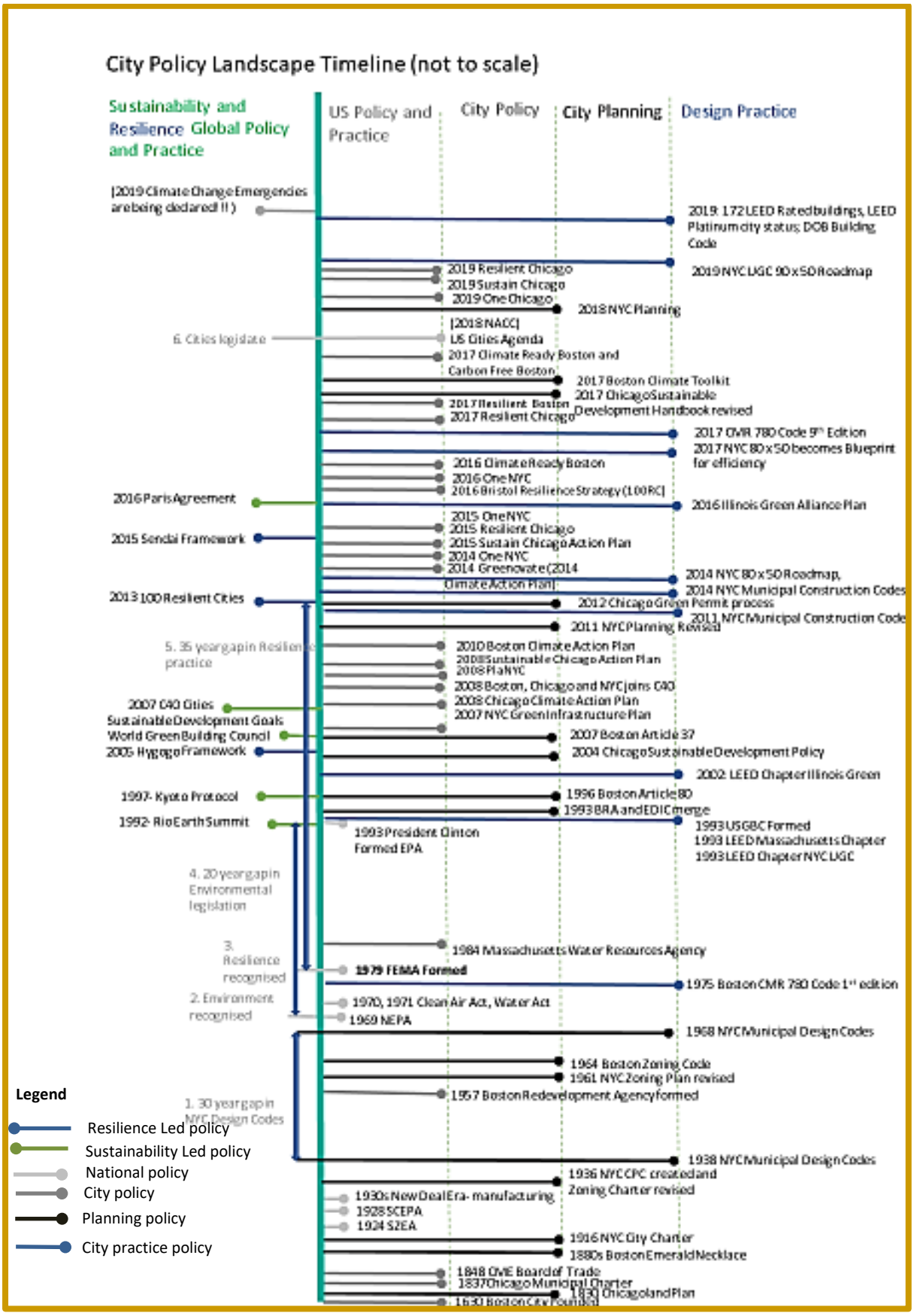


Figure 4.1 Interplay timeline for case study cities (see Appendix 4.1 for improved resolution)

4.5.1 Cross city Policy, Planning and Practice Landscapes

Each city has adopted a different strategy towards resilience and sustainability but in doing so city governance has created measurable entities with goals, initiatives and targets. The interpretations of both concepts have informed the policies for a period of time. However, planning and design practice is different with codes of practice in temporal cycles but there is commonality with the use of the LEED framework (Section 4.5.2). Tracking the interplay timelines indicate that the real shift in policies started to occur after the 100RC programme financed the CRO position in local governance (Figures 4.4, 4.9, 4.13). Boxes 4.3, 4.6 and 4.8 show how the 100RC has interpreted resilience for each city and shown in Box 4.2 is the characteristic analysis of the three cities. The common characteristics that are shared between the three cities are: **aging infrastructure, economic inequality, inadequate educational systems, poverty, rainfall flooding and severe storms**. The 100RC characteristics also show that bespoke responses have been determined for each city.

What is most interesting is comparing how each city chooses to measure resilience as shown in Box 4.2 and the descriptive quotes used in the city strategies (Sections 4.6.3, 4.7.3, 4.8.3). Each city has created a framework of measured entities to manage the consequences and to measure progress towards the cities' goals (Section 2.3). However, the use of frameworks generates fragments and stratifies the conceptual interpretations which create conflicts or synergies in decision-making.

Box 4.2 100 RC characteristics for all three cities.

Shocks and stresses in all three cities are shown in **BOLD, in total there are 6.**

Shocks and stresses in two cities are shown in **BOLD, in total there are 7.**

The 100RC process identified 18 shocks and stresses that applied to the city context which were: **Aging infrastructure**, **Climate Change**, **Coastal/ tidal flooding**, **Economic inequality, Extreme heat,** Homelessness, Hurricane/typhoon/cyclone, **Inadequate educational systems**, Inadequate health systems, Inadequate infrastructure, Lack of affordable housing, **Population growth/overpopulation, Poverty,** Power outage, **Rainfall flooding,** Sea level rise/ coastal erosion, **Severe storms** and **Shifting macroeconomic trends**. (100 Resilient Cities, 2019).

Chicago 100RC profile identified 14 shocks and stresses to the city which are: **Aging Infrastructure,** Crime/Violence, **Economic Inequality**, Financial/ Economic Crisis, **Inadequate Educational Systems,** Infrastructure Failure, **Poverty, Rainfall Flooding,** Riot/Civil Unrest, **Severe storms, Shifting macroeconomic trends, Structural racism, Terrorist attack,** Unemployment (100 resilient cities, 2019).

Boston's 100RC profile identified 20 shocks and stresses to the city which are: **Aging infrastructure**, Blizzard, **Climate change**, **Coastal/Tidal flooding**, Cyber-attack, **Economic inequality,** Ethnic inequality, **Extreme heat**, **Inadequate educational systems,** Inadequate public transportation systems, lack of social cohesion, **Population Growth/Overpopulation, Poverty, Rainfall Flooding,** Sea Level Rise/ Coastal Erosion, **Severe storms,** Storm Surge, **Structural Racism**, and **Terrorist Attack** (100 resilient cities, 2019).

The case studies have identified gaps in decision making between zoning and codes of practice, but when comparing the cities together more dominant shifts have been observed. Identified on Figure 4.1 are three generational shifts (points 1,2,3,4,5) which are described as follows:

> 1) 30 year gap between revisions to municipal design codes in NYC, this has been repeatedly recognised in all three case studies policy and practice landscapes. Chicago's generational gap is larger than NYC and Boston, is more regular with revising policy and practice after the introduction of BRA in 1957.
>
> 2) 25 year gap between the enactment of NEPA in 1969 and Rio Declaration. With the Rio Declaration, Boston and NYC practice create LEED Chapters in 1993. Boston follows with the enactment of Article 80 (Section 4.8.3). Chicago is five years slower. However, once Chicago mobilised LEED, city policies were rapid with Green Permits and Sustainable Development Handbook (Section 4.7.3). NYC appears to sit tight until PlaNYC was launched in 2007 with the NYC Green Infrastructure program (4.6.3).

> 3) 35 year gap between the recognition of the need for recognition of emergencies with the formation of FEMA in 1979 (Section 4.2.1) and the launch of the practice led 100 RC program in 2013. The creation of 100RC has a big impact on mobilising city policy and several revisions to city strategies are made in a comparatively short amount of time of 4 years. In fact, this is ongoing and led to cities creating their own power shift with the enactment of NACC (Section 4.7.3) (point 6).

4.5.2 Green Building (LEED)

From the generational gaps identified in the case studies, each city shows a lack of updated municipal design codes for long stretches of time and report recent changes to their policies. Figure 4.1 positions policy and practice chronologically, and it shows that NYC and Boston created a LEED Chapter within a year after the Rio Declaration. Yet, city policy and municipal standards stagnate until 2007.

The case studies have already discussed that city policy has mobilised LEED NBC standards but to varying degrees (Section 4.6.7, 4.7.7, 4.8.7). Chicago adopted LEED as a standard for city policy, where NYC and Boston were less prescriptive in their city policies until recently where it has become more dominant in the city strategies, especially in NYC with the Blueprint for Efficiency (BPDA, 1996, 2007; Department of Buildings, 2012; de Blasio, 2014). However, all cities have yet to prescribe LEED standards for refurbishments or domestic equivalent or stipulate requirements associated with LEED ND.

4.5.3 City Decision Making Factors

The thematic approach to the research has expanded the understanding of decision-making behaviour, influences and actors (Section 2.3). Table 4.1

collates all three cities decision-making factors for pattern matching. From reviewing Table 4.1, C40 and 100RC dominate as actors, which were enabled and adopted by the city mayors (Sections 4.6.3, 4.7.3, 4.8.3).

LEED is also recognised as a dominant actor for positive shifts; however, habitual practice in decision-making has also been identified (Section 4.5.1) where there are extended periods of time with no change to city policy, city planning and municipal codes. This is further discussed in Section 6.2.

Table 4.1 Case study cities decision making factors

	Influencing Factors and Actors	Sustainability- Resilience Procedural Data	Decision making levels
NYC	C40 100 RC Global Policy of Paris Agreement SFDRR City Governance (actor) US GBC Hazard Events and recovery of Storm Sandy LEED practice of city design FEMA	NYC One City Strategy and measurement targets Local Laws Blueprint for Efficiency	City policy
	Mnemonic Practice- no change to manage storm events and climate change risks	Municipal Planning Process 2011- Environmental measurement	City planning
	Mnemonic Practice- no change manage flooding risks LEED Practice	Municipal Codes 2014 NPCC 2019	City Design
Chicago	C40 100 RC Global Policy of Paris Agreement Sendai Framework City Governance (actor) US GBC	Resilient Chicago Sustain Chicago Chicago Climate Change Summit	City policy
	Mnemonic Practice City Practice	DOB Green Permit Chicago Sustainable Development handbook	City planning
	Mnemonic Practice- LEED Practice	Municipal Codes	City Design
Boston	C40 Cities 100 RC cities Global Policy of Paris Agreement SFDRR City Governance (actor) US GBC Hazard Events of Hurricane Sandy FEMA	Resilient Boston Carbon Free Boston Climate Ready Boston Greenovate E+Program	City policy
	Mnemonic Practice City Practice (LEED-RELi)	Municipal Planning Process – Act 80 and Act 39 LEED RELi	City planning
	Mnemonic Practice- LEED Practice (RELi) Scope of works	Climate resiliency Guidelines (waterfront); Municipal Codes 2014 CMR 780	City Design

4.6 Sustainability and Resilience decision-making landscapes of NYC

NYC is the most populous city in the US with 8.537m residents; reflected in its CO_2 emissions measured at around 52 042 186MtCO_2e (CDP, 2017). Moran (2018) measures the city's carbon footprint as 233.5Mt CO_2 (CityCarbonFootprints, 2019) and **ranks it 3rd out of 13000 cities worldwide**. While these data sets measure CO_2 differently, they correlate in that NYC is a city with one of the highest global carbon emissions. NYC is considered a 'megacity' with a growing population (World Economic Forum, 2019), which means that carbon emissions and land use issues will likely continue to increase.

4.6.1 City Context

NYC is famed for its islands: Manhattan, Staten and Long Island, and its location at the mouth of the Hudson and East Rivers (Figure 4.2) (Encyclopedia Britannica, 2019). NYC is an iconic city located on the North Eastern Atlantic coastline, south east of New York State. NYC has an average temperature of 12.86 °C and an average rainfall of 1177mm, which is classified as Koppen's temperate oceanic climate (Rubel and Kottek, 2010).

Despite its moderate rainfall, NYC's geography has history of issues with managing surface water and today NYC frequently experiences floods in downtown Manhattan (NYC , 2019). NYC 'island' landscape was created by

glacial recession, which over time revealed hard rock outcrops of granite and formed islands (American Museum of Natural History, 2019).

Figure 4.2 Location of NYC (source- NYC metropolitan area. Encyclopedia Britannica, Inc.)

These strong granite rock outcrops (Manhattan Island) facilitated the economic boom of the industrial revolution because skyscrapers could be built on the rock. This led to creating NYC's famous skyline and generating prosperity as global trading took place through the city's ports on the islands perimeter as seen on Figure 4.3. Figure 4.3 shows NYC in 1782, there is marshland indicated and canals.

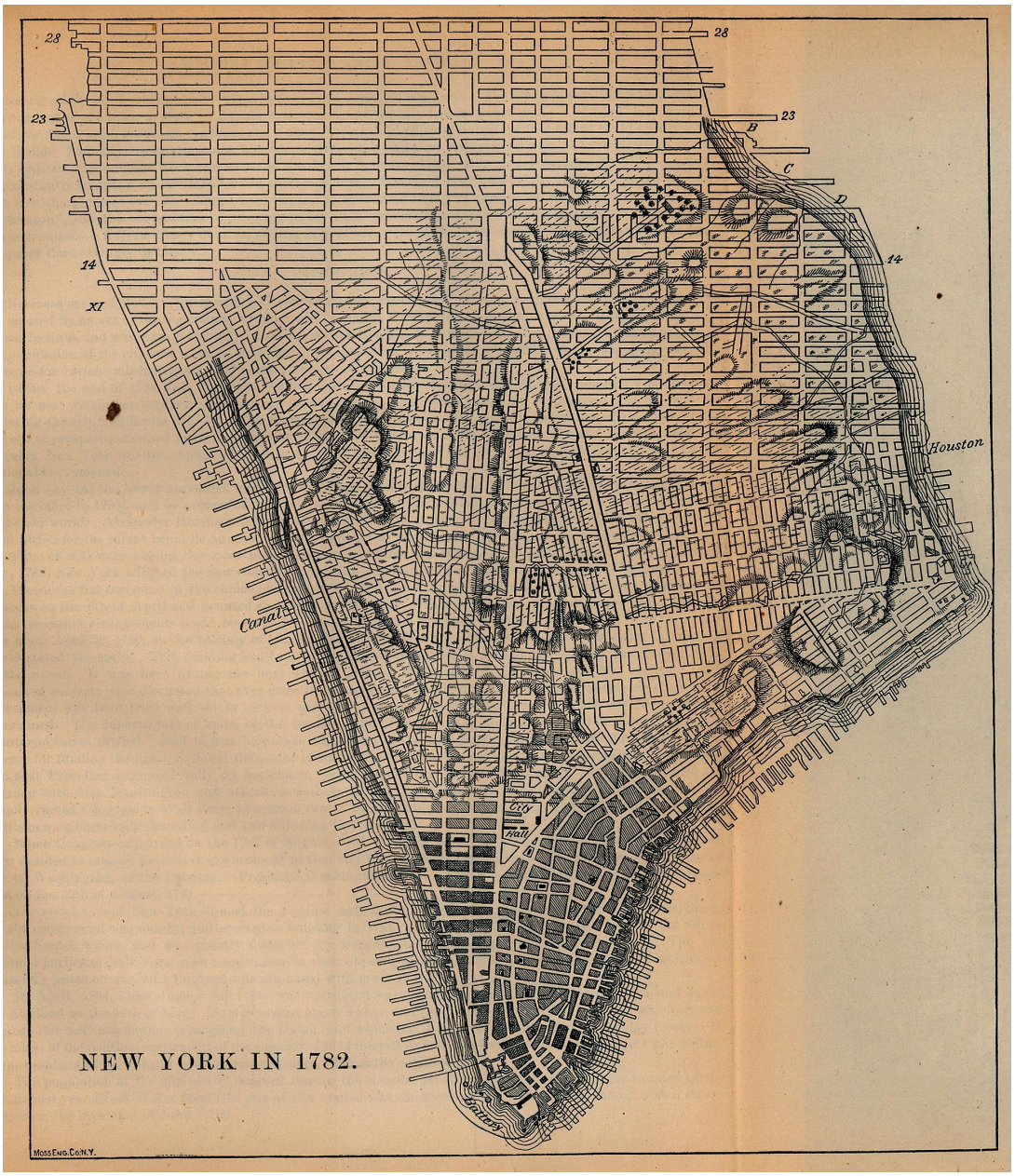


Figure 4.3 Historical map of NYC in 1782 ((The University of Texas at Austin, 2019)

As NYC developed in 1880-1930s, the island's land mass was extended by reclamation and a post-war development boom (Campbell-Dollaghan, 2013). Today, with sea level rising, this land is now subjected to coastal erosion, and the River Hudson carries sedimentation away especially after storm-related events (NASA Earth Observatory, 2011). Due to its physical location of being surrounded by water, it has always been vulnerable to these major

storm events and this vulnerabilty is becming more evident in the face of climate change.

It is this same geology that created the city's landscape between its islands. Over time these islands have developed their own social dynamics and represent the city's five boroughs: Manhattan, Brooklyn, the Bronx, Queens, and Staten Island, which support a growing population. In 1952, NYC incorporated a **global political role by becoming the base for the UN** (through the reorganisation of the Northern Atlantic Treaty Organisation) (Office of the historian, 2019). Consequentially, NYC has a global political role, and Federal (national) policies are developed in Washington DC.

Today, the **city has its unique cultural, social and economic diversity, which has led to much juxtaposition, such as racial and economic inequality**. In the early 1990s, the city was in crisis with its crime rates, homelessness, drugs and health pandemics. Mayor Giuliani in 1993 imposed 'Zero' tolerance policies to reduce crime rates but did not address the social inequalities (Kelling, 2009). This period of NYC history abruptly changed when the Twin Towers were destroyed in the 9/11 terrorist attack (Dolfman and Wasser, 2004).

Post 9/11, NYC politics shifted significantly thanks to Mayor Bloomberg (Steinhauer, 2001). He changed the way the governance institutions operated, introduced 'open plan' offices and promoted city commissioners to have autonomy of their decisions. However, the response to 9/11 created a real shift in how the city's residents were to be engaged in decision-making, starting with the launch of the 'Ground Zero' project (Crane *et al.*, 2014; Gin

et al., 2014; Svendsen and Campbell, 2014). This involvement of **community stakeholders is a monumental change of decision-making**, which is now represented by '8.6 million stories' (NYC Office of Recovery and Resilience, 2019). From 2010 to 2013, Mayor Bloomberg was the president of the **C40 cities programme**, and NYC's development agenda was driven towards more environmentally friendly development represented by the 'High Line' Project and NYCs Green infrastructure programme (Bloomberg, 2005, 2007a). Bloomberg's governance introduced a Chief of Sustainability and the Office of Long Term Planning and Sustainability (OLTPS) (Office of the Mayor, 2006).

By 2009, Mayor Bloomberg had introduced PlaNYC "*a greener, greater NYC*" aimed at meeting the city's climate change targets (Bloomberg, 2007b). Climate change policy progress was tested by Storm Sandy and in the storms aftermath, PlaNYC became "*a greener, greater New York, a stronger, more resilient New York*" (The City of New York, 2014b). **The impact of Hurricane Sandy had a profound affect across all of NYC, leading to the re-evaluation of flooding, adaptation, emergency management, and community resilience** (Lawrence *et al.*, 2013; Rosenzweig and Solecki, 2014; Wagner, Chhetri and Sturm, 2014; Graham, Debucquoy and Anguelovski, 2016; Yin *et al.*, 2017).

To recover from Hurricane Sandy, development shifted towards 'the Big U' project[3] (Rebuild by design, 2019) and the redevelopment of JFK airport (New York State, 2019). During this time, the city elected its new mayor,

[3] The Big U project has been recently expanded into the Lower Manhattan Climate Resiliency project(NYCEDC, 2019)

Mayor Bill Blasio. Shortly afterwards, **Blasio launched the 'OneNYC-Building a resilient and equitable city'** (Blasio, 2015), the OLTPS was replaced by the Office of Recovery and Resilience (ORR) and the Chief of Resilience was appointed to make decisions about sustainability and resilience (Resilience, 2018). Whilst the impacts of Hurricane Sandy are resounding, the scope of this research is limited to how decisions interplay, not how hazard events have specifically impacted the interplay, although this has clearly been a trigger for subsequent policy development.

Reflected in this case study is how NYC's future development is being driven by political leadership and legal systems. Between the actors of mayors Giuliani, Bloomberg and Blasio, the NYC's political landscape has experienced monumental and environmental shifts.

4.6.2 NYC Interplay timeline

Created in Figure 4.4 is the Interplay Timeline of NYCs policy and practice landscape with global and national representation (Section 3.4.4). The most critical time for the city is from 2007, when city sustainability practice starts to change pace. What has not been depicted is the volume of local laws enacted under city policy (Section 4.6.3) and the relationship between design practice and city policy (Sections 4.6.5 and 4.6.6).

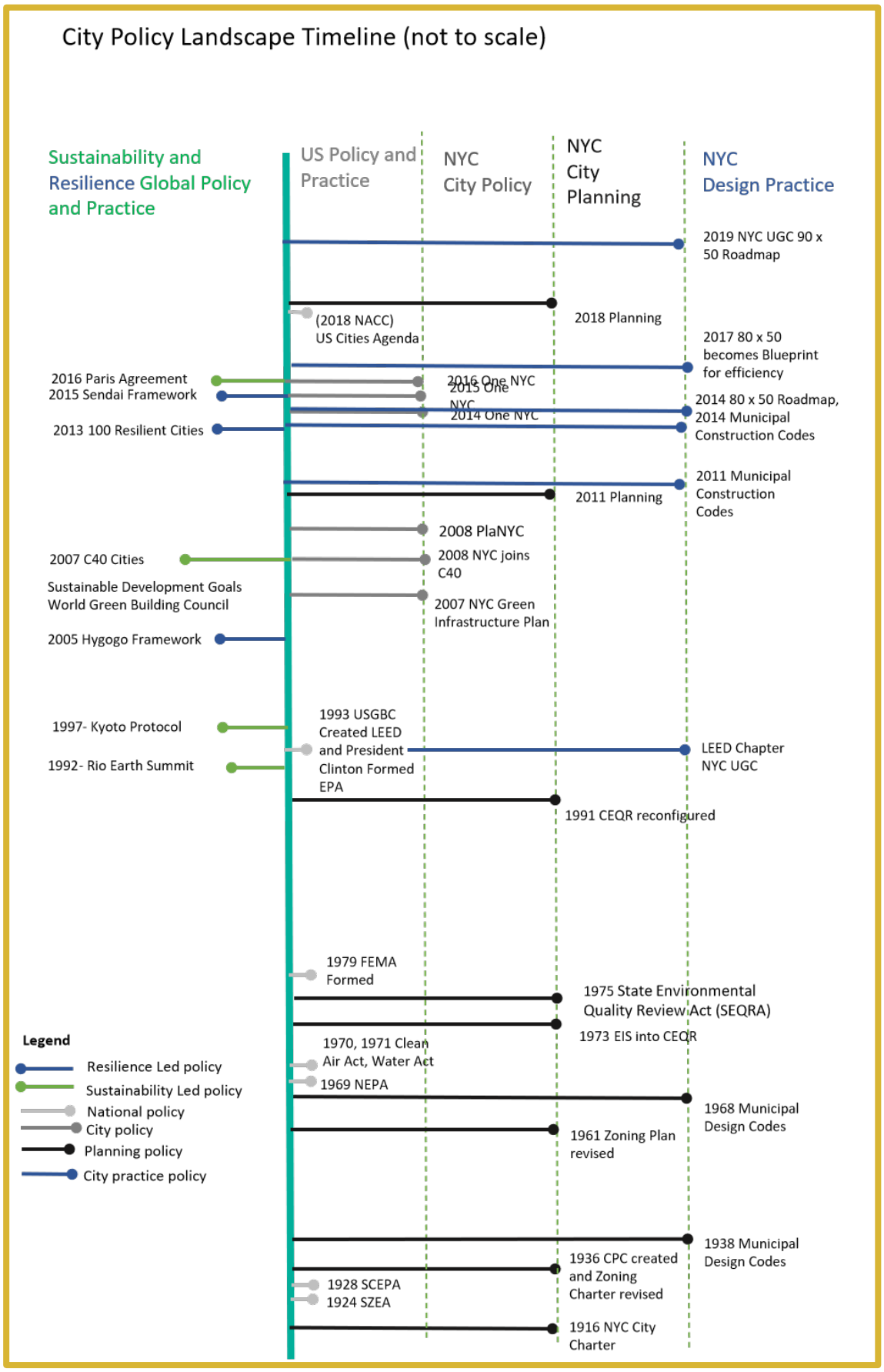


Figure 4.4 Interplay timeline of NYC policy and practice landscape

4.6.3 Policy Landscape

During late 19th and early 20th century, the Home Rule movement swept across the USA, which led to a **shift from Federal governance towards municipal governance and autonomy in its decision-making** (Vanlandingham, 1968). The NYC City Charter was enacted in 1916 (NYC Planning, 2019). Today, New York state has 2 democratic senators and 27 representatives (6 Republican and 21 Democrat) (GovTrack, 2019). NYC has 5 districts which between them have 59 community boards. NYC first city policies emerged in 1916 when the city had to instil spatial order into the overcrowding and tenements that resulted from being an economic trading hub and created its zoning code (New York (N.Y.). Board of Estimate and Apportionment. Committee of the Whole., 1916). **The zoning code was revised in 1936** and at the same time the City Planning Commission (CPC) was created (NYC Planning, 2019). This was followed by the **municipal building code of 1938** (NYC Department of Buildings, 2019).

It took another thirty years for both the **zoning and design codes to be revised in 1961** (NYC Planning, 2019). By the 1980s, NYC was notorious for crime, racial and social inequalities as well as its 'boom or bust' approach to economics (Friedman, 2011; Indergaard, 2013). During Mayor Giuliani's term, zero tolerance policies were introduced to reduce crime rates but were not socially always just (Kelling, 2009).

What unfolds through Bloomberg's administration is relatively rapid change. Driven by the 9/11 attack, Mayor Bloomberg radicalised the governance institutions (The Guardian, 2013). In 2007, NYC joined the C40 group of

global cities which aimed to tackle climate change and increase sustainability; suddenly all municipal policies are subjected to new political influences and frameworks (C40 Cities, 2007).

NYC's sustainability policies start to take shape with the NYC Green Infrastructure plan and PlaNYC 2030 - NYC vision for the future (Bloomberg, 2007b, 2007a). PlaNYC was a long-term sustainability plan which comprised **127 initiatives in six key areas**: Land, Water, Transportation, Energy, Air, and Climate Change. The mayor started to use Executive Orders (EO) and Local Laws (LL) to create the required policy changes (The City of New York, 2011). Bloomberg's governance created LL86 of 2005 and Executive Order 149 in 2009 to manage buildings and energy in the city (Bloomberg, 2005; The City of New York, 2005, 2011). **After fifty years, the design codes were revised in 2008** (NYC Department of Buildings, 2019), **the zoning code was revised in 2011** (NYC Planning, 2019), and the respective actions were managed through Building Bulletins (BB) and the local laws.

Local laws start to focus on Energy Consumption of buildings: LL84 of 2009 (NYC, 2009a) which creates an energy benchmarking system for buildings and LL85 of 2011 that creates the **NYC Energy Conservation Code** (NYC, 2019). More specific laws and regulations follow: LL87 and LL88 of 2009 (City, 2009; NYC, 2009b) address sub-metering and energy management practice of buildings; LL5 of 2010 (de Blasio, 2011) facilitates the use of alternative materials in construction; LL20 of 2011 (de Blasio, 2011) and LL6 of 2016 (NYC, 2016) focus on the promotion of alternative fuel sources such as solar power and geothermal systems. These laws aimed to address

loopholes in the decision-making systems and facilitate better practice between LEED, state codes and local city codes (USGBC, 2017). Returning to the direction of city policy, the **NYC LEED Chapter (NYC UGC) created the 80x50 Roadmap which was adopted by governance** (The City of New York, 2016b). The roadmap outlines how to reduce the built environments **carbon emissions by 80% by 2050** through investment, regulatory frameworks and society and subsequently LL66 of 2014 makes the target of 80% of GHG by 2050 law (NYC Council, 2014).

The local laws of 2016 / 2017 retain an energy bias from the earlier precedent set in the fields of energy management (de Blasio, 2016a, 2017a), alternative energy supply and mobilising LEED standards and specialist knowledge into design teams. Could it be that NYC is trying to reduce its power and energy consumption to be able to cope with hazard events?

PlaNYC became a platform policy that primarily supported sustainability policy progresses towards energy and GHG management. Then in 2014, **PlaNYC 2030 was titled "a sustainable more resilient NYC**"(The City of New York, 2014b) and the Blasio administration commences. It was Mayor Blasio who collected the policy threads **post-Hurricane Sandy to pull a sustainable and resilient vision together in OneNYC** (de Blasio, 2012, 2015; Goldstein, Peterson and Zarrilli, 2014; Blasio, 2015; de Blasio, Shorris and Chandler, 2015). In a short timeframe, a series of reactive policy documents were produced which led to OneNYC being revised again to **"OneNYC- a plan for a strong and just city"** and the **2008 design codes were revised in 2014** (NYC Department of Buildings, 2019). In parallel, the **Rockefeller Foundation launched the 100 Resilience Cities** campaign

(100 Resilient Cities, 2019), where its city resilience index was used to assist the development of a city-wide resilience strategy to manage domestic recovery that led to: **OneNYC and Build it Better Campaign** (Bill DeBlasio, 2014). Box 4.3 lists the resilience characteristics identified by the 100RC process.

Box 4.3 100 RC characteristics identified for NYC

The 100RC process identified **18 shocks and stresses** that applied to the city context which were: Aging infrastructure, Climate Change, Coastal/ tidal flooding, Economic inequality, Extreme heat, Homelessness, Hurricane/typhoon/cyclone, Inadequate educational systems, Inadequate health systems, Inadequate infrastructure, Lack of affordable housing, Population growth/overpopulation, Poverty, Power outage, Rainfall flooding, Sea level rise/ coastal erosion, Severe storms and Shifting macroeconomic trends. (100 Resilient Cities, 2019).

Blasio's office also restructured the governance institutions to manage this long term vision for the city which was articulated by OneNYC goals, initiatives and actions (de Blasio, 2011, 2016b, 2017c, 2018b). With this edition of OneNYC (2014) the city strategy document became an umbrella policy. From the NYC narrative review, it became apparent that any policies prior to **"OneNYC - a plan for a strong and just city"** were incorporated into the latest edition or were retained under its umbrella. It has utilised Mayor Bloomberg 2007-2014 PlaNYC strategies and created new guidance. The document portrays an integrated strategy of community as its stakeholder engagement included New Yorkers. **One NYC is the city's vision for future NYC growth as it outlines in four vision areas: 1) Growth, 2) Equity, 3) Sustainable and 4) Resilience and continues to**

monitor them using multiple indicators (M. B. De Blasio, 2016, p.191-291).

Understanding how sustainability has informed city policy is represented by One NYC's vision 3 and its sustainability indicators (Table 4.2).

Table 4.2 One NYC Sustainability Measurement Goals (The city of New York, 2015, p. 161)

Vision 3 Indicator Group	Description of Target
1. 80x50	Reduce NYC's GHG by 80% by 2050
2. Zero Waste	Zero Waste to landfill by 2030
3. Air Quality	Best Air Quality amongst US cities by 2030
4. Brownfields	Address contaminated land and convert it to safe and beneficial to low income communities
5. Water Management	To mitigate flooding and provide high quality water services
6. Parks & Natural Resources	All New Yorkers to benefit from useful, accessible and beautiful open space

The interpreted **sustainability definition adopted by OneNYC** is:

> *"Sustainability means the activities we undertake today will not compromise the present generation's or future generations' ability to meet their own needs. It is grounded in the recognition that people, economic development, and the environment are interconnected, and for any to thrive, all must thrive together"* (The City of New York, 2015, p. 162).

The scale of application applies to: water infrastructure through open space, urban water drainages systems, green roofs, development and environmental improvement of brownfield sites and an increase in open space as a way of improving air quality and managing toxic spots. **A major component is the objective of reducing the carbon emissions 80% by 2050** through transportation and operational energy of buildings (by passive

means). Renewable energy and power regulations need to be addressed as well as solid waste. **Sustainability indictors are subdivided in 6 indicator groups, which are described in Table 4.2**. Under each group are further indictors which are being tracked in the 2016, 2017, 2018 progress reports. In recent progress reports, this target is being set at 90% by 2050.

Appreciating how resilience has informed city policy is represented by One NYCs vision 4 and its resilience indicators (Table 4.3).

Table 4.3 One NYC Resilience Measurement Goals (The city of New York, 2015, p. 215)

Vision 4 Indicator Group	Description of Target
1. Neighbourhoods	Every city neighbourhood will be safer by strengthening community, social, and economic resilience
2. Buildings	The city's buildings will be upgraded against changing climate impacts
3. Infrastructure	Infrastructure systems across the region will adapt to maintain continued services
4. Coastal Defence	NYC's coastal defences will be strengthened against flooding and sea level rise

The **OneNYC resilience definition** has been interpreted as:

> *"When we speak of resilience, we are referring to the ability of people, the places where they live, and our infrastructure systems—such as transportation and energy—to withstand a stress or shock event, to recover, and emerge even stronger. Mitigation reduces the impact of a stress or shock event or prevents the impact altogether, such as bolstering the defences of coastal communities to withstand flooding. In response to future threats, adaptation takes place to change the physical form or function of a structure, a place, or a community, such as hardening power supplies to withstand the effects of extreme weather and climate change".* (The City of New York, 2015, p. 217)

Resilience has been closely related to the events of Hurricane Sandy. "*Sandy claimed the lives of 44 New Yorkers and caused $19 billion in damages and lost economic activity. It also highlighted the vulnerability of NYC—as well as the entire region—to the risks posed by coastal storms. As the city counted the costs and pushed ahead with a robust recovery effort, a new conversation began: Recovery must also result in a city better able to face a wider range of risks—not just the "next Sandy*." (The City of New York, 2015, p. 216). Subsequently, the **interpretation of resilience is closely related to climate change** "*The first of these risks is climate change*" (The City of New York, 2015, p. 216) with reference to the New York Panel on Climate Change (NPCC) Annals report and provides climate change projections through to 2100 and risks posed by coastal storms. OneNYC also has incorporated PlaNYC's visions of a stronger more resilient New York (The City of New York, 2014b), but with additions in the form of **community strengthening and emergency planning**. With the launch of One NYC's vision (2014), the revisions to the planning process (2011) and the municipal design and construction codes (2014) established a new working platform for city planning and design.

Yet questions remain about how the policies will continue to develop as there is now a strong advocacy relationship with the NYC UGC and NPCC with the Blueprint for Efficiency (NYC Urban Green Council, 2018). The **NYC UGC has been supporting governance to make better decisions and their knowledge has created the 80x50 roadmap** (and stretching it to 90x50) and has created a Green Task Force and a Climate Resilience Task Force. (Urban Green, 2019). New Climate projections will be adopted with reference

to **NPCC Building the knowledge base for climate resilience** (Rosenzweig and Solecki, 2019).

The City projects an image that it wants to help others beyond its boundaries by tackling its own GHG emissions through the Blueprint for efficiency (NYC Urban Green Council, 2018) and creating a more resilient city, which is measured through the OneNYC progress reports (NYC, 2009; Blasio, 2015; M. B. De Blasio, 2018). Blasio's administration is moving policies and restructuring where considered necessary on a frequent basis, demonstrated by the annual revisions to OneNYC (Blasio, 2015; de Blasio, 2016b, 2017c, 2018c), the policies are stable and being tracked (de Blasio, 2018b). City policy supporting the Big U has expanded into the Lower Manhattan climate resilience project, as the city starts to **prepare its coastal defences for more frequent and extreme storms** (NYC EDC, 2019).

Subsequently, in 2019, the NYC City Charter of 1916 is being reviewed and re-considering land use (NYC Planning, 2019). NYC governance continues to participate in C40 (C40 Cities, 2019). **Any previous governance offices that manage sustainability and resilience are now ORR**, which includes the New York Panel of Climate Change (NPCC) (NYC Office of Recovery and Resilience, 2019). All offices are charged with supporting the OneNYC program,

> *"which aims to promote equitable growth and climate change resilience. Key Objectives include reducing 80 percent of the city's greenhouse gas emissions by 2050 and preparing the Big Apple for rising sea levels." (The Architects Newspaper, 2017)*.

Policy projects the interpretation of climate change and emergency planning. Yet, how are these local laws and policies affecting the 2011 planning process, zoning handbook of 2018 and 2014 design codes?

4.6.4 Planning Landscape

The city's 1916 zoning plan was enacted because NYC had become a complex social space (skyscraper, 2019). NYC Planning records its historical documents and reports this original zoning plan was not revised until 1961.

However, decisions about the planning process did evolve. By 1930s the decision system needed to change, the city voted to adopt the 'City Charter' in 1936 (NYC Planning, 2019). The city charter established a decision-making group called the City Planning commission (CPC), which lasted until 1989, when the charter was amended to change the composition of the commission (NYC Planning, 2019). The new commission has 13 commissioners who are chaired by the mayor. Each commissioner serves a 5-year term. When the zoning plan was updated in 1961, the accompanying zoning code was updated and remained until recently. In 2011, the code was revised to '2011- zoning in the city' (NYC Planning, 2019). As the zoning code details considerations for building design to be considered, this gap of no revisions for fifty years has led to the city having one of highest GHG emissions in the world.

To apply for any development, the planning application process of five steps must be adhered to (Figure 4.5). Step 1 outlines the guidance and step 2 initiates the process, **step 3 prepares the environmental analysis** and step 4 is linked to payment and the final step 5 grants approval. Procedurally, for

resilience and sustainability the most important step is step 3. Step 3 includes ‘environmental analysis’, which is accompanied by the Zoning Handbook and the **2014 Technical CEQR manual** (Mayors Office of Environmental Coordination, 2019). The Environmental Analysis directly relates to an ‘**Environmental Impact Assessment** ‘(EIA). The CPC calls the EIA process the ‘City Environmental Quality Review’ (CEQR), which results in an Environmental Impact Statement (EIS). The EIS is a product of the consenting system related to the NEPA 1971 and was introduced to NYC’s planning process in 1973 with the Executive Order 87 (NYC Mayors Office of Environmental Coordination, 2020). Preparation of an EIS requires specialist environmental knowledge and professional qualifications. Without an EIS or a Pre-Application Statement (PAS), a permit to build can not be issued by the Department of Building (DOB).

Environmental measurement frameworks defined in the EIA are employed in the CEQR, and what becomes evident from reviewing the **CEQR is that procedural knowledge and scale of application of sustainability and resilience is restricted by the PlaNYC (2007) policies on urban development**. It became difficult to track what changes were happening to the step 1 guidance documentation, but the zoning handbook has been recently revised in 2018 (NYC Planning, 2019).

Today, **NYC Department of City Planning has six strategic objectives: neighbourhood improvement, housing, economic development, resilience and sustainability, land use reviews, data and expertise** (NYC Planning, 2019). They provide information on zoning and land use, as well as support with the application process. The city’s zoning handbook *“provides*

the up-to-date information […] on all zoning changes made since the 2011 edition including the Flood Resilience, Mandatory Inclusionary Housing, Zoning for Quality and Affordability, and Zone Green text amendments, as well as numerous new special districts" (NYCPlanning, 2019).

While planning documentation is currently undergoing significant change, the process of EIS/EIA remains the same. Currently, the CEQR process does not reflect the OneNYC policy. This suggests that PlaNYC and its relating laws were significant, but this document needs to be revised with NPCC information (Rosenzweig and Solecki, 2015a; Yin *et al.*, 2017). The CEQR does not prescribe city or state design codes but does so for policy. This suggests that practice holds the knowledge to compile EIS and that the CEQR process is asking practice to refer to PlaNYC. However, PlaNYC does not prescribe environmental responses, but outlines visionary actions. The **CEQR process outlined is to comply with the State Environmental Review process and in turn support the application of NEPA**. This is outlined in point 300, Section 1 page 30 of CEQR (NYC Planning, 2014).

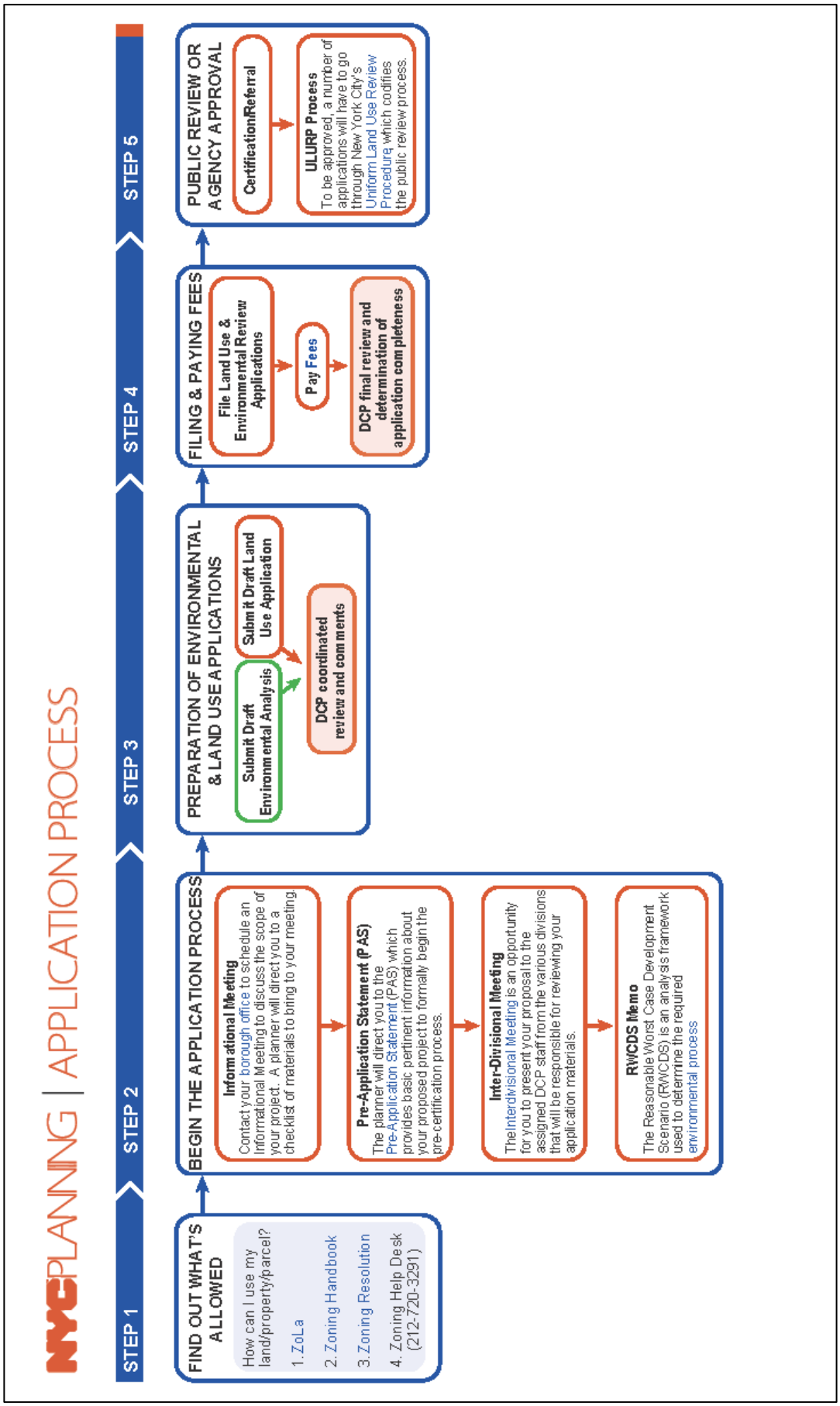


Figure 4.5 NYC Planning Process (NYC Planning, 2019)

4.6.5 Practice landscape

Department of Building (DOB) are the custodians of the design and construction codes. **NYC Board of Estimation established a Building code in 1938**, which was revised in 1968 and until 2008 were considered 'city' practice (NYC Department of Buildings, 2019). From 2008, building bulletins were initiated to manage 'changes in the code and to facilitate a transition in practice (NYC Buildings, 2019). The 2008 code has recently been revised to the '2014' codes.

The 2014 codes include: General administrative provisions, building code, fuel gas code, mechanical code and plumbing code with a section on code updates.

> In Building One City (de Blasio, Shorris and Chandler, 2015), Mayor Blasio states *"To expedite the right kind of development, we must expedite the development process. What we need, and what we will have, is fundamental reform at the Department of Buildings."* (de Blasio, Shorris and Chandler, 2015, p. 1).

NYC Building keeps a record of updates on the latest published code and since the 2014 code, there have been 71 updates managed by local laws and 2016 edition of the NYC Energy Conservation codes (NYC Buildings, 2019). Reform at the DOB is evident in the general administration and building codes because it projects a modern version with terms such as cool roofs, energy efficiency, **but the codes do not define sustainability or resilience or dictate a LEED performance standard**. A decision-making relationship between NYC planning and NYC Building exists where the decision to build and receive a permit relies on the DOB and the compliance

with the planning process and whether the ‘design’ complies with the 2014 design standards. The recent **Blueprint for Efficiency must consider how to interpret itself across all design team disciplines and deliver sustainable development** (NYC Urban Green Council, 2018).

4.6.6 Green Building Measurement

Figure 4.3 indicates NYC operates its own ‘Urban Green Council’ (NYC UGC). This organisation represents the USGBC LEED Chapter. It was founded in 2002 as a non-profit organisation. NYC UGC currently supports five strategies: drive demand for super-efficient buildings, bring the retrofit market to scale, advance sustainable building policy, educate building professionals and engage and mobilise market makers (Urban Green, 2019). Under these strategies there is knowledge development on how to achieve policy goals, legislative changes listed and design guidance beyond LEED requirements. **However LEED ND and NBC performance standards do need stipulating** NYC UGC most recent statement on “advance sustainable building policy” shown in Table 4.3 illustrates that **LEED practice is informing and leading NYC policy**. It describes their conceptual interpretation, their advocacy work in policy and how this will be moved forward (Urban Green, 2019).

Table 4.4 Policy development listed by NYC Urban Green Council (Urban Green, 2019). Their conceptual interpretation is (in Bold), and their procedural knowledge is highlighted in black.

"Our policy work drives green building progress in NYC and beyond. By improving codes, we can make every current and future building more sustainable. By engaging key stakeholders, we fashion energy and climate solutions that work for the environment and the bottom line. Our efforts have helped transform NYC's green building landscape and shaped the building code to be among the most efficient and resilient in the nation.

In addition, Urban Green led two blue ribbon commissions, The Green Codes Task Force and The Building Resilience Task Force, on behalf of the City of New York. We co-chaired the Mayor's One City: Built to Last Technical Working Group with the Real Estate Board of New Yor . And we continue to convene NYC's leading building and energy stakeholders through the 80x50 Buildings Partnership.

We're also expanding our thought leadership and advocacy at the state level. As we have in NYC, we connect the real estate industry with program planning and design, creating policies that are high-impact and cost-effective for the state.

Finally, we're working to develop next-generation policies to meet the city's energy and climate goal —with smart, innovative policy solutions, NYC and State will remain at the forefront of green building.

WHAT WE'RE WORKING ON:

Implementing the Blueprint for Efficiency to cut carbon in NYC's large buildings

Developing a roadmap to advance electrification in multifamily buildings

Advancing other 80x50 efficiency policies for new and existing buildings

Unlocking efficiency in the city's landmarked buildings

Improving efficiency in the city's steam-powered buildings

WHAT WE'VE ALREADY DONE:

Produced the Green Building Roadmap in advance of the 2017 Mayoral Campaign.

Identified key updates to NYC's Zoning Resolution in Zone Greener, our follow up on the 2012 Zone Green amendments.

20 of our proposed measures were adopted to make New York buildings and residents better prepared for the next extreme weather event (Building Resilience Task Force Report).

Engaged key stakeholders to compile the Green Codes Task Force Report, which suggests measures to improve our building code.

Developed and drove improvements to the NYC Energy Conservation Code that require more efficient buildings.

Outlined NYC's path to 90x50 (90x50: NYC Can Reduce Its Carbon Footprint 90% By 2050)."

4.6.7 Decision-Making influences landscape

Positioned chronologically in Figure 4.4 is the relationship between policy and practice. What is evident is that there has been little change to municipal practice from a policy perspective, however city practice has continued to evolve and is now a critical actor to city policy. Observed from the city's landscapes (Sections 4.6.1-4.6.6) are critical causal influencers and actors that are operating at levels of decision making. This information demonstrates considerable activity at city policy level (Table 4.5).

Table 4.5 NYC decision-making influences

Influences and actors	Sustainability- Resilience critical documents	Decision making levels
C40 100 RC Global Policy of Paris Agreement SFDRR City Governance (actor) US GBC Hazard Events and recovery of Storm Sandy LEED practice of city design FEMA	NYC One City Strategy and measurement targets Local Laws Blueprint for Efficiency	City policy
Mnemonic Practice- no change to manage storm events and climate change risks	Municipal Planning Process 2011- Environmental measurement	City planning
Mnemonic Practice- no change manage flooding risks LEED Practice	Municipal Codes 2014 NPCC 2019	City Design

As an explanation, Bloomberg made **sustainability and GHG reduction a legal issue through creating local laws** (Bloomberg, 2005; de Blasio, 2009, 2010, 2011, 2016a, 2017b, 2017a, 2018a).

The local laws set about to change existing systems and create new ones that allow better change. The **transitions between outgoing Mayor Bloomberg and the incoming Mayor Blasio**, coupled with the event of Hurricane Sandy, created fluctuations within the relationship between resilience and sustainability and communications become very reactive until 2015, when the revised **OneNYC-One city - rebuilding together** (Blasio, 2015; de Blasio, 2016b, 2017c, 2018c) became the clear umbrella policy.

Synthesising what has been learnt from NYC practitioners with the NYC case study (Section 4.5) creates a causal relationship between policy and practice (Figure 4.6). Figure 4.6 provides an interpretation of critical practice and NYC policy and the arrows mark the flow of knowledge between them. **Figure 4.6 shows that NYC policy has mostly been affected by joining C40 in 2008, sustainability policies (shown in green) developed with PlaNYC and the formation of NPCC**. Sustainable building practice was enabled by the formation of the USGBC in a response to the Rio Declaration, and in NYC has generated its own knowledge foundation. Resilience policy (shown in blue) was mobilised by 100RC in the wake of Hurricane Sandy. In 2014, NYC UGC becomes related to the OneNYC policy and then shifts in practice and policy occur. This is demonstrated by the collaborative project called Blueprint for efficiency and that municipal planning and codes have started to change. The final position known is the OneNYC (2016) and the Blueprint for Efficiency (NYC UGC), however this would have already **shifted as policy and practice documentation is revised (Box 4.4).**

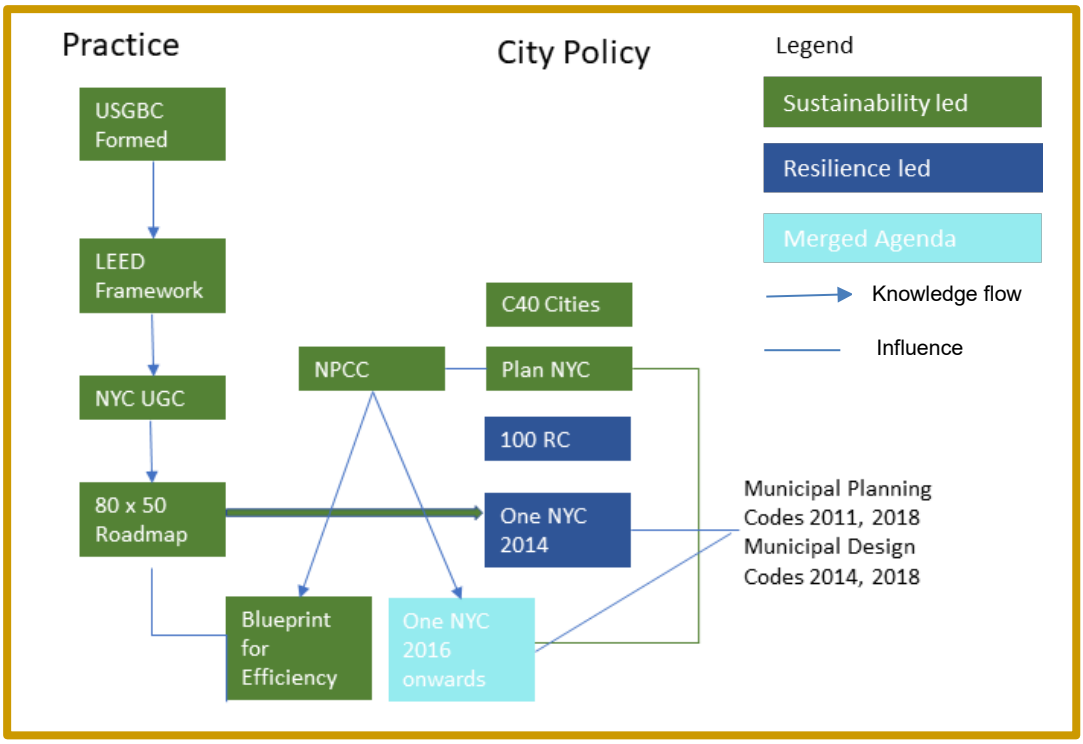


Figure 4.6 NYC decision-making relationship between policy and practice

However, what remains consistent through this period of significant change is that this city's governance has created its own laws and own version of measurement with regards to sustainability, climate change and resilience (Section 4.6.4). With climate change becoming incorporated into the city's law, NYC has shown how it values its legal system, but it does remain to be seen how effective these steps will be in meeting the city's targets. Box 4.3 outlines the current city policy status.

Box 4.4 NYC policy current status

The **OneNYC policies are monitored through the OneNYC Indicators** (de Blasio, 2018b), and this document reflects the working policy of the city. The recent Blueprint for efficiency is starting to bring decision makers together (de Blasio, 2018b; NYC Urban Green Council, 2018). The city is also reviewing its city charter and carrying out stakeholder engagement (The City of New York, 2019a)

4.7 Sustainability and Resilience decision-making landscapes of Chicago

Chicago has 2.72m residents and the city wide carbon emissions in 2017 were estimated to be 30 955 862MtCO_2E (CDP, 2017). Chicago is **ranked 8th of 13000 cities** with a 152.9Mt CO_2 making it a global city with one of the highest carbon emissions (City Carbon Footprint, 2019). To understand how Chicago has a large carbon footprint needs an evaluation of how decisions are made with regards to its built environment to support the case for sustainable-resilient buildings (USGBC, 2013).

4.7.1 City Context

Two globally renowned ecosystems (the American Prairies and Great Lakes) encompass Chicago. Geographically, it sits on the southern shore of Lake Michigan which is one of the five Great Lakes (Zimmermann, 2017) and on the fringes of the American Prairies (National Park Service, 2018). Lake Michigan affects the city's microclimate because its latitude is close to the Arctic Circle (Chicago Weather.Net, 2019) which impacts its diurnal temperatures and humidity. The vast expanse of 'uninterrupted' water also creates increased wind speeds called a Polar Vortex. These meet the Prairie winds which are warmer or colder due to the changes in land mass temperatures making it a changeable and extreme (either hot or cold) climate. Koppen classifies the climate as hot-summer humid continental (Rubel and Kottek, 2010).

Geologically, it is relatively flat topography due to glacial recession which has formed the Lake's drainage basin (Bretz, 1939). Flowing into the lake is the Chicago River, which has been a trade route from the Mississippi river to the Atlantic Ocean (via the Great Lakes) (Baer, 2019).

Chicago city is the seat of Cook County of the North Eastern State of Illinois (Figure 4.7), the third largest US state and a dominant 'mid-west' economic hub.

Figure 4.7 Location of Chicago (Google Maps, 2019)

Chicago's population is 2.7m+, but it fluctuates between growth and decline due to its **economic dependency on agriculture or manufacturin**g (City Mayors, 2019). This city has a history of an eclectic mix of notable personalities: Noble Laurates, US Presidents and notable politicians, first black and female mayors alongside social rights activists and notorious crime characters. **It is a place deep rooted in US politics** as Abraham Lincoln represented Illinois to abolish slavery (Strickland, 1963); it was also a place for the arts and crafts movement to be expressed (Sandberg, 1970), a place of need during Roosevelts presidency (Philips, 2015), and a place of global manufacturing during the Second World War and more recently President Obama and Hilary Clinton.

Chicago has layers of **complex historical social and cultural diversity** (Low and Altman, 1992; Talen, 2003). Baer (2019) outlines how Chicago has been a 'peoples'' meeting place of nomadic native Americans with tribes using the rivers to transverse the country, western Americans drawn to the agricultural opportunities and more immigrants arriving on the lakes' shores looking for employment.

Geographically, this city has had many social identities and Bretz (1939) provides a detailed geological introduction to 'Chicagoland', which was a swamp area that became inhabited with wooden housing and prone to disease during its early development era (Figure 4.8).

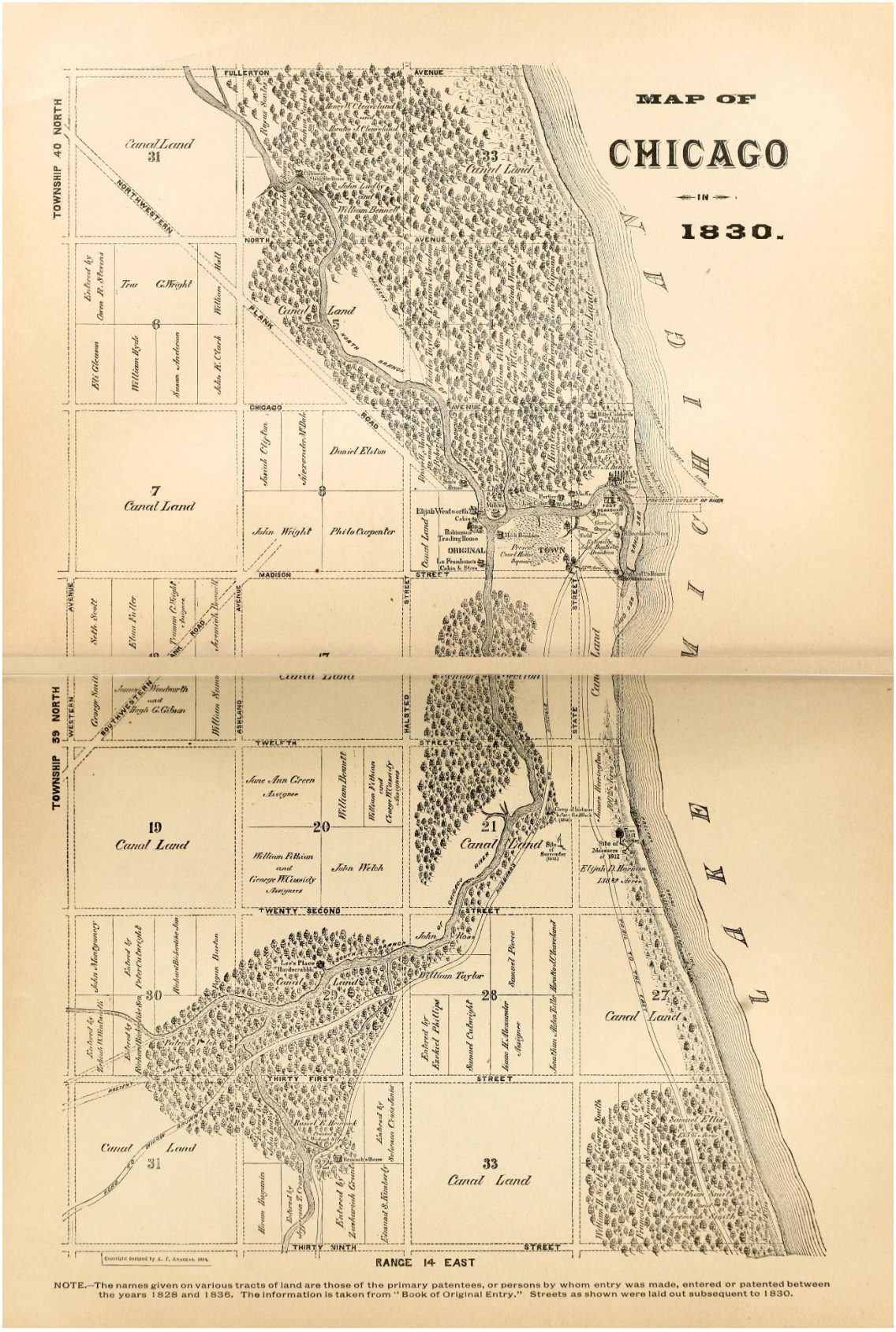


Figure 4.8 Chicago 1830 Plan (Wikimedia, 2019)

Chicagoland's city origins are from the commissioning of James Thompson in 1830 to create Chicago's first 'plat' (Encyclopedia of Chicago, 2019) that laid out a town with straight streets and alleyways bisecting each block. City development brought rapid transit infrastructure called 'the loop' for cable cars and thus creating the Central Business District (CBD). Outside of the city, the 'Railroads' were being constructed to get commodities such as grain, meat and raw materials out of the Prairies and Mississippi Basin for wealth and manufacturing. To improve the land from swamp, the Illinois and Michigan canal system was introduced to drain the land but also move freight. **This connection between agricultural ecosystems, social migration and immigration, and access to water led to the establishment of Chicago's Board of Trade (in 1848) and Chicago Mercantile Exchange (CME) in 1898** (CME Group, 2019).

With the important trade and city development, the rich and poor emerged and shanty towns grew too. In 1871, the 'Great Chicago Fire' devasted the city, causing $200 million in damage and destroying a third of the city, making 100,000 people homeless (Encyclopedia Britannica, 2019). However, this event led to a rebuilding of Chicago and new buildings regulations were enforced (Tarem, 2017). By 1890, Chicagoland's population was nearly 1m. This history of 'visionary' ideals has enabled Chicago to become the third largest US city, at times (mostly1890-1980) rivalling NYC for the biggest US city (Advameg.Inc, 2019) and a historical policy shift in the 1930's described in Box 4.5. The city's urban grid, loop and 1830s canal infrastructure are still evident today, however it is now a problem because it is archaic and now supporting a city of nearly 3m people.

Box 4.5 Chicago policy shift from agriculture to manufacturing

Chicago in 1930s was in a grip of recession and President Roosevelt New Deal (Encyclopedia of Chicago, 2019). The New Deal eventually lead to manufacturing opportunities and more economic success. Chicago urban development evolved into a metropolis, its **social culture became a 'city of neighbourhoods**', the 'city of broad shoulders' (Sandberg, 1970).

More recently, other catastrophic events have occurred with its built environment: in 1995, 739 people died due to a heatwave, attributed to the **urban heat island effect and the vulnerable society living in unmodernised housing** (Klinenberg, 2000). 2019 Chicago's 'coldest' winter yet (Lutz, 2019) exposed the role of buildings in the city, and the vulnerability of homeless people. This again reflects that the city's microclimate affects its people. It is a city with global references but projects a different risk to future climate change because it is not a coastal city, but in land (by water).

Governance and decision-making in this city have an intricate history with the evolving urban development (Talen, 2003; Schwieterman and Caspall, 2006). The politics that shaped the city were also visionary with the Daley dynasty making a 'city that works' (The University of Illinois Library, 2019). Jane Byrne (1979-1983) the first female mayor) and Harold Washington (1983-1987) the first Black Mayor. The creation of the Mayoral system in Chicago was due to the city decentralising itself from federal governance by creating the 1837 Municipal Charter). This generated a council and alderman to represent the neighbourhoods. This 'home rule' style of politics remained until **1995 when there was power shift towards the mayoral position** and better representation. Mayfield (2019) outlines that decentralisation created frustration with those who had global ideals. Mayor Emanuel has held office

from 2011 to 2019 and makes the transition to Lori Lightfoot (the first black female) (Fox News, 2019). Given this recent political transition, the case study will be based on Mayor Emanuel's policies.

Chicago is a member of the C40 and 100RC, which signifies that the mayor has strong-partial powers in association with the built environment (C40 Cities, 2019). Chicago's C40 initiatives are: energy, transportation, and urban planning and development. Box 4.6 outlines that Chicago has assessed its climate risks, shocks and stresses where storms (rain and snow) flash floods and heat waves are classified as serious, then river flooding and wind storms as less serious (100 resilient cities, 2019).

Box 4.6 100 RC characteristics identified for Chicago

Chicago 100RC profile identified **14 shocks and stresses** to the city which are: *Aging Infrastructure, Crime/Violence, Economic Inequality, Financial/ Economic Crisis, Inadequate Educational Systems, Infrastructure Failure, Poverty, Rainfall Flooding, Riot/Civil Unrest, Severe storms, Shifting macroeconomic trends, Structural racism, Terrorist attack, Unemployment* (100 resilient cities, 2019).

With regards to sustainability and resilience, the pinnacle of Mayor Emanuel's city policies during his term resulted in NACC, which brought together North American Cities to oppose the federal direction of President Trump and keep moving the agenda forward by signing to GHG commitments to adhere to the Paris Agreement (Chicago Council on Global Affairs, 2018).

4.7.2 Chicago Interplay timeline

Chicago's development urban plan, infrastructure and commercial growth are historically linked, they precede the City Charter (1837) (Section 4.7.1). From 2004, there was a big climate change investment in the city policy and planning due to Mayor Daley. **Figure 4.9 represents the decision interplay timeline of Chicago's policy and practice landscape with global and national representation** (Section 3.4.4, Figure 4.1). At this juncture, it is important to recognise some research limitations (Section 7.4) because the historical municipal codes have not been systematically reviewed as they are not available on line (Chicago Public Library, 2013). However, there is literature around buildings codes that present a position indicating that there are issues with their current status (City of Chicago, 2019) (Section 4.7.5).

Section 4.7.6 outlines the city's relationship with the LEED Rating system and this is represented on the timeline. Tracking shifts in municipal practice has been challenging apart from the recent acknowledgement that changes need to occur in building codes (Tobais, 2019) (Section 4.7.5). Within the last five years city polices have started to shift, but they hold firm to the vision set out in City's climate change plan (2004) (Section 4.7.3). Chicago can be considered either a city of political foresight or a city of mnemonic practice and needs a social voice (Section 5.3).

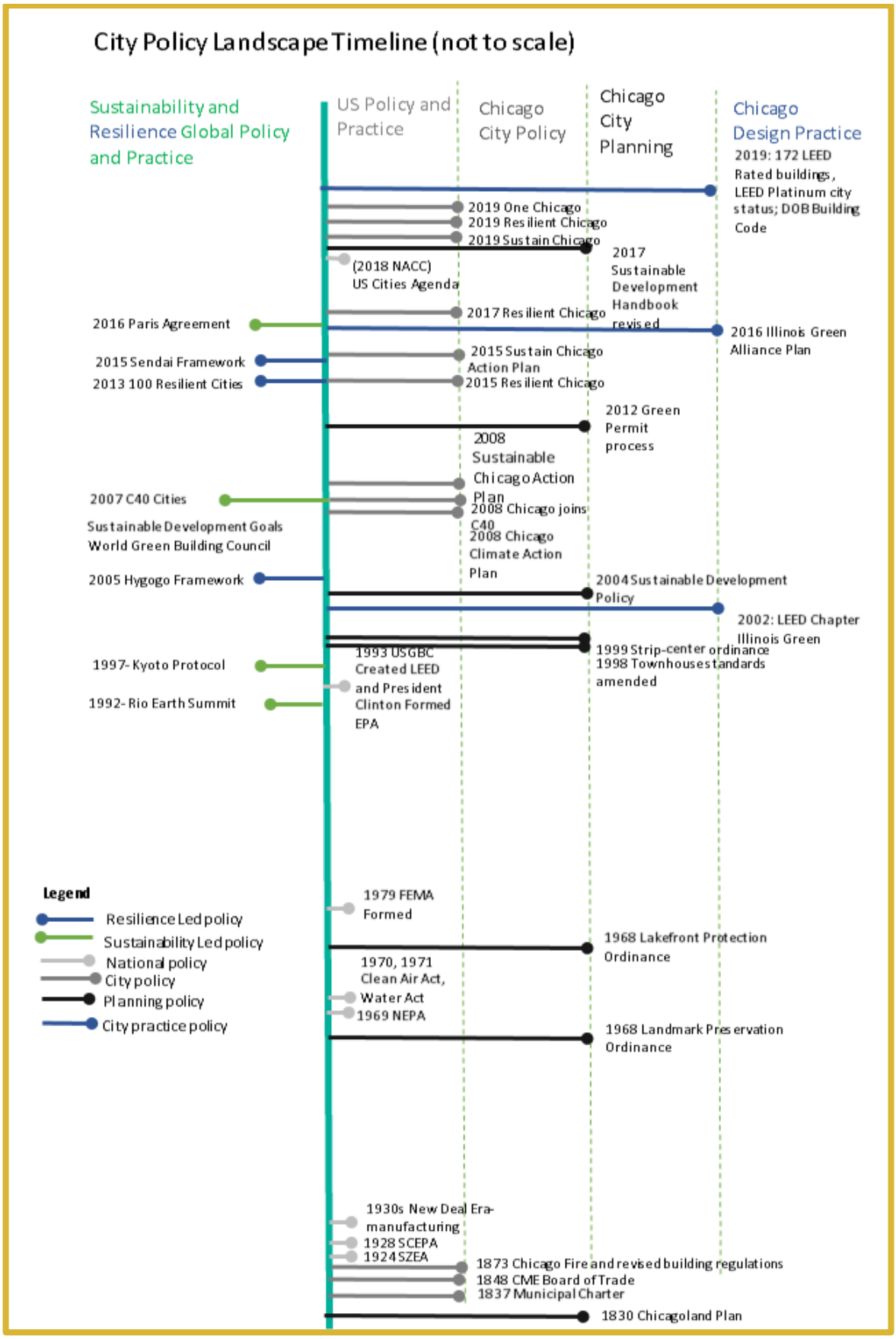


Figure 4.9 Interplay timeline of Chicago policy and practice landscape

4.7.3 Policy landscape

Chicago has autonomy with its decision-making through the 1837 municipal charter, while Illinois State has two democratic senators and 18 representatives (5 republican and 13 democrats). The city has 77 Neighbourhoods between 9 districts (The Chicago 77, 2019). The origins of Sustainable development policy in Chicago stem from energy efficiency and LEED rated buildings, as Chicago claims to have 1**72 LEED certified buildings** (RE Journals, 2019). **"Green" construction is supported by the City of Chicago's Green permit program which represents the planning process** (Department of Buildings, 2012). **Chicago governance led a Climate Summit in 2018, which has resulted in NACC** (Chicago Council on Global Affairs, 2018) signed by mayors representing 50 cities. The NACC produced the North American Cities Alliance, an alternative contribution to the Paris Agreement, focused on GHG reduction. The charter is managed by the Chicago Council for global affairs.

The City projects a history of interest in climate change which is collated in the Climate Change Action Plan in 2008. This went through a transition in 2011, then was recreated with 'Sustainable Chicago' after joining C40. **Sustainable Chicago Action Plan (SCAP)** (Emanuel, 2015a) is a separate document with more prominence and its **interpreted definition of sustainability** is:

> *"**By tapping into energy efficiency as a resource, we will meet the energy demands of a growing city**, invest in our infrastructure, save money, and reduce our environmental impact. Through energy saving retrofits for our businesses, residences, and government buildings, and investments in renewable energy sources, Chicago will improve*

> *citywide efficiency by 5 percent, and create at least an additional 20 MW of renewable energy."* (Emanuel, 2015a, p. 4).

To mobilise this **interpretation of sustainability bias towards energy**, a sustainability council was appointed which includes: Chairman (the Mayor), Chief Sustainability officer, Department of Aviation, Department of Buildings, Department of Fleet and Facility Management, Department of Housing and Economic Development, Department of Procurement, Department of Street and Sanitation, Department of Transportation, Department of Water Management and the Office of Budget and Management.

The SCAP has seven core themes, which are: 1) Economic Development and Job creation, 2) Energy efficiency and clean energy, 3) Transportation options, 4) Water and wastewater, 5) Parks, open space and healthy food, 6) Waste and recycling and 7) Climate change.

SCAP's vision outlines that Investments will be made to bus and rail transit system, water system, electrical infrastructure and energy retrofits as well as in reducing traffic congestion, improving air quality, bikes and pedestrian safety, resource conservation and recycling.

After its publication, **SCAP was very quickly revised with Sustainable Chicago 2015: Action Agenda 2012-2015 Highlights and Look Ahead** (Emanuel, 2015b), which expands on the seven core themes and provides 24 goals or actions. It is important to note Goal 24 "*protect the city and its residents by preparing for changes in the climate"*- and its detailed actions are:

> *"Prepare for the human impacts of climate change by supporting people with information and services, such as cooling centers.*
>
> *Prepare the natural environment for climate impacts and maintain biodiversity.*
>
> *Prepare the infrastructure for climate change by reducing the urban heat island effect, managing flooding from high intensity storm events, and strengthening resilience to extreme weather."* (Emanuel, 2015b, p. 24).

Sustainable Chicago 2015 (Emanuel, 2015a, 2015b) is the city's most recent sustainability plan which has since lead to '**Sustain Chicago**' (City of Chicago, 2019). Sustain Chicago is a new platform for the city, but the policy remains the Sustainable Chicago Action Plan. **Climate Change is the focus of the Sustainability Strategy and infringes on resilience with adaptability goals and emergency preparedness**. In parallel from 2015, resilience policy appears with the launch of 100RC and appointment of Aaron Koch. Resilient Chicago was initiated in 2015, funded by the 100RC work.

> **The report defines resilience as** *"the ability of its individuals, institutions, businesses, and systems within the community to survive, adapt, and grow despite the chronic, stresses or acute shocks it experiences. A truly resilient city is not only expected to perform well in good times but also recover expediently after challenges."* (Emanuel, 2019b, p. 9).
>
> *It uses resilience agenda to address four critical areas: (Emanuel, 2019b, p. 7): Reducing disparities between Chicago's neighbourhoods; Addressing the root causes of crime and violence; Ensuring the provision of critical infrastructure; and, Promoting engaged, prepared, and cohesive communities.*

Resilient Chicago has a broad steering committee with 37 stakeholders, who have formulated a vision that is constructed of 3 pillars (strong neighbourhoods; robust infrastructure; prepared communities), 12

goals and 50 actions which has been derived from using the 100RC measurement wheel (Emanuel, 2019b, p. 8)(Da Silva and Moench, 2015). Resilient Chicago outlines the social focus and emphasises that both 'sustainable and resilient Chicago' policies should align. For example, two of the ten Chicago's resilience priorities have a direct sustainability focus such as: environmental sustainability and climate change but a further five remaining priorities such as poverty socio-economic inequality, education, jobs and the economy, community participation and housing affordability definitely overlap. The final three are public safety, racial equality and employment training are imperative to the building sustainable-resilience in the built environment (Emanuel, 2019b). This work projects that Chicago's resilience lies with its social inequality and that sustainability is a part of the solution to resilience (Emanuel, 2015a, 2019b).

> **The document concludes with the following statement:** *"Resilient Chicago presents a vision for the city – one where residents, neighborhoods, institutions, and government agencies are successfully connected to each other in the pursuit of economic opportunity, safety, equity, and sustainability. The strategy also describes a number of actions that will benefit residents, in particular those most vulnerable."* (Emanuel, 2019b, p. 140).

Resilient Chicago was formally launched in 2017 (100 Resilient Cities, 2016), but the strategy has only recently been completed in 2019 (Emanuel, 2019a). Where **Sustainable Chicago** is focused on energy reduction, parks and open spaces it lacks social focus and could be incorporated into Resilience Chicago or vice versa (ICA, 2019). However, neither documents look towards the planning and design codes. A recent press release identifies that Resilient Chicago has founded 'One Chicago' (Emanuel, 2019a). **One**

Chicago (2019) has focused policy towards citizenship to support better cohesion of a diverse society. Given the rapid transition on these policies, there is confusion with the comprehension of what is existing policy. This is representative of discursive use of language (Foucault, 1972).

Box 4.7 Chicago policy current status

Mayor Emanuel's office included an Environment department, which incorporates sustainability. Office staff include a Chief Sustainability Officer (Stark, 2017) and more recently a CRO (Emanuel, 2019a). There is an Emergency Management and Communications Department, which includes 'emergency preparedness and emergency management' and extreme weather and security are considered in this jurisdiction (City of Chicago, 2019). The 'Fleet and Facility management' considers energy procurement and management (City of Chicago, 2019), and sustainable development belongs in the Planning and development department (City of Chicago, 2019). Mayor Lightfoot's management structure or policies have not been reviewed, but currently Sustain Chicago, Sustainable Chicago Action Plan and Resilient Chicago still exist.

4.7.4 Planning landscape

Keating (2004) links the history of Chicagoland's urban development and 'mosaic' of communities as depicted by Park & Burgess (1925) to the local agriculture, flow of people and the development of the railroads. The City Charter 1837 and the City Plan 1830 (Figure 4.5) outline Chicagoland's future, so how have planning and design processes adapted over time, and how has LEED become such an integral part of Chicago's Green building scene (USGBC, 2018)? The planning process and permitting is managed by the DOB (City of Chicago, 2019). The DOB operates the building code, permits, inspections and reports and trade licensing. The Green Permit process is where the 'review' occurs and a Guide to Permits is provided, advocating the use of LEED Rating systems for various buildings. The Guide

to Permits includes ‘green roof’ and solar panels but directs to the Building Code for compliance.

The Department of Planning and Development (DPD) are the custodians of the following sectors: housing, zoning, economic development, planning and sustainability, historic preservation and real estate (City of Chicago, 2019). They operate a commission structure with bureaus to manage each sector. The zoning amendments code however does not mention LEED, environmental policies, or zoning history of local laws (Emanuel, 2018).

The Planning and Sustainability bureau provides a Chicago Sustainable Development Policy, which was mobilised in 2004. It is an umbrella handbook used alongside community plans and ‘open space and sustainability plans’ (Emanuel, 2017) (City of Chicago, 2019). The community plans represent local ‘zone’ requirements and the open space considers specific requirements for areas alongside the infrastructure, such as Chicago River Corridor Design Guidelines, Green infrastructure for stormwater. What this suggests is that **planning considers both specific details and city-wide ideas**. However, these must be coordinated through the planning process but who claims responsibility for this, **DPD or DOB**? At this stage, it remains unclear how the environment component of planning is a part of the ‘planning process’ as it points to the municipal code which is in abeyance (City of Chicago, 2019), the zoning code (American Legal Publishing Corporation, 2018), and open space and sustainability plans (City of Chicago, 2019). What this suggests is that there is no independent environmental review process. It is the ‘sustainability development process’

and the LEED process promoted through DOB that provides direction and guidance on environmental processes.

Created in 1923 was the first zoning ordinance but it is difficult to track changes historically without actively tracking shifts in the city's morphology (Talen, 2003). Schwieterman and Caspall (2006) identify that the **1923 code was not sufficient due to land ownership issues and that by 1957 the code was revised**. "*Over the next several decades, community involvement in zoning decisions gradually increased, and the city adopted several supplemental measures, including the Landmark Preservation Ordinance (1968), Lakefront Protection Ordinance (1973), a Townhouse Standards amendment (1998), and the Strip-Center Ordinance (1999)*" (Schwietermn & Caspall, 2005).

However, urbanists report that historically zoning codes and laws have created many conflicts because the Aldermen remain at the heart of the system (Schwieterman and Caspall, 2006; Talen, 2012) The overarching **zoning code was last amended in 2018** and providing overarching planning guidance to all this is 'Chicago's sustainable development policy' (City of Chicago, 2017), but where does that fit with the recent shifts in city policy? (Section 4.7.3)

Beyond the city boundary, Chicago Metropolitan Agency (CMAP) operates a regional planning approach for Illinois' counties (Cook, DuPage, Kane, Kendall, Lake, McHenry and Will). This operates under the public act 095-0677 and by-laws. CMAP operates Illinois Environmental Protection Agency (IEPA). CMAP has produced 'On to 2050' (CMAP, 2018) to support regional

development, but this is out of scope from a city perspective. ‘On to 2050’ has developed a series of indicators (CMAP, 2019), which interact with the city because the city’s urban area has expanded into the county boundaries. CMAP projects an understanding of resilience and sustainability. Yet, Illinois State planning or design regulations do not appear to be publicly acknowledged through the DPD or DOB.

City Zoning Codes appear in a state of flux as environmental permits are a part of ‘business and environment’ but there is no further information at this date (City of Chicago, 2019). The municipal planning regulations are due to change with the Burnham Plans, meanwhile DOB still maintain the permitting process and use LEED guidance to provide instruction to the EIA process.

4.7.5 Practice landscape

DOB Building Code (City of Chicago, 2019) provides the minimum standard for all buildings and permitting can not be achieved without its compliance. Included in the code are the following sections: Administration, accessibility, building (new construction), conveyance Devices (elevators), Electrical, fire prevention, fuel gas, mechanical, Energy conservation, plumbing, signs, trade licences, work in existing buildings, minimum requirements for existing buildings, zoning.

Tobais (2019) reports that the Design and Planning codes and Burnham’s nationwide code are due to change and the city is in a state of flux (Holland, 2019). Currently, the DOB operates a City Building Code (City of Chicago, 2019). There is a specific limitation to this case study, which is that historical codes can only be viewed in the municipal library (Chicago Public Library,

2013) but the **DOB reports significant modernization program to recent construction codes** (City of Chicago, 2020) (Holland, 2019). The city's administration outlines that the entire Municipal Code of Chicago including the Construction Codes (which contains the new construction, existing buildings, fire, energy conservation and zoning components) are being revised (City of Chicago, 2020).

4.7.6 Green Building Measurement

Illinois Green Alliance formed itself in 2002 and become a USGBC member in 2010 (USGBC, 2019). They have created their own strategic plan in 2016 to engage 77 communities, over 4 years to achieve three goals of : Engagement, empowerment and education (Illinois Green Alliance, 2016). This group is actively mapping the impact of the 'strategic plan' of Chicago and is actively targeting community buildings, schools and residential buildings (Illinois Green, 2019). The Illinois Green Strategic Plan (Illinois Green Alliance, 2016) outlines recent policies which signpost to 'Illinois Future Energy Jobs Bill', 'Value for High Performance Homes, Evanston Energy and Water benchmarking Ordinance, Chicago Energy Benchmarking Ordinance and Chicago Sustainable Development Policy.

With this exemplary practice, LEED has also launched LEED Cities using Chicago as a pilot city, which has achieved 'Platinum' status (USGBC, 2018). LEED has been successful administered in Chicago through the Green Permit process. This suggests that the LEED green rating system is acting as city policy.

4.7.7 Decision-Making influences landscape

This city is becoming polarised between global and local approaches, with NACC representing global and **Illinois Green Building Alliance's** plan is considers all 77 neighbourhoods. The local approach is fractured because of the volume of districts and zoning codes for each district, it would need further investigation to piece together how the decision-making process is operated. The revisions to city policy strategy documentation (2008,2015,2017,2019) is rapid and blurs boundaries between what is resilience, sustainability and climate change. The actors and influences are shown in Table 4.6.

Table 4.6 Chicago decision-making influences

Influences and actors	Sustainability- Resilience critical documents	Decision making levels (themes)
C40 100 RC Global Policy of Paris Agreement Sendai Framework City Governance (actor) US GBC	Resilient Chicago Sustain Chicago Chicago Climate Change Summit	City policy
Mnemonic Practice City Practice	DOB Green Permit Chicago Sustainable Development handbook	City planning
Mnemonic Practice- LEED Practice	Municipal Codes	City Design

However, the city policy seems to hold firm to its 2004 origins. The current position is One Chicago (Chicago Council on Global Affairs, 2017; Emanuel and Reifman, 2019), but this is also subject to political shifts between Mayor Emanuel and Mayor Lightfoot and remains to be seen how this will change. LEED appears to be all encompassing and recognised in the DOB planning

process, design practice and city policy, but what determines whether the development is both sustainable and resilient? It could be that the structure of decision-making is more advanced than realised. However, the municipal codes of practice have not been reviewed for a long time (Frydland, 2019). Currently, there are **172 LEED buildings in the City**, which is leading practice, but in a city the size of Chicago, this seems a small proportion.

Synthesising what has been learnt from Chicago practitioners with the Chicago case study (Section 4.6) creates a causal relationship between policy and practice (Figure 4.9). Figure 4.9 provides an interpretation of how the levels of decisions and their influencers affect Chicago.

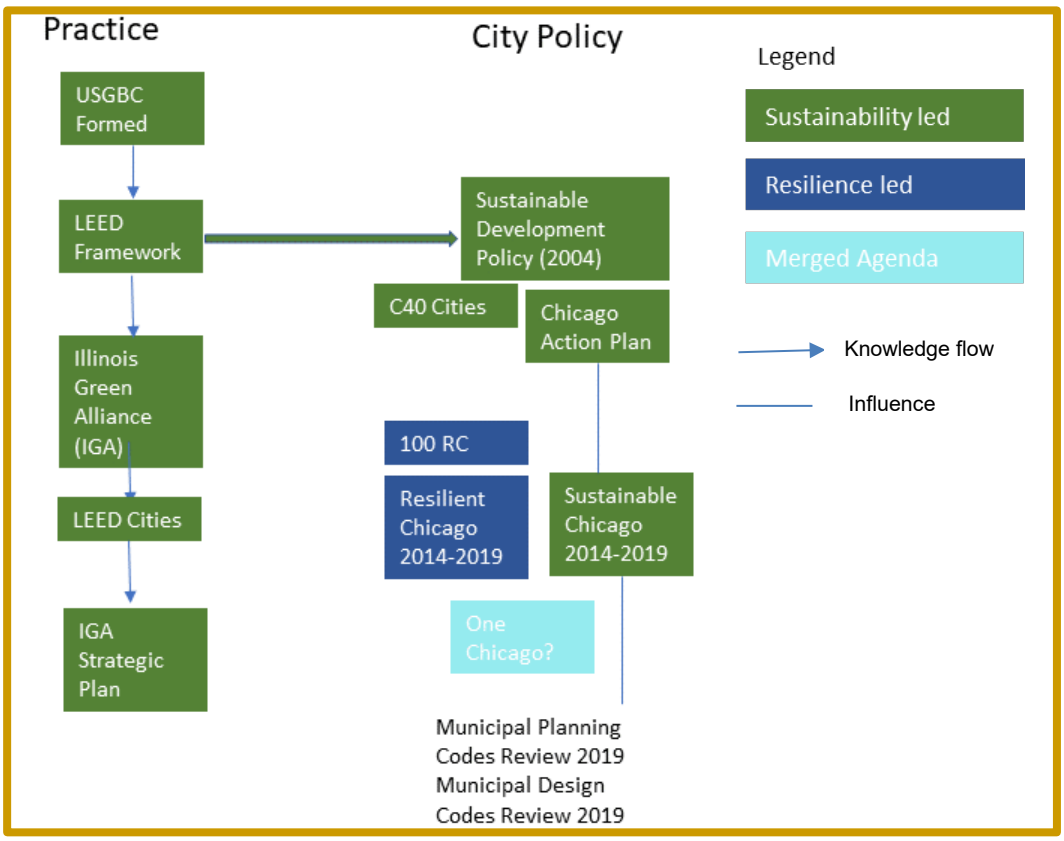


Figure 4.10 Chicago decision-making between policy and practice

Figure 4.10 indicates that the foundation of the sustainable development policy was adopting LEED to inform policy. This is reflected by the 2012 DOB planning process which advocates LEED.

Mayor Daley's policies were established before C40 and the principles are maintained today in its third generation of policy. Even 100RC points back towards Sustainable Chicago. However, what Chicago shows is a reliance on LEED and consequently their municipal planning and design codes have not been re-evaluated. Practice also seems to be in parallel with policy, there is little cross referencing because LEED links them both.

4.8 Sustainability and Resilience decision-making landscapes of Boston

Boston, the capital city of Massachusetts, has 0.669m residents with city carbon emissions estimated at 6 462 485MtCO2e (CDP, 2017) making Boston the **55th ranked city of 13000 cities** with a 37.1Mt CO2 (CityCarbonFootprints, 2019). City policies indicate that Boston is aware of the impacts of extreme weather but is this understanding affecting decision-making in the built environment?

4.8.1 City Context

Boston is located by the Atlantic coast at the delta of Rivers Mystic and Charles, forming a natural harbour (Figure 4.11).

Figure 4.11 Location of Boston (source- Boston region. Encyclopedia Britannica, Inc.)

Puritan colonists from England founded Boston as - ‘a city upon a hill’ - in 1630, the Cambridge Agreement that established the colony as a self-governing entity. Boston was pivotal for the ‘New World’ era and remains a city of both historical and cultural significance today (WorldAtlas, 2019).

Boston has an average summer temperature of 26.67 °C and an average rainfall of 1177.29mm which is classified as a temperate oceanic climate (Rubel and Kottek, 2010) but it rains a lot with strong seasonal winds called ‘Nor’easters’ (Advameg 2019). Boston has experienced the 1755 Earthquake (Tilton, 1940), smallpox (Riedel, 2005), a great fire of 1760 and 1872 (Pencak, 1979; Hornbeck and Keniston, 2017), the American revolution, then Boston became a city in 1822 (Britannica 2019). Over the centuries, Boston’s story of the development of post-colonial and modern civilisation has resulted in a city whose inhabitants have a strong sense of civic responsibility. Figure 4.12 shows Boston’s city layout in 1814, with public parks depicted.

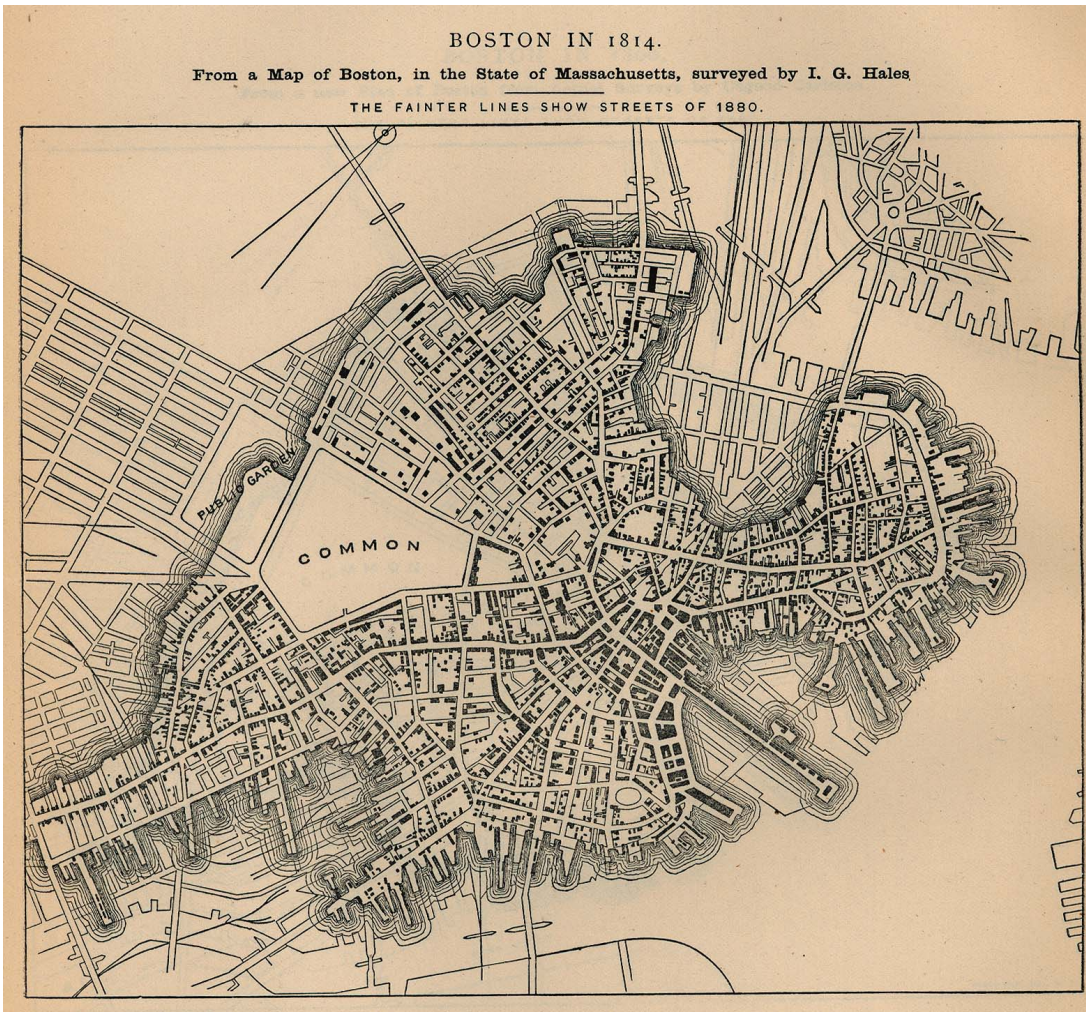


Figure 4.12 Boston city plan 1814 (The univeristy of Texas at Austin, 2019)

Today's built environment has been shaped by prominent events and social migration of ethnic groups (Linnean *et al*. 2013; Britannica 2019). Notably, in 1880s the Emerald Necklace was introduced by a landscape architect Fredrick L. Olmsted, who created parks, wetlands and a dam to form a 'greenbelt' and consequently shaped where built development occurred (Zaitzevsky, 1982).

Today, it could be argued that the **Emerald Necklace is an historical interpretation of ecosystems adaptation** (IUCN, 2019). **Boston's**

population is complex due to historic social migration, which has created areas of post-colonial development (Britannica 2019).

This relationship of social migration with development led to the creation of the **Boston Redevelopment Authority (BRA) in 1957 and Massachusetts Water Resources Authority (MWRA) in 1984** (BPDA, 2019). More recently, Boston had a commercial boom when the Building code allowed taller buildings (Britannica 2019) which led to tower construction to facilitate the establishment of the financial industry in the 1960s thus increasing the built environment density and contributing to the city's wealth. Modern Boston now has concerns about how 'resilience' issues will affect its densely populated reclaimed land, its riverside developments, and an aged and over its capacity stormwater system, coupled with increasing storms and rainfall (100 Resilient Cities & Walsh 2017; Walsh 2019b).

Today Boston is rated as a top 10 US city for global growth (Hathaway 2019) with the research institutions such as Massachusetts Institute of Technology (MIT) and Harvard Universities, city leadership and shifts in sustainability transitions make Boston a **critical place for the development of the 'green economy'** because of the combination of venture capitalists and knowledge in the area Gibbs & O'Neill (2014).

Sustainability and resilience have filtered into city governance through Mayor Tom Menino's policies and character (Gibbs & O'Neill 2014) and now Mayor Martin J. Walsh (Walsh 2019b). Boston's mayor is a member of C40 and has participated in the 100RC program. The 100RC characteristics are outlined in Box 4.8 and compared with the other case studies in Box 4.2.

Box 4.8 100 RC characteristics identified for Boston

Boston's 100RC profile identified **20 shocks and stresses** to the city which are: Aging infrastructure, Blizzard, Climate change, Coastal/Tidal flooding, Cyber-attack, Economic inequality, Ethnic inequality, Extreme heat, Inadequate educational systems, Inadequate public transportation systems, lack of social cohesion, Population Growth/Overpopulation, Poverty, Rainfall Flooding, Sea Level Rise/ Coastal Erosion, Severe storms, Storm Surge, Structural Racism, and Terrorist Attack (100 resilient cities, 2019).

Boston also benefits from leading practitioners in resilience and sustainability such as Linnean Solutions[4] (2013) who have developed understanding of resilience for the mayor. Recently, the Mayor has outlined how **sustainability and resilience need to be considered in 'Climate Ready Boston'** (100 Resilient Cities & Walsh 2017; Martin 2015; Walsh *et al*. 2017) and a program called Greenovate (City of Boston, 2019).

BPDA lists many articles, but Article 2 provides definitions of the zoning code which state Green Building as:

> *"Structures and their surrounding landscapes designed, constructed, and maintained to decrease energy and water usage and costs, to improve the efficiency and longevity of building systems, and to decrease the burdens imposed on the environment and public health" (Boston Redevelopment Agency, 2019)*.

As this affects the built environment, sustainability and resilience components of projects are mandated through BPDA development review process known as 'Article 80' (BPDA 1996). **Article 80 includes Article 37** (BPDA 2017), which manages **sustainability and climate resilience components of**

[4] Linnean Solutions is an architectural practice based in Boston who have provided publications on resilience for the city.

projects. **Article 37 is mostly founded on the USGBC LEED Gold Targets and provides a checklist for resilience**, but there are doubts about what this policy delivers in practice (Beauregard, 2014). Boston's governance has a CRO (City of Boston, 2018) and an Environment office which takes action on climate change through its commitment to reducing the carbon pollution and preparing for the impacts (City of Boston, 2019).

From a design practice perspective Boston's code of practice requirement is **'Massachusetts State Building Code- 780 CMR**'. If these standards are complied with, then article 80 can be achieved. MA CMR Code 1st Edition was published in 1975. The current version of the code is the MA 9th edition of code is based on modified versions of International Code Council (ICC) 2015 codes.

4.8.2 Boston Interplay timeline

Created in Figure 4.13 is an Interplay timeline of Boston's policy and practice landscape with global and national representation (Section 3.4.4). Boston appears to have been respondent to both C40 and being aware of its geophysical landscape. The 100RC program brought a new focus to its city strategies (Box 4.8) and these have slowly merged into a revised Climate Ready Boston (Section 4.8.3). Other city policies still exist because they mean something to practice.

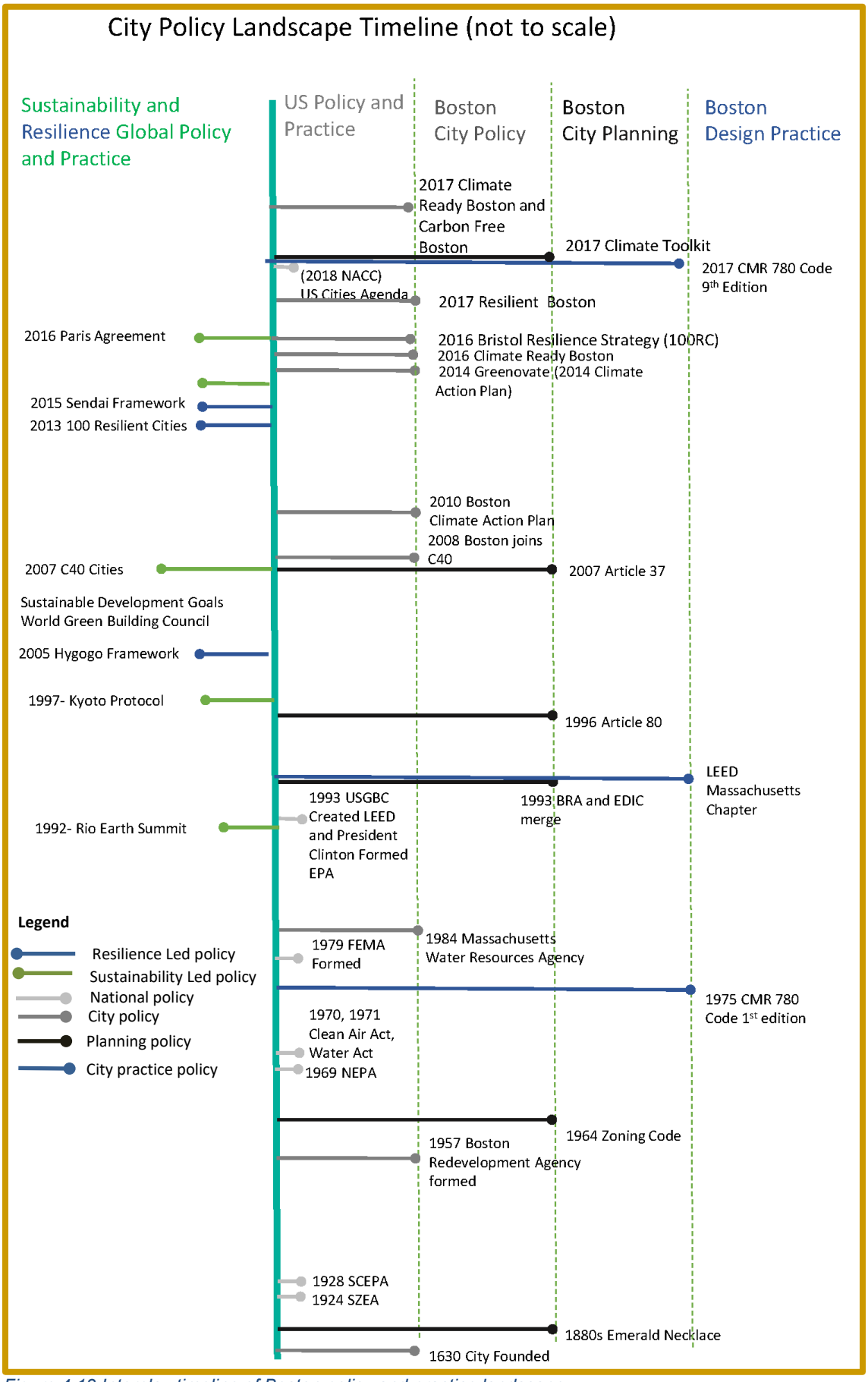


Figure 4.13 Interplay timeline of Boston policy and practice landscape

4.8.3 Policy Landscape

Since the Cambridge Agreement, Boston has enjoyed 'self-rule' for nearly 400 years (Vanlandingham, 1968). It comprises **23 neighbourhoods** (City of Boston, 2019), two democratic senators and 9 democratic representatives (Gov Track, 2019). Boston City is the member of both 100 RC and C40 and Box 4.8 outlines the city's shifts in policy. C40 has identified that the city's mayor has strong powers and prioritised the C40 initiatives on: energy, finance and economic development, measurement and planning, transportation and urban planning and development. Both 100RC and C40 indicate that Boston has assessed its climate risks, shocks and stresses (100 Resilient Cities, 2018, C40, 2018). Storms (rain and snow), extreme cold are seen as serious, but associated hazards with sea-level rise; storm surges as well as river and coastal flooding are classified as "extremely serious".

Box 4.9 Boston policy shifts

BRA has merged with Boston's Economic Development and Industrial Corporation (EDIC) (BPDA, 2019) to form Boston Planning and Development Agency (BPDA). However, both organisations operate co-independently. BPDA has created the Mayor's E+ Green Building Program (BPDA, 2017), which targets high performance such as LEED Platinum. Boston's key city policies discussing climate change emerged in 2010, this was followed by Greenovate Boston (Boston, City of, 2014), Bristol (Boston) Resilience Strategy report (Cities, 2016). Greenovate Boston program has established itself as an umbrella for local governance and strategy to implement the cities climate action plan.

Greenovate adopts the 2014 Climate Action Plan (Walsh *et al.*, 2014) which outlines the city's policy approach to sustainability. An introductory statement from the mayor reflects an understanding of how natural hazards

can affect the city and the city's social movement to become more sustainable and reduce GHG. The report is structured as follows:

1- State of Climate
2- Cross cutting themes
3- Boston's Carbon footprint
4- Implementation and next steps
5- Neighbourhoods
6- Large Buildings and Institutions
7- Transportation
8- Climate preparedness
9- 80x50

Boston has an understanding of sustainable development that is weighted towards reducing GHG emissions concerned with energy consumption and transportation (25% reduction by 2020 and 80% by 2050). The Green Ribbon Commission manages targets and strategies and carries out stakeholder engagement to continue its reduction. Cleaner energy production and more public transportation seem to be the easy wins so far with buildings in use on the agenda. However, city governance also wants to prepare Boston for the Impacts of Climate Change and sets out the following priorities (Walsh *et al*. 2014; p7):

> *Work with regional and state agencies, and surrounding communities to align and accelerate regional preparedness planning.*
>
> *Incorporate climate preparedness into existing local planning and community engagement efforts.*

> *Ensure public- and private-sector developments and major capital projects are prepared for expected climate change over their projected life.*

The document also recognises **'resilience' and outlines its exposure relating to Boston being a coastal city, as well as its social vulnerabilities because of the existing urban environment**. Recognised risks are in relation to flooding, subsidence to water ingression, warmer weather and Nor'easter storms. Walsh *et al.* (2014, p. 69) outline the coordination climate preparedness efforts across city, state and federal levels for buildings, transportation, land-use and natural systems, energy, water infrastructure and emergency management.

In 2016, 'Climate Ready Boston' was launched which outlines what Boston is going to do to manage climate change. There are 11 strategies outlined (Walsh, 2016, pp. xxxix–xii) which merge the principles of **adaptation, mitigation, resilience (hazards, risk and vulnerability) and sustainability**.

> *The 11 strategies are:*
>
> *1. Maintain up-to date projections of future climate conditions to inform adaptation.*
>
> *2. Expand education and engagement of Bostonians on climate hazards and action.*
>
> *3. Leverage climate adaptation as a tool for economic development.*
>
> *4. Develop local climate resilience plans to coordinate adaptation efforts.*
>
> *5. Create a coastal protection system to address flood risk.*
>
> *6.Coordinate investments to adapt infrastructure climate conditions*

> *7. Develop district-level energy solutions to increase decentralisation and redundancy.*
>
> *8. Expand the use of green infrastructure and other natural systems to manage stormwater, mitigate heat, and provide additional benefits.*
>
> *9. Update zoning and building regulations to support climate readiness.*
>
> *10. Retrofit existing buildings against climate hazards.*
>
> *11. Insure buildings against flood damage.*

As there are no predetermined references to sustainability, what this suggests is that Boston seeks to reduce climate change through a variety of policies towards the built environment and reduce is vulnerabilities to hazards and risks associated with climate change. Resilient Boston was produced in 2017, driven by the Mayor, CRO and 100RC. Resilience here is defined as:

> *"the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and thrive—no matter what kinds of chronic stresses and acute shocks they experience."* (Walsh, 2017b, p. 9).

Boston's approach to 'equality and equity' resilience (Box 4.8) includes **facilitating racial equity to unite social fractions to address 'structural racism'** as identified by the 100RC process: "*We believe that the only way to foster citywide resilience is to address racial equity along with the physical, environmental, and economic threats facing our city*" (Walsh, 2017b, p. 8). **The report was co-produced with 11,000 Bostonians**. Its records Boston's history of vulnerabilities, the risks and hazards. The resilience strategy is centred on **4 long-term visionary goals** with associated initiatives set out to achieve these. There are **23 initiatives in total**. The long term goals are: **1)**

Reflective city, stronger people: social cohesion with 4 initiatives, 2) Collaborative, Proactive Governance: community led processes and community partnerships with 5 initiatives, 3) Equitable Economic Opportunity: intergenerational wealth (education and careers) with 7 Initiatives, 4) Connected Adaptive City; resilient infrastructure and systems to respond to climate change with 7 Initiatives.

> **Expanding Goal 4 is the most relevant for this interpretation as quoted:** *"GOAL 4.1: Develop a redundant and reliable public transportation network to provide equitable accessibility for all Bostonians.; GOAL 4.2: Prepare for the impacts of climate change and other threats, while accelerating sustainable infrastructure, environment, and communities; GOAL 4.3: Improve the collaboration of partners working in Boston communities to address climate change and other emergencies."*(100 Resilient Cities & Walsh 2017, pp.106–130).

This report defines sustainability as "Consisting of reliable and effective structures and procedures to survive over time (including leadership, capacity, and funding streams)" (Walsh, 2017b, p. 138). Mayor Walsh has recently launched Climate Ready Boston and maintained a policy called Carbon Free Boston (Walsh, 2016, 2019a). The Mayor's announcement in October 2018 (City of Boston, 2018) to the Chamber of Commerce outlines the mayor's vision for the city. Mayor Walsh (2019b) advocates the use of Climate Ready Boston, BPDA development review process, Greenovate, the use of IGBC and the BPDA Article 37 checklist. It has the process and people in place to creative effective change for 'large' scale projects. It's waterfront development is prominent for the application of a 'building resilience toolkit' and protection of the city from stormwater affects (Edelson, 2018) (City of Boston, 2018). Mayor Walsh 'Jan 29, 2019' speech on Climate

Change, discusses all Boston's policies, but there is a focus on the Boston's Climate Action Plan (City of Boston, 2019).

What remains unclear is how the built environment will respond to delivering the reality of this vision. Has the detail of planning and design been thought out? How much adaptive capacity is being built in, or is the reductionist approach to GHG emissions going to provide enough functional resilience? However, as the city strategies are outlined the built environment trailblazing, performance and knowledge gaps become exposed and create the need for legislation, for example the relationship between **Article 37 and the E+ Green Building Program**. Real conflicts in decision-making start to appear even with the best interests (Section 2.3) (Foot, 1985).

4.8.4 Planning Landscape

Boston operates a 'Zoning code' which was enacted in 1964 to manage the merging of small towns into 'the city of Boston', the towns are known today as 'neighbourhoods'. What is meant by zoning is "*the set of rules by which the City's neighbourhood planning is implemented and dictates the allowed shape, density and use of development in a given area*" (BPDA, 2019). The zoning code is operated by the **BPDA, Boston Zoning Commission** and the mayor. The zoning process is part of the development review and stipulates that Building Code 780 CMR must be complied with. MA CMR definitions do not include sustainability references, but the code does define base line flood elevation and flood hazard area. It does not define anything more significant to do with surface water or storm water management (CMR 2018, Chapter 2). Today, the City operates a Zoning Viewer, this zoning viewer shows the

FEMA flooding zone, but how is climate resilience managed in the planning process documentation?

From a local institutional perspective of achieving a design project in Boston the critical stakeholder is BPDA (who is representative of the BRA and EDIC). BPDA are the custodians of the planning process and zoning (BPDA, 2019) and operate a development review process titled “Article 80” (BPDA, 1996; BPDA, 2019). Article 80 prescription is described in Box 4.10.

Box 4.10 BPDA planning application compliance with Article 80

Article 80 was launched in 1996 for small and large projects (new development). What this means is that any development (or built environment project) exceeding 20,000 sq. ft needs to go through a review process. 20,000sq ft (or 15+ residential units) translates to about 20, 4 bedroom houses in the UK (where a typical 4 bed house is 993.5ft2 (Hudson, 2015)). What Article 80 does not do is manage refurbishments or developments smaller than 4 bedroom houses.

However, the process can be employed on any transportation, public realm, environmental or historical resource project.

In 2007, ‘Article 37’- Green Building and climate resilience guidelines (BPDA, 2017a) was added to the Article 80 process. Through Article 37, the city has started to operate an **Interagency Green Building Committee (IGBC)** to serve as an advisory body to local governance for decisions concerning green buildings. However, Article 37 is only compulsory for new large projects, although parameters are shifting, and updates are becoming available:

> *“Additional details are available in the* Climate Resilience Guidance and Checklist *document…[…]… The update also introduces the* BPDA Sea Level Rise (SLR) - Flood Hazard Area Map Mapping Tool*. …[…]… the map models future coastal flooding conditions due to a 1% annual*

> *storm event with 40" of SLR and provides projects with a SLR - Base Flood Elevation for project planning." (BPDA, 2017).*

Currently, the South Boston Waterfront area is being developed and is showcasing 'resilience' projects. More specific resilience guidelines have been provided for these areas which include construction details of bunding and how to manage stormwater (Boston Public Works Department, 2018a, 2018b).

BPDA also advocate the Massachusetts state building code CMR 780 which was revised to its 9th Edition in 2017 (Commonwealth of Massachusettes, 2019). The foundations of the state code use international building codes (published 2015). The city also operates the 'Inspectional services'(ISD) which administer and enforce building, housing, heath, sanitation and safety regulations mandated by City and State Governments (City of Boston, 2019). They provide permits on minor changes to buildings and new construction. The guidelines stipulate that the permit application goes to the zoning Board, which indicates that the BPDA guidance must be followed (City of Boston, 2019).

> **The following statement about LEED and BDPA compliance is provided**, *"On October 31, 2016, the US Green Building Council closed all LEED 2009 Rating Systems and the LEED Home Mid-rise 2010 Rating System to new registrations. Projects required to comply with Boston Zoning Article 37 Green Buildings that are submitting their first substantive filing to the BPDA must demonstrate Article 37 compliance using the most current LEED v4 Rating System. Projects filing a Notice of Project Change AND proposing to use an earlier Rating System version should consult with the IGBC before filing". (BPDA, 2019)*.

BDPA's Article 80 and Article 37 establish a development process that incorporates sustainability and climate resilience highlighting their importance to the city's built environment. However, neither articles cater for domestic scale projects or refurbishments. Existing building stock is at the liberty of whether the owner or developer feels it necessary to refurbish according to LEED Existing buildings and design codes, the minimal requirements. As Hurricane Sandy indicated, it was the domestic scale properties that created the most risk (The Balance, 2018). A small project of 20000sq ft does not have to consider Article 37 but must consider zoning (neighbourhood) requirements. Therefore, unless the zoning code has sustainability or climate resilience components, neither will be addressed unless built environment practice use 'responsible' design processes.

Article 37 is based on LEED BDC certifiable, but state requirements now operate LEEDvs4.0 and the performance standards will have changed meaning that practice will need to too. Currently, the BDPA Article 2 (Section 4.8.1) and Article 37 are employing different interpretations of sustainable development. This suggests that there needs to be an alignment of operational terms of sustainability and resilience. LEED is also referred to in BDPA guidelines which infers that there will be a certain level of green building achieved by complying with the USGBC LEED certification process. Where there is lack of clarity on resilience and sustainability for projects is when they fall outside of the 'large project' boundary. All other projects are required to follow the zoning codes and state regulations.

For smaller domestic scale projects or retrofitting, guidance is provided in 'Housing a changing city: Boston 2030' (Boston 2014). Included is a 'Green

and sustainable housing' Chapter that refers to the 'climate action plan' released in 2014. (Boston 2014, p.97). What is also outlined as a preferential approach is to use the E+ Green Housing Program Initiative which stems from Greenovate (Section 4.8.3).

> *The guidance provides 10 goals as outlined below:*
>
> *1. Recognise and promote green building leaders*
>
> *2. Incorporate green building education into training programs*
>
> *3. Explore energy score for residential housing*
>
> *4. Enforce the building energy code*
>
> *5. Identify opportunities to integrate no-cost energy assessments into the permitting process*
>
> *6. Continue to explore new outreach strategies for Renew Boston*
>
> *7. Improve owner access to retrofit project finance*
>
> *8. Ensure developers, owners and tenants understand how climate change will impact housing and provide guidance on preparing their homes and buildings for these impacts*
>
> *9. Prioritize new construction along public transit and increase other options for alternative modes of transportation*
>
> *10. Ensure that BHA buildings meet their current Climate Action Goals*

Between the descriptions of Article 80, 37 and LEED BDC, multiple scales of development are provided with a decision-making framework but LEED ND has yet to feature in policy. Although, it would appear that the city strategies are in a state of flux due to the recent policy changes. Practice must track what is the latest guidance or initiative to know how to manage

sustainability and resilience beyond Article 37 and zoning (Section 4.8.7 and Figure 4.13). It also reveals that the backstop of compliance is LEED certification and when LEED cannot be employed to use the city's building initiatives.

4.8.5 Practice landscape

Despite Article 80, Article 37 and the city's 'resilience toolkit' (City of Boston, 2019), Beauregard, (2014) suggests that city practice is not as 'green' as it could be. Article37 LEED BDC requirements are paced at 'silver'-not Gold or even Platinum and not targeting every scale of project, although the E+ Green Building Program is targeting better performance standards in housing design. City practice is mostly managed through the zoning code and compliance with the planning process. Building codes that need to be complied with are either the international codes or CMR780. Boston city manages individual design and climate resilience requirements through the zoning code. Reflecting on what this means, is that there is no municipal code and the control mechanism is the planning process.

What does need to be recognised is that the zoning code includes requirements that can be greater than the minimum LEED compliance and can operationalise different design parameters. The BPDA and mayor have opportunities to dictate what happens through the zoning code, yet still comply with State requirements.

4.8.6 Green Building Measurement

Boston has active professional Chapters on LEED with the USGBC Massachusetts Chapters (USGBC, 2019). Consultants Perkins and Will have founded RELi (C3 Living Design Project, 2019)(Section 2.3.5). This indicates that there are highly knowledgeable people and organisations working in design and planning in Boston (Section 3.4.3). The city of Boston has set out its policies but they are limited by what is described in **Article 37 and currently the resilience design guidelines are targeted for the 'Habor districts**' (City of Boston, 2019).

City design and planning practice must comply with professional standards and a development review process to achieve a building permit. **Massachusetts State Building code 9th Edition and Boston zoning codes** have been identified as the design standard to achieve a compliance for a building permit. However, there are nuances already identified with LEED BDC performance and what version of code to comply with. This cross theme review of policy, planning and design is concerned with the following causal relationships:

- Article 37 relationship with Massachusetts State building code with reference to LEED performance.
- Article 37 with E+Green Buildings Program
- Boston Zoning Code and Massachusetts standards
- Relationship with FEMA.

Article 37 outlines that "Boston Green Building Credits" (Section 3.7.2) is working towards LEED certifiable project and that Boston IGBC will provide

advice on projects (Box 4.11). The IGBC committee does not include a state representative.

Box 4.11 LEED BDC performance in Boston codes

LEED v4.0 is now the state requirement due to CMR 780. Without reviewing precise performance characteristics between IBC and ASHRAE codes with LEED by providing comparative data, it can only be assumed that performance standards are increasing.

Box 4.11 highlights that design requirements are constantly shifting in a short amount of time and given that large scale developments can have a project life of a few years this may be problematic for practice. Boston has not published data on what buildings target which LEED credits so a trend can not be established at this time.

Sustainability in the International Building code (IBC) is recognised in the International Energy Code (IEC). It does acknowledge Passivhaus, Energy Star and other calculation methods. From this, it must be recognised that a specialist would be able to translate these calculation methods and what it means in terms of standards.

What needs to be acknowledged is that LEED v4.0, ICC does, Article 37, Boston green credits and MA 9th edition codes all stipulate a version of energy requirements. From appearances, the MA code does not reference stormwater management, surface water management or resources and therefore not reflecting the holistic practice of LEED v4.0.

In conclusion, what can be recognised is that there are a variety of methods and codes all evolving and at use in practice at the same time. Considering sustainability and resilience concepts, what is portrayed well is Energy - it has a tangible code section and targets established. WBDG outlines that the 1992 Energy Policy Act and Energy Policy Act of 2005 are responsible for ASHRAE and IECC establishing a dialogue to promote better practice. Resilience still is mostly considered as an urban flooding issue due to aging infrastructure or stormwater, but due to the recent efforts of the 100RC there has been a policy shift towards structural racism (Sections 4.8.2 and 4.8.3).

4.8.7 Decision-Making influence landscape

Boston has made a steady shift from 2008 about its city policies towards sustainability and climate change. The influences and actors on decision making have been collated in Table 4.6.

Table 4.7 Boston decision-making influences

Influences and actors	Sustainability- Resilience Critical documents	Decision making levels (themes)
C40 Cities 100 RC cities Global Policy of Paris Agreement SFDRR City Governance (actor) US GBC Hazard Events of Hurricane Sandy FEMA	Resilient Boston Carbon Free Boston Climate Ready Boston Greenovate E+Program	City policy
Mnemonic Practice City Practice (LEED-RELi)	Municipal Planning Process – Act 80 and Act 39 LEED RELi	City planning
Mnemonic Practice- LEED Practice (RELi) Scope of works	Climate resiliency Guidelines (waterfront) Municipal Codes 2014 CMR 780	City Design

More recently, it made a shift towards resilience which has filtered into city sustainability policies. The result is Climate Ready Boston, which has created design guidelines and a planning process that is a guardian for a better urban development. However, the standards of what is currently advocated, such as LEED silver, could be improved as could its applications to all projects. There is a sense that the Mayor is in control and that practice is informing policy, but within reasonable steps because compliance with CMR 780 practice has been revised periodically over time.

Synthesising what has been learnt from Boston's practitioners with the Boston case study (Section 4.7) creates a causal relationship between city policy and practice (Figure 4.14). Figure 4.14 provides an interpretation of this relationship in Boston.

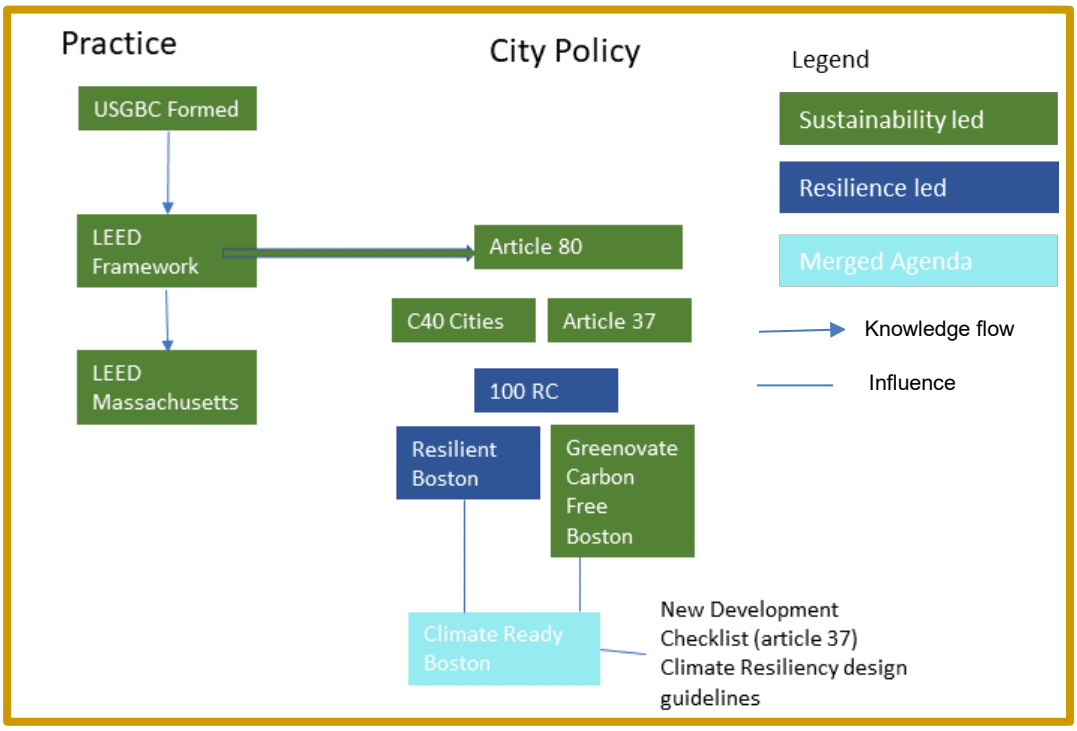


Figure 4.14 Boston's decision-making relationship between policy and practice

Figure 4.14 positions article 80 as the initial shift in policy which has become enhanced by LEED to produce article 37. With the 100RC program, it provided the city with an opportunity to review their processes and particularly towards flooding. This exposed new thoughts to be processed in parallel with the existing policy frameworks. The result is Climate Ready Boston which has started to provide design and planning guidance for city practice.

4.9 Chapter Summary

Considering the city landscapes of policy, planning and design practice has allowed the examination of interpretations of resilience and sustainability and measurement frameworks in decision-making of the built environment (Sections 4.6, 4.7 and 4.8). This context provides an insight into what influences exist in decision-making (Table 4.1) and critical junctures of interplay identified (Figures 4.1, 4.4, 4.9, 4.13). All three cities have demonstrated decision-making bias towards climate change; and resilience thinking is emerging towards hazards emergency management, as well adopting C40, 100RC and LEED as frameworks (Figures 4.6, 4.10, 4.14).

City policy landscapes indicate that there have been some abrupt shifts in policy (Sections 4.6.3, 4.7.3, 4.8.3) but informed by practice (Sections 4.6.5, 4.7.5, 4.8.5). Each city has a high representation of policy actors and influences (Table 4.1) but political shifts and the effect of habitual decision-making processes have been recognised. Themes have been tracked in the case studies (Section 3.4) and emerging themes of habitual practice and political shifts have been recognised (Section 4.5).

It has been recognised through the 100RC framework and C40 Cities that the city mayors have strong powers to create their city strategies for resilience and sustainability. In a short space of time, the concepts of resilience and sustainability have merged as each city provides a city strategy that encompasses both concepts which is further discussed in Chapter 6. However, Chapter 5 provides the reality to this decision making which tells its own story of rhetoric.

Chapter 5 Cities' discursive themes

Examined in this Chapter are the responses from nineteen semi-structured interviews to abductively construct causal relationships of city decision-making interplay (Table 3.6). Each case study considers how city practitioners have **interpreted resilience and sustainability in the landscapes of city policy and governance, city planning and city practice**. Stakeholder representation was assessed in Section 3.4, and due to the stratified purposive sampling their responses are very insightful. Already, their responses build an understanding that could be further explored and expanded into a full causal network or ANT (Sections 3.3.5, 7.4, 7.5).

Section 2.4 recognised themes in the sustainability and resilience narrative and the city case study narrative has expanded these themes (Section 4.9). First, the **conceptual interpretations** are considered per case study city (Section 5.1). Secondly, identifying which **measurement frameworks** (Section 2.2.3) have been recognised in city practice (Section 5.2). This Chapter provides further **city reality to the decision-making themes** in Section 5.3.

To position the reality of the causal behaviour and what approach is galvanising city practice towards better resilient and sustainable development decisions (or not), the cities' responses are streamlined (Section 5.4). Boxes and illustrative quotes are continued to be used to highlight discursive themes.

5.1 Interpretations of sustainability and resilience by city practice

Understanding how conceptual nuances represent themselves starts with defining what is known in city practice. In order to be able to set the scene for the interview and gauge the interviewee's subject knowledge, a two part context setting question was asked (Table 3.7): 1) how would you define sustainability and 2) resilience? The responses to this question have been interpreted for conceptual understanding and represent what is known in city practice. The outcomes to the question were analysed using the coding framework (Section 3.4.4) and responses are provided in the following two sections. Boston and NYC provide a range of responses, but Chicago does lack responses (Table 3.10).

5.1.1 City Practice's initial definition of sustainability

Section 2.2 outlines the variances in conceptual understanding and interpreting all the responses from city practice suggests that the origins of sustainability have been understood by the reference to Brundtland and the TBL (Elkington, 2004). Themes on conceptual interpretation have been identified in each city (Section 4.9). City policy suggests that Brundtland's agenda of sustainability has been utilised to drive efficiencies in building and infrastructure systems to reduce GHG and climate change (Sections 4.6.3, 4.7.3, 4.8.3). However, what is the reality of this conceptual interpretation in decision-making?

1) NYC and Chicago's interpretation

Responses from NYC and Chicago show that the concepts captured in Brundtland (1987) are still recognised and fundamental (NYC02, NYC07, CHIC05, NYC04). However, NYC 05 clearly states it is about being more efficient.

> *"you know, Brundtland Commission […] way back when."* (NYC07).
>
> *"the triple bottom line that we use. It's about being environmentally sensitive, economically viable, socially responsible" (NYC02).*
>
> *"The triple bottom line definition where you're considering values and outcomes related to people, profit, climate" (CHIC05)*
>
> *"Brundtland Commission definition again" (NYC04)*
>
> *"I like to use the word "Efficiency," instead of "Sustainability." (NYC05)*

2) Boston's interpretation

Although each person describes sustainability differently, there is a common theme that suggests a broad understanding of the concept. Sustainability has become an encompassing way of practice (BOS02, BOS03) but BOS04 and BOS06 interpret it as an approach to drive increases in mitigation efficiencies.

> *"Sustainability means very specific things and it means that systems and organisations can sustain themselves..[sic].. Sustainability is a step along that way to that kind of regenerative activity."* (BOS02).
>
> *"Sustainability, it's a broad umbrella"* (BOS03).

> *"I like to see sustainability described in terms of efficiency of functions performed based on the efficiency of resources being consumed or used or extended or replaced and recycled"* (BOS04).
>
> *"I see that as a mitigation measure, reducing our carbon footprint, to help in the long run"* (BOS 06).

From all three cities, the responses broadly fall into two categories of use: 1) the umbrella concept and reaffirming the Brundtland commission (NYC02, NYC07, CHIC05, NYC04, BOS02, BOS03) or 2) as a way to mitigate or promote efficiencies (NYC05, BOS04, BOS06).

5.1.2 City Practices and initial definition of resilience

Considering all the responses collected, there was a wide interpretation of meaning for resilience, but they broadly relate to 1) Capacity building of systems 2) response to hazards and 3) Rate of Response. Reaching a consensus of how city practice has interpreted the term 'resilience' is based on verbal feedback from the interviews.

A capacity of systems has been interpreted to mean an understanding of disruption and that the impacts of disruption affect a system (BOS02 and NYC03).

Responses to hazards reflect an understanding a position of building resilience into capacity of responses to all hazards. This involves forecasting for all risks, all the time and that vulnerability needs to be considered too (NYC03, BOS04, CHIC05).

Rate of response yields the most recognition by use of the following terms: adaptative, mitigating, recovery from "disaster" or "extreme events", hazards

and disruptive events, so that there is a rapid return to normal (BOS01, CHIC01, CHIC02, CHIC03).

When considered at a city practice level, each city has a range of responses, but a generalised interpretation suggests that resilience is about managing the future forecasting for a scenario of emergency risks or disruptive events and being able to respond quickly. The responses are summarised by city and Chicago is well represented in this element.

1) NYC's interpretation

> *"For Resilience, we need to be looking at what is a forecast of the future that we need to address?"* (NYC02).
>
> *"unforeseeable disruption, with system ability and back into balance, resilience look for way to manage it."* (NYC03).

2) Chicago's interpretation

> *"it has gone from the buzz word about environmental stuff to thinking much more concretely about adaptations"* (CHIC01).
>
> *"The ability to respond to an extreme event whether it's a natural disaster or a manmade disaster."* (CHIC02).
>
> *"Resilience is the capacity to withstand and respond quickly to extreme events"* (CHIC03).
>
> *"you've got houses in a floodplain, you know, you have your high exposure and your high – and depending on your level of income or your ability to like go stay at your grandma's house while your house floods, you know, that's your sensitivity."* (CHIC05).

3) Boston's interpretation

> *"resilience is by strict definition, is the ability to recover or bounce back and it's been applied to cities in case of a disaster."* (BOS01).
>
> *"resilience is about building the capacity within a system. The definition is to help systems build capacity to thrive and evolve in the face of disruption."* (BOS02).
>
> *"and don't just think about the lovely sunny days, think about it when there's all kinds of things hitting the fan under current conditions and future condition"* (BOS04).

5.2. City practice measurement frameworks

Identified in city policy is the use of the LEED measurement framework in decision-making (Sections 4.6.7, 4.7.7, 4.8.7). To examine how sustainability and resilience are measured in practice, data collected considers, 'which' measurement frameworks have been recognised by practice and 'what' measurement tools are being employed to manage sustainability and resilience (Table 2.2).

From the coded data collected on measurement frameworks (table 3.7), interviewees discussed the frameworks operationalised in their decision-making practice. The frameworks have been ordered in Table 5.1 according to recognition and the respective number of responses.

Table 5.1 Measurement Framework Summary [5]

Which Framework is known?	Quantity of response	Who
LEED	14	As above + 3
Other Frameworks	10	RELi – BOS03, BOS04, CHIC04 CHI 02 and NYC05- WELL certification NYC03- FEMA BOS 05- Moody's BOS03- AIA 2030 commitment CHIC01- MAP 21 and FASTACT, Flood susceptibility Index Passivhaus – CHIC02
100 RC	6	BOS02, NYC07, BOS05, BOS03, BOS04 CHIC05
Own Tool	5	NY 03 Cost benefit analysis tools BOS03- cost benefit analysis CHIC04- we developed our own tools NYC08- the bank's (company own) NYC05- Lendlease (company's own)
C40	2	NYC07, CHIC04
Envision	1	NYC03
Cities Index	1	BOS05
MMCRC	0	
ACCRN	0	
Mercy Corps	0	
Resilience.io	0	
STAR	0	
TAMD	0	

Table 5.1 shows that LEED is the mostly recognised system, followed by frameworks in the 'other' category, 100RC and own tools. LEED, Passivhaus, LEED- RELi are well known built environment frameworks which operationalise sustainability and efficiency of systems to be able to operate "off grid" (Wilson, 2006) and have been previously recognised in the

[5] Where measurement was discussed it was classified as 'other' or their own tools.

decision-making landscapes (Section 2.1, Chapter 4). However, there are new sources such as WELL[6] (WELL, 2020), AIA 2030 Commitment[7] (AIA, 2020) and Moody's[8] (Moody's, 2020). These additional frameworks have been in circulation between 2014-2017 but tracking their uptake in practice would require further investigation. Where the Health or Happy frameworks are starting to be used in city practice (Section 2.2.4) (APA, 2019; Lewis and Abdallah, 2016; Brown, Abdallah and Townsley, 2017) as well as FEMA are an influence in decision-making processes but many of the frameworks in Table 2.2 are not yet recognised (Section 2.2.2).

Initially, in data collection the category of 'Other frameworks' was considered arbitrarily, but it has the second most responses. This represents the diversity of frameworks being used in practice. Responses from practice indicate that the tools to assist with decision-making are not suitable and in doing so create their own tools (Table 5.1). This supports the principle that resilience and sustainable mean many things (Levine, 2014) because in city policy landscape here are different interpretations of resilience and sustainability in operation which measure a variety of consequences (Sections 4.6.3, 4.7.3, 4.8.3).

Due to the range of measurement frameworks available, the results indicate that there should be consideration of why the existing frameworks are not working or others are not being utilised (Section 7.6). The interviewees

[6] WELL was launched in 2014 by the International Well Building Institute to focus more on the occupant health of buildings (Building Green, 2020)
[7] AIA launched their initial plan in 2017 but a climate action plan was set in place in 2019 (Architect Magazine, 2019)
[8] Moody's ESG and Climate Risk framework was launched in 2016 with Green Bond Investments (Moody's, 2020)

responses lead towards considering that existing measurement platforms may already have the answers.

Description of the case study landscape (Sections 4.6.6, 4.7.6, 4.8.6) outline that LEED has filtered into city practice, but how it is operationalised in policy is an issue.

> *CHIC02 raises the point that LEED has become institutional knowledge and new measurement systems are starting to be adopted: "LEED is being replaced with Green Globe [9], living building challenge [10], passiv-haus, energy star [11]. To me LEED has become sort of a zero sum game, it's really become about compliance. And we don't – particularly with stormwater, I've never LEED inspire sort of a creative solution for stormwater."*

Further to that, there are differences within best practice about whether LEED (or Green Building Assessment Methods) work with delivering operational performance value, but also deliver positive contributions to the community (Cole, 2003, 2005, 2015; Bordass and Leaman, 2013).

Box 5.1: LEED recognized as a leverage point (Section 2.2.5)

BOS01 is a global expert, who outlines that LEED is a good entry point to create transitions in practice, but it also is restrictive "*LEED is a good entry point. LEED in general is an invitation for fragmentation. I am going to count the points, right, so you're not working at the whole system and as result there is not a coherency, so are we going to get the LEED certificate?"* (BOS01).

[9] Green Globe certification looks at businesses and how to make them more sustainable: https://greenglobe.com/green-globe-certification/
[10] Living Building challenge considers net zero, building users and sustainable development context: https://living-future.org/lbc/
[11] ENERGY STAR is a U.S. Environmental Protection Agency voluntary program that helps businesses and individuals save money and protect our climate through superior energy efficiency: https://www.energystar.gov/

Recently LEED has expanded from the buildings and neighbourhoods platform into the cities and communities , as well as resilience with LEED-RELi (Champagne and Aktas, 2016). BOS01 continues to describe what happens to the mindset if you add resiliency into the discussion and provides a warning that, as resilience solely becomes quantified by credits, it could lead to a similar situation as sustainable building practice in LEED certification, i.e. the building has a certificate, but does that really mean its sustainable and resilient?

> *"… 'Or will we get the resiliency certificate? That means that you're actually paying attention to a system of issues which is good, that's really important point, that there are systems of issues, but they are not particularly a place-based system and actually what's missin*g *from our culture*." (BOS01).

BOS 01 also highlights the issue of sense of place and that perhaps measurement frameworks find this difficult to evaluate as an indicator? As the case study narrative reveals, many cities have adopted LEED has as a benchmark for municipal policy, as outlined by a policy practitioner BOS04:

> *"One of the reasons that we adopted LEED as opposed to a different standard is because there is that, not quite but nearly infinite number pathways to achieve compliance, so many credits of multiple ways to obtain them, that you're not being prescriptive*." (BOS04).

Yet, BOS04 also recognised that this flexibility allows for easy credit wins "*like the sustainable sites transportation type credits*" (BOS 04) that may lead to not tackling greater sustainable development issues. Despite this

movement away from LEED, practice forerunners discuss its future position and how LEED practice is incorporating resilience:

> *"There's a whole thought in the resilience world which I helped to perpetrate, about what's called passive survivability.[It] essentially describes a situation which a building gets unplugged from all of its inputs and still manages to be liveable."* (BOS02).

However, as green building measurement systems create fractures in practice, BOS03 describes "*LEED RELi is a game changer* "and that policy shifts the building energy performance component towards passivhaus standards, "*Goals in NYC are shifting to passivhaus and developers want to do it. Scale of application is an issue*." (NYC05). The practical implications of shifting practice standards have to be filtered into the policy standards and CHIC 03, an energy specialist, considers that it is possible,

> *"I mean California, New York, Washington D.C. have adopted net zero codes so by 2030 they have an energy performing index that's steadily decreasing"* (CHIC03).

These practitioners highlight that when resilience is added to systems like LEED, practice becomes focused on energy and water survivability, particularly in times of emergency. Through consideration of measurement frameworks used in practice, resilience and sustainability are merging on the point of 'passiv-survivability'. What is meant by this term is that a building or group of buildings must be able to cope in emergency situations and manage without power. This means that passive design- natural ventilation, daylighting, low U values in the thermal envelope, rainwater harvesting

become viable building options and this knowledge can be mobilised through LEED-RELi.

5.3 City practice rhetoric on decision-making

While the city case studies created the decision-making landscapes of policy, planning and practice, the meta-cognitive and the procedural knowledge of city practice needs to be constructed from the same landscapes (Table 3.5). These landscapes combined build the cities' reality of how sustainability and resilience have been interpreted in city practice. Each section starts with the positioning of the decision makers then the relationships with policy, planning and design practice follow (Sections 5.3.1, 5.3.3, 5.3.5). From the analysed data of interview transcripts, the cause and effect relationship were explored to create an understanding of the decision-making influences in each city (Sections 5.3.2, 5.3.4, 5.3.6, 5.3.7). This understanding then enables the causal relationship between policy and practice to be built (Section 5.3.7).

5.3.1 NYC's practice of sustainability and resilience

Three actors of governance were identified; the mayor, the CRO and New York State of Department of Environmental Conservation. Key policies recognised were 80x50, city zoning, FEMA and LEED. What is notable is that although the city policies are not openly referred to (Section 4.6.3), the people who make the decisions are, i.e. the mayor and the CRO.

City practice acknowledges the 80 x 50 Roadmap which was generated by the NYC UGC and in turn has become dominant policy in the OneNYC (Section 4.6.3). The benefit of this policy has resulted in the city converting

fuel supply to natural gas which means a shift in power infrastructure and the emphasis on “emergency” supply. However, the cities design codes are woefully unprepared for this change and LEED was discussed as an educational tool for younger generations. The lack of interview responses actively discussing OneNYC suggests that it is not affecting the ‘built environment’, but focusing on city projects as both NYC01 (a local governance representative) and NYC02 (a practice leader) discuss the infrastructure of JFK Airport, and the Lower Manhattan climate resiliency project as flood protection (Section 4.6.1). No clear resilience policy is discussed but FEMA, emergency planning and city zoning are mentioned.

All interviewees highlight the conflicts and gaps in the data available to inform decisions, particularly where flooding is an issue:

> *“New climate data is supposed to help decision makers look forward and use water data in their decisions. The residential code requires for residential structures to build 2ft about the flood plain for a 100-yr. event, this is not right or effective.”* (NYC01).

NYC 03 also highlights that development in flood plains is still occurring and puts more vulnerable people at risk. The issue of zoning is raised and that as policy has created new regulations where the existing infrastructure does not comply with the new standards. NYC03 highlights is that because policy has not regularly revised municipal zoning and design standards or managed sustainable development, these situations have arisen with infrastructure.

> *“ [zoning] documents were developed liked decades ago without the understanding of risk that we have now when it comes to showing all the natural risks. It’s turned out that with this those new regulations, the amount of 7,500 dams, like 70% of those dams, so, you know, 5,000*

> *dams are now – they actually – they don't meet the New York State regulation in that sense. And that's probably, you know, the price of bringing back those structures into compliance is that it has been estimated between 600 million to $800 million actually just in the State of New York."* (NYC03).

Now that city policy has shifted with the OneNYC (Section 4.6.3), dealing with emergency planning is infringed by the existing urban infrastructure because emergency vehicles need wider street space than is available:

> *"if you wanted a very narrow street, it still has to be large enough for a fire truck to fit through and there are so many restrictions"* (NYC05).

These responses reflect that there has been a lack of investment in sustainable urban development and a history of poor planning decisions which has increased the city's risks to extreme events as described in Box 5.3. The increased risks have led to the emergency scenario planning with infrastructure such as JFK airport and the Lower Manhattan Climate Resilience projects (Section 4.6.1).

Box 5.2: Habitual planning process and use of Environmental Laws

It is clear from the interviews that the planning process 'lacks vision' and that it is managed in a silo-ed way because it does not operate a collective response to development planning. This denotes Mode 1 thinking (Gibbons *et al.*, 2006). This is not unsurprising that Mode 2 thinking has not been incoporated, given that the planning process did not change from 1961 to 2011 (Figure 4.3) and that the environmental component (Figure 4.4) relied on EIS. EISs were stipulated by NEPA (1970) and the process was only reviewed by President Clinton and Vice President Al Gore in 1993 (EPA, 2019).

Interviewees (Table 3.9) outline that it is the planning process that lacks long term visioning, and current zoning codes are not sufficient for future hazard

scenarios predictions. Fainstein (2000) suggested that the role of planning in decision-making was critical and if planners have not been positioned to make better decisions, then these responses reflect that further exploration of the decision-making pathway is required (Section 7.6). NYC01 draws attention to the policy process and codes that are involved, emphasising that decisions must be made with consideration of future climate change projections and should become a part of city (and state) code. There needs to be consistency with how such issues as sea-level rise and urban flooding should be managed as part of the design process; currently people can fluctuate between city and state codes. NYC03's response highlights that designers have planning experience and metacognitive knowledge; but unfortunately, their outreach is limited to the projects worked on and are limited by lack of engagement (by local governance) with their expertise to inform the city vision. This insight reflects silo practice between public and practitioners of the built environment. Recent terror acts and disasters such as 9/11 and Super Storm Sandy have created an opportunity for public opinion to be engaged in the planning process. NYC02 recalls these events and indicates that communication between governance, public and practice is starting to improve.

NYC05 is a property developer who outlines that there is a silo mentality to collaboration and that design practice should collaborate more with planning to challenge the boundaries of what is possible, but this is only possible if planners are positioned to do so (Fainstein, 2000; Mehmood, 2016). NYC05 infers that there is a lack of guidance for building refurbishment as most of the new policies are catering for the new built environment rather than the

existing incentives, which also play a role in how to facilitate transitions and these can be supported by local governance.

NYC07, a global city specialist, raises the question of how investment has been spent. Has it been simply replacing infrastructure that was damaged, rather than putting back better designed assets with more resilience? What is potentially lacking is a real vision, a visual representation of how these issues are affecting NYC overall and future-proofing the city in a resilient manner. NYC appears to still be in reactive mode where monetary funding is reducing for city practice. NYC is fortunate that it benefits from contributions of international design practice, because professional standards are maintained concerning design issues. However, municipal building codes have suffered from the same lack of investment and not changed from 1968 to 2008 (Figure 4.4).

It appears that there is a state of flux and that working practice has tried to steer the city through the 80x50 roadmap to create a clear goal now represented by the Blueprint for Efficiency (NYC Urban Green Council, 2018). Sustainable development infrastructure was initiated with the NYC Stormwater project [12] (Bloomberg, 2007a), **but designers are merging the concepts of energy reduction and emergency planning because there has been a lack of guidance towards sustainable development**.

What NYC05 described is that in an emergency scenario, the longer-term strategy of reducing power demand is helpful, especially if the power can be

[12] Response to NYC Green Infrastructure plan has become known as NYC stormwater project: https://www.nyenvironmentreport.com/city-soakers-6-projects-that-will-be-like-sponges-for-nyc-stormwater/

self-generated (by localised renewables or battery storage). However, it does not make power infrastructure resilient to risks or overcome decisions to put back up generators in a basement that is prone to flooding.

> **NYC 05 outlines the issue faced by improving existing buildings** *"I think a building code is great for the new buildings, but […] there are so many current or existing buildings that we don't wanna have to rip down and rebuild…"* and then continues to outline that the city has become too focused solely on emergency scenarios *"city mandates are so focused on carbon emissions and reducing energy loads of buildings. And i think that plays into the resilience factor because obviously we wanna be consuming less energy to prevent black-outs or in scenarios when we don't have access to power"* (NYC05).

NYC01, the local governance representative, knows this from previous experiences and outlines that the detailed protection issues need consideration, such as **"*…where are we going to 'bund' during high tides?"* (**NYC01). This issue of bunding is expanded on because of the decision-making affects and NYC01 continues to describe them *" **How do we make policy decisions based on where to bund is becoming an issue (because of governmental politics) because no one wants to talk about relocation in whole planning, how do you determine in planning what urban areas are what is high risk and very high risk, now, during tidal events**?"* (NYC01).

NYC01 description in Box 5.4 highlights the issues that the tools for the decision-making are ineffective and practice creates their own tools (Section 5.2) particularly with reference to the planning process.

> *" It is very difficult, there are no good planning tools, what happens when it gets too cold, it is an issue, how do we deal with it? and it will*

> *accelerate and become something that we have to grapple with in the next five years. I think, certainly in parts of the US. There is a study on the East coast US, what is the US going to do? How are they going to manage infrastructure to those areas. What are we going to do with this entire coastal area and built up parts?"* (NYC01).

Taking the scenario planning into account, NYC08 who is an engineer, relays a more accurate response that describes the recent shifts in municipal codes is helpful (Figure 4.3, Section 4.6.5), "*I think they've done an awful lot of work and I can't speak to specific elements that may still be in need of updating, but it's one avenue that this city pursued very attentively and aggressively to ensure there are requirements that will allow the city to increase resiliency and help achieve its carbon mitigation goals*" (NYC08).

These responses suggest that the city's interpretation of sustainability and resilience is fully recognised (Section 5.1.1). What is reducing causality between sustainability and resilience is that NYC governance wants to make the city more resilient to climate change, and that it needs to focus on its energy supply and key areas to be able to cope with emergency responses such as black outs and access to hospitals and airports.

5.3.2 NYC's practice of decision-making influences

Extrapolated and interpreted from semi-structured data collected has been reality of decision-making. Causes and effects have been considered with influencers and actors (Table 4.1). Synthesising the case study (Section 4.5) and semi-structured interviews (Section 5.3.1), it has been observed that NYC data clustered around nine issues which are summarised as follows:

Point 1. Habitual Practice

Represented in Figure 4.4 is generational shifts between municipal planning and design codes (Berger, 1960). NYC 01, NYC 02, NYC 03, NYC 05, NYC06 identify that mnemonic responses are provided to decisions, partly due to practice efficiencies and standardised ways of working. Institutions such as AIA, APA, ASCE practice need codes updating and restructuring to promote better decisions. Codes of practice lack foresight scenarios and governance has focused on carbon reduction rather than wider environmental issues.

Municipal codes tend to be out of date and do not reflect the environmental risks that have increased: wind loads, storm events and flooding. NYC has now revised its codes in 2011, 2014 and 2018 (Sections 4.6.4 and 4.6.5). Design guidance (COP) is out of touch with sustainable design principles and not reflected in scope of works, although the Mayor has enacted several local laws to enable transitions in decision making (Section 4.6.2). Despite its acknowledgment in NYC policy (Section 4.6.6), LEED is limited in its practice use-energy and water focus (Section 5.2).

Point 2. Tax Revenue

Tax revenue creates the budgets to undertake the work that is needed to make people less vulnerable but at their expense. If you make something more resilient and sustainable, it can be out of sync with existing infrastructure and creates interface issues with old and new (Section 5.3.1). This is a real issue. The tax is being spent not managing the vulnerable people who are not near emergency infrastructure corridors (i.e. to airports,

hospitals) but tax is being spent on the airport and flood defence. There is also evidence that lack of Zoning control is pushing vulnerable people into flood zones.

Point 3. Codes of practice

Response from NYCs design practice indicates that COP need to promote both sustainability and resilience because their outcomes impact public safety (NYC 06). Regular discussions between governance and practice need to be held about service life loadings and what scenarios are more prevalent, because it is not reflected in COP. If it is not in the COP, it must be in the municipal code. Currently, there has been a reliance on International Building Codes (IBC) because they have been the more prescriptive and provide more stringent standards (NYC 04). However, local context is required for designs and quality control needs to manage both resilience and sustainability in decision-making and not necessarily standardised codes of practice or measurement frameworks (NYC 04, NYC 06, NYC 08).

Point 4. Organisation decision making behaviour

Recognised in context by the cause and effect between wanting to make better decisions, but the finances were not available or there was no direct instruction. Authorities need to want to change and recent disasters have led to increased public funding under the guise of “resilience”- but it is not necessarily spent in the right way.

Reflected in the organisational structure are two separate governance and policies - one on sustainability and one on resilience; they even work in different offices, although the ORR is now in place which is led by the CRO.

Practice indicates that there is a lack of funding to sort out the smaller scale issues and that there is a lack of reporting on investment. Consequently, the larger scale issues of producing a citywide policy have taken priority but perhaps were not the most important to resolve such as the planning process and municipal design codes. However, without the investment in innovation, things will get more expensive (NYC 08).

Point 5. Competing political shifts

Figure 4.4 and Section 4.6.2 identify that the city policies have kept shifting. As political personalities change so does policy.

> *"I think largely it's due to skills. It's not due to wilful disregard. I think some of it is skills, some of it is competing interests. I think sustainability is not prioritised in New York to the same level that it had been in the past"* (NYC07).
>
> After a hazard event, the policies shift as well *"I mean, the code is constantly changing in terms of how stringent it gets, but the flood design is the same, it was just now more areas are required or get triggered sooner for the grey areas, yes, after Sandy. Energy reduction is too much of a focus and limits what else might be at risk."* (NYC06).

Municipal codes need to find a way of overriding political shifts and the creation of local laws to do what practice should be doing (Section 4.6.3 and 4.6.5).

Point 6. LEED

Responses indicate that LEED is limited in its practice use-energy and water focus. After 16 years, LEED (is only now) well established and its targets have become adopted by policy. What practice suggests is that LEED practitioners get disillusioned with the process because it has become limited

by city policies placing emphasis on energy conservation. It also suggests that city policy has engulfed LEED and that the stretch targets or more sustainable practice is limited too.

> *"I'm a little disillusioned with the LEED process in general…… So, there's a question of whether you're really committed to sustainability, do you want to spend that extra percentage of project budget on doing a more passive heating strategy that might have an initial front investment, or do you want to spend it on the paperwork that then gives you this rating?"* (NYC06).

Yet, LEED is the most recognised framework (Section 5.2 and Table 5.2).

Point 7. Un-responsible real estate

This poses the question, why are buildings that are at risk of regular flooding being used?

> *"Real estate in a city like New York, no matter where you are there's always going to be people that want to buy the spaces. And some people they'd rather take the risk of being in a flood zone. So, I think it really depends on the risk appetite of the company that is going to be occupying the space."* (NYC03).

Scales of risk need to be considered and evaluated so that people do not put themselves at risk and the responsibility must come from somewhere- but where?

> *"But I think as responsible citizens that we should be challenging the buildings to be investing more whenever possible"* (NYC03).

This might be possible in a city like New York, but there are vulnerable people who will occupy places that are at risk. Decision making is complex when it involves financial income and tax revenue.

> *"when a new building site is looked at and say it's somewhere in Queens where it has poor soil, and it has flooding, then it would be like, okay, maybe this isn't the right place. But if you're in Manhattan or Brooklyn, where there is so much of a demand for estates and real estate, […] owners, developers are going to be willing to pay for the extra deep foundations, or special flood proofing that would be required in order to have the locations."* (NYC06).

Point 8. Scope of works

Initially, scope of works is always given to the architect or project manager, it has been worked on with lawyers and urban planners. Now, when considering how this affects decision-making, it is pivotal to how practice operates, how a design team works and how work is managed. If a scope of works focuses on energy reduction targets, that is what will get delivered, not necessarily improvements to infrastructure or investment in biodiversity. Suddenly, all the context that could be considered is 'out of scope' or not in the budget. Considering resilience is an opportunity to redefine how risk is managed in projects and affect the scope of works. Practice metaknowledge or discipline skills can get overlooked due to mnemonic practice of design team scope of works.

> *"Do we think a lot on a day to day basis about sustainability, and that's – because that was always a big area of my interest, and I was a bit frustrated when I first started practicing. […] So much of it lies in mechanical engineering, architectural decisions and of course, there's education, and for me, it's really, the most we can do is about the efficient use of the structure that we have and guiding the architect towards that..."* (NYC04).

> *"What the engineer can do is understand risk and impact vulnerabilities, […] to understand what that really comes down to. But it doesn't point in that direction yet."* (NYC06).

Decision-makers need to reconsider who can manage the risk scenario planning within the design team and to adapt the scope of works towards that knowledge.

Point 9. Lack of Public Awareness

Mostly in response to recent hazard events in NYC, the risk of existing building stock and infrastructure has come to light, particularly at domestic basement conversions.

> *"But then it was the modifications that people made to their homes. So, there is an element of us getting back to – when you're talking about policy, it's education. So, nobody knew – they just thought, I'm making upgrades to my house."* (NYC06).

This is echoed in unresponsible real estate (point 7) where, NYC04 indicates that commercial zones in NYC mean more than properties getting flooded, so basements will get used for commercial operations.

5.3.3 Chicago's practice of sustainability and resilience

The Mayor's office was recognised as the voice of local city policy, it was acknowledged that there is lack of guidance, especially given that the Department of Environment had been disbanded and decisions relate to open space planning (Section 4.6.3). It was indicated that the population of Chicago is decreasing (it is 3rd most populated city in the US), so to

compensate the Mayor is supporting '**energy ordinance'** that provide opportunities for economic growth (Section 4.7.3).

> **CHIC02 reported that the DOB who enforce the energy code is understaffed:** *"The people down there are sharp, they know there is an energy code. But […] they don't have enough time, […] people, […] resources to enforce"* (CHIC02).

Not many recognised Sustainable Chicago. Those who are aware of it view Sustainable Chicago as an economic opportunity for alternative energy sources promoting the practice of energy ordinance using LEED as a foundation (USGBC, 2018). However, in practice this enforces LEED's bias towards Energy credits (Section 4.7.6) and the USGBC (2018) has started to pilot LEED Cities with Chicago achieving a platinum award (the highest level) based on its 'Chicago Energy Rating System' and Retrofit Chicago policy.

The interview responses have been analysed for critical planning issues, which were found to be: zoning, urban flooding, infrastructure and political jurisdiction not social and economic disparity as required by Box 5.3.

Box 5.3 Reality of resilience in practice

Despite the city having a CRO and its involvement in the 100RC program, working practice of city resilience policy was not fully recognized. CHIC02 a resilience specialist for an architect's firm, suggested that resilience was understood as managing extreme heat. The extreme heat exposes poor building design because people need air conditioning to cope due to lack of openable windows and advocated the use passive design. Unfortunately, not everyone can afford air conditioning either due to social and economic disparity between neighbourhoods. Currently, the city's energy policy does not consider social vulnerability or passive requirements as discussed by (Klinenberg, 1999a).

The city policy vision has set the target of 25% reduction in stormwater (which comes from LEED WA credits) however, this is not enough because local parkland must be used as a large 'soakaway' in situations where there is too much rainfall and flood. CHIC02 outlined that Chicago's policies create conflict with other environmental issues such as access to drinking water or sea-level rise because of the access to the inland Great Lakes. Yet, CHIC02 and CHIC04 infer that the existing urban water infrastructure is polluting lake Michigan and due to the expanse of impervious surfaces of the city, surface water runoff is creating urban flooding and overloading the canal systems.

Considering water infrastructure and open space towards flooding is being considered from a regional perspective and influencing city planning. CHIC01 a regional planner discussed resilience issues around considering the watershed and infrastructure and highlighted the political frustrations:

> *"– we're moving to try and do more of this based on watershed, which is obviously the right way to do urban flooding work, but because again of the ridiculous jigsaw that is the jurisdictional map of the Chicago area, that's very difficult…[…]...there is no incentive for a municipality to work at the watershed level, none, other than altruistic reasons. Altruistic and factual climate orientated reasons. But political reasons, zero."* (CHIC01).

There is no motivational tool to consider watershed decision making as previously outlined by CHIC01. However, there are opportunities to make changes when investments become available as described in Box 5.4.

Box 5.4 Reality of financial investment

CHIC01 also recognized the influence to shift the mindset on urban infrastructure was the national policy of The Fast Act (2018) [13] because highway design can now consider surface water runoff in a more sustainable way (such as swales and better road pavement). The Fast Act mobilizes $6.3 billion investment into infrastructure that had been neglected for years and that CHIC 01 says this funding has enabled discussions about considering watershed as an issue for infrastructure design "*it was a combination of opportunism in that there was definitely funding on the table for resilience, that otherwise we wouldn't have been able to get into a few areas that we wouldn't want to get in to for our work…"* (CHIC01).

As there are no national planning regulations in the US, policies such as the Fast Act which have a budget attached to them and funding from FEMA can mobilise action around urban flooding and infrastructure. CHIC01 discusses that the lack of investment in roads and infrastructure has led to the Fast Act to manage roads between communities. Without this investment, emergency response cannot get into the affected areas, nor can they be made resilient because they will need constant resurfacing. CMAP has used the Fast Act to mobilise what resilience measures are possible within their jurisdiction. Temporally, the time scale on the foresight of decisions has been confirmed as 10-15 years which is limited by political shifts.

When considering the scale of regional infrastructure and the urban area of Chicago, CHIC01's considers that decisions are not thought about in the long term beyond 20 years. This highlights the brutal reality that planning is not a simple process because the area of land for 'planning' has many social, political and economic entities that shift about over time,

[13] The Fast Act is a US policy on freight transport that considers highway investment https://www.transportation.gov/fastact/freight-factsheet

> *"we have a huge urban planning problem in the region that we're in. It tends to affect communities of colour and low-income communities more so than affluent communities. Some of that has to do with the price of land in areas that are flood prone. Some of it has to do with the lack of capacity in a region on the part of some governments in a region with 1500 units of local government."* (CHIC01).

CHIC01 perspective highlights the scale of political decision making in Chicago (Schwieterman and Caspall, 2006). Chicago has 77 neighbourhoods and the 1830's Burnham masterplan has changed over time (Section 4.7.1). Planning of cities needs to be considered on both regional, national and local issues, not just as a city:

> *"there is still a need to think about how we can minimise climate change, but I think, especially from where we sit, we don't have as much control over things like ecological systems in development. We have much more control over where development happens and where it doesn't."* (CHIC01).

The regional planning perspective has been insightful because it highlights that planners are subject to significant political jurisdiction and are quite limited - on a spatial scale - to what impact they can have. Planners might have sustainable ecosystem principles, but it is not in the rule book and thinking in systems can be considered outside of political jurisdiction. CHIC01 indicates they are regularly subjected to legal impeachment between regional and city planning departments. However, when CMAP provide some guidance on sustainability and resilience (Section 4.7.4) city practice is aware of it "*CMAP has recently placed some targets incentive on resilience to encourage action*" CHIC05.

What was evident from the responses is that attitudes to planning have neglected the impacts of surface water management on existing infrastructure:

> *"And again, one of the major issues is stormwater. So, they have some points you can get for stormwater. I just think it's not enough, it's not stringent enough in my opinion. I think that even for stormwater that the city could be and should be doing more."* (CHIC02).

Over the time that Chicago has grown, repeated decision making has led to the infrastructure not being able to cope beyond its original city vision (Section 4.7.1). The issue is complex because it also involves aging infrastructure:

> *"our sewer pipes are too small […], so when it rains, streets flood, the pipes overflow into the river with sewage and storm water mixed together so it's like poor water quality, and then homes flood, so sewers back up in basements of homes and there's literally like every time it rains […]. This is a real issue because FEMA […] doesn't even acknowledge urban flooding; it only focuses on river rain[14] flooding or coastal flooding, which are just where a body of water […] over-tops its edges"* (CHIC05).

Making changes to this is restricted by zoning and political jurisdiction because the root cause of the issue may lie in one district, but the effect is felt by another, and these have different social profiles. CHIC05 also acknowledges the difficulties with the Department of Water Management

[14] River rain has been interpreted to mean an increase in surface water runoff in urban areas due to an intense period of rainfall that runs into the river and increases the river height to flood.

when trying to make the existing infrastructure more resilient and the role of using better climate change data:

> *"They're using old flood definitions so, you know, the one-year flood, the two-year flood, the five-year flood, […] using rainfall data from the '70s."* (CHIC05).

CHIC04 brings the zoning issue to life by articulating how tenants are disincentivised to be more sustainable because developers have no incentives either.

> *"Large buildings are usually built and then sold straightaway, so you're completely absolving a certain responsibility for it once it's built. Office buildings are […] tenanted and usually there's no incentive for the tenants to do anything sustainable because you usually have to pay a set bill and it doesn't matter what energy you're using or how much water you're using anything like that. For apartments you do own the apartment, but you don't own the building."* (CHIC04).

Designers have become fatigued by the decision makers in the planning process, when trying to do new things:

> *"I did some work with the Department of Planning on integrating commercial farming and community gardens into the zoning code so that there was proper uses that were written in the zoning code. [But this took] a year almost of meetings with the Department of Planning"* (CHIC05).

Interview responses were also analysed for metacognitive knowledge and data clusters on energy design, the lack of codes and out of date policies with regards to storms, climate change with focus on heat and cold as described in Box 5.5

Box 5.5 Practice finds policy limited

"The codes in the United States have definitely been improved and some people would say too quickly. But I think it's been too incremental. I think we need a huge jump." (CHIC02). When considering Figure 4.7, the new municipal design and planning codes have the opportunity to create a link between city policy and practice, CHIC02 considers that "we just need to go with a terminal condition, which would be requiring something like Passive House. It would definitely add cost, but those costs would come down quickly I think because the market would respond. […] I also think we need to look at existing building performance and codes" (CHIC02).

Designers understand the risks of climate change for Chicago (Klinenberg, 1999) and see 'passive' design as a solution to reducing the need of air-conditioning and associated operational costs, but because of the way building development is financed, the passive design incentive is reduced:

> *"it's actually very hard in a residential building to induce natural ventilation […]. You can't really do an atrium because it's very expensive. But also, you run into issues with fire code and privacy and all that and noise…[sic]…but it adds cost and complexity. And right now, I don't see a lot of people that value that very much"* (CHIC02).

Passive design is seen as a way of reducing social vulnerability, but without the developer and incentive these buildings can't be the most favoured option.

Designers have also become 'tired' of LEED because it has become a regulation standard: "*Even […] if you do go the Full Monty and do green roofs, permeable paving and all that, you still have to have a tank. To me LEED is never a driver for creative innovative solutions, at least the way it's been used in the industry here*" (CHIC02). What this indicates is that LEED

has become a ‘regulation’ - which is good, but it has also started to restrict better performance standards and sustainable outcomes.

Considering the responses and the description of the case study, the interpretation of resilience and sustainability in Chicago still needs to promote better building design to cope with climatic changes. The UBE still has a watershed problem, but water can flow through spatial boundaries where social and political issues can not, right now there is polarisation between the city and its neighbourhoods.

Regardless of sustainability and resilience, effective decisions are limited by those who make the decisions, and Chicago is too fragmented historically (77 neighbourhoods) and politics between the Aldermen have widened social issues (Schwieterman and Caspall, 2006). Chicago is political; it is tied up with investment as well as a lack of it, which has increased social vulnerabilities. This has been highlighted by the new Mayor Lori Lightfoot: “f*or too long decisions have been made for the few, not the many*” (Fox News, 2019). Sustainability and resilience are limited in how they can affect decision making in planning unless mobilized to do so, until then there is permanent conflict with those who know the issues and want to address them.

5.3.4 Chicago’s practice of decision-making influences

The analysis of the semi-structured interviews (Section 5.3.3) coupled with the Chicago case study (Section 4.7) has led to the observation that there are four critical issues: habitual practice, tax revenue, out of date codes and political shifts.

Point 1. Habitual Practice

Generally, resilience and sustainability are immobilised concepts that have not filtered into the decision-making trajectory. There is a detached understanding of impacts of climate change with decision makers. Design solutions to manage climate change have been to use air conditioning in buildings rather than use passive design or even promote natural ventilation techniques. The urban density and microclimate are not considered in design codes or planning decision making. The response has been to focus on energy efficiency due to local governance funding and policies. Developers have no long-term interest in reducing operational costs or using passive design techniques because there is no financial incentive, and the incentive has been eroded away because Chicago's economy has been shrinking. Also, no one has been working with the public to a provide a wellness alternative, so luxury items remain high in demand in new buildings.

There is also a lack of systems response to urban planning- CMAP and DOP work at different scales. What designers and planners end up doing is creating their own methods and tools to override the issues but also operate at a level to prepare for 'resilience' when the policies catch up:

> *"as we got to the last plan that we adopted, the last regional plan, we really started to get better at making the case analytically. So, what is the urban flooding doing to these various other issues that we're facing. What does it look like when municipalities have to make sure that their senior citizens have places to go when the heatwaves occur. So, we've got better and better at making these issues – crystallising, clarifying these issues for local decision makers, and in doing so, we're able to justify with subsequent regional plans, more emphasis on this."* (CHIC01).

Point 2. Tax Revenue

Using a tax revenue that promotes assessing risk and vulnerabilities on existing buildings might shift how buildings and infrastructure are managed long term, so that the taxpayers do not have a gigantic increase when the building is at risk.

> *"if the tax rate you're charging allows you to get to a point where you're keeping up with those assets, then that's a really good thing and ten years ago, that generally was not true. Now it's much more true and that's a lot to do with us constantly plugging away on capital improvement plans"* (CHIC01).

Point 3. Out of date codes

The codes are out of date by several generations, so LEED and an International building code are adopted by working practice to get better performance standards. As decision making has become so entrenched in the way that things have also been done, the shift of policy adopts best practice. Policy has based itself on LEED (Table 4.1, Section 4.7.6) and the municipal codes are slow to respond to shifts in performance standard design (revisions to codes are work in progress during 2019). The planning process is constrained to land use and by local or state governance because it is too fragmented by political zoning.

Point 4. Political Shifts

Figure 4.9 shows how city strategies have been revised and practice reports that municipal guidance has not moved forward with these visions (CHIC 05). CHIC 06 changes jobs due to political shifts in policy between Mayor Daley and Emanuel. Emanuel has created sustain Chicago, Resilient Chicago,

Chicago Climate Change Charter yet no succinct decision making in the city itself, because Resilient Chicago reports of social disparity and lack of effective decisions. Chicago has 77 neighbourhoods; can cohesion be created without a stronger voice and vision unless the neighbourhoods start to get involved.

5.3.5 Boston's practice of sustainability and resilience

Interviewees acknowledged the mayor as the decision maker, but it was also recognised that policy is subject to national policy shifts (Section 4.8.1). This reflects the C40 profile that the mayor has strong leadership and power, but as the leadership changes there is a loss of knowledge and sometimes a breakdown of political allies to collaborate on issues. The impact is that the meaning of the term changes, even broadens to mean many things (Section 5.1.1) and creates knowledge shifts, BOS05 a policy maker says "*I'm not sure that I have a strong, ready definition of sustainability. I should.*" (BOS05).

Identified as critical policy influences were: C40, LEED, FEMA, and city policies: Carbon Free Boston, Resilient Boston and Article 37. The city is promoting both Resilient Boston and work related to Carbon Free Boston as working city policy under the umbrella of Climate Ready Boston. C40 has provided leadership to Boston which has led to a strong carbon reduction policy - Carbon Free Boston. However, consequently the city has become too focused on carbon reduction and neglecting other issues. Carbon Free Boston (now Climate Ready Boston) has set a target for Boston to become carbon neutral by 2050. The mayor's statements are targeting resilience and

sustainability, but there are institutional changes that need to occur. Perhaps it is difficult to move with the constant changing pace of policy change (Figure 4.4). BOS03 a resilience and sustainability specialist says:

> *"Everything is going through a transition. Like I said, the conversation is still kind of new. People are still jumping on to this and I think there are a lot of policies and a lot of energy and effort happening here in this city, that is getting the conversation going and it's great. I know that we recently – the state of Massachusetts recently just received a $1.4 billion environmental bond towards climate adaptation"* (BOS03).

However, BOS01 an experienced architect outlines that Boston's urban environment is already facing known challenges "*Boston is already at risk and vulnerable to climate change and urban flooding*" (BOS01).

To manage future urban flooding, the policy response has been to include flooding plans into 'zoning' codes in Article 80. This work has supported by FEMA, which provided funding opportunities for cities to manage their flood risks and prepare for emergencies. Now, FEMA is subject to national policy and political conflicts (Section 4.2.1). The initial FEMA funding has enabled change, but it is now up to the city to carry out the necessary works.

The position of having to generate flood maps and embed it into the planning process suggests that there have been some poor planning decisions over time (Figure 4.4). BOS01 and BOS04 a consultant specialist outline that the position concerning Boston Waterfront project using FEMA funding is controversial. From their perspectives, FEMA funding has been spent to protect what is at risk to regular flooding, rather than make more informed decisions about what is causing the urban flooding and reduce it. BOS06

also projects the view that the waterfront project is helping to restore the local marine ecosystem because the environmental laws and lack of restriction on urban development have polluted the water.

Boston's policies and planning process has merged climate change, green building and resilience into Article 37 (Section 4.8.3). The interview responses recall Article 37 and the Boston New development checklist, but also discuss state jurisdictions and zoning. Political relationships impact planning by way of its governance structure: Massachusetts is a Commonwealth with 15 municipalities who apply 'zoning rules', i.e. specific requirements to the municipality. The municipalities have different social-economic profiles and decisions can be overruled through local compliance with the development review process:

> *"our sustainability policy is in the zoning code because the state controls the code. So, as a city, we don't have any control over our building code."* (BOS05).

Article 37 is a part of city policy and planning process, it is focused on LEED performance, but it needs a review because its targets have evolved and currently it is only required on large projects. All other regulations are managed by zoning or state code compliance. Boston New Development Checklist is targeting resilience issues, but it is only for new developments, not refurbishments and existing buildings. This creates juxtaposition with Boston's existing infrastructure and buildings as they all have different functionality with regards to 'risk' performance and zoning of vulnerabilities. So, despite the sustainability and resilience components being in the

planning process, they have limited action due to zoning codes and the way the decisions are managed, both in application to new buildings and that zoning decisions can override the decision itself as described in Box 5.6.

Box 5.6 Boston practice limited by political jurisdiction

The interview responses recall the Massachusetts 780 CMR Code, LEED and LEED-RELi. However, political relationships with Massachusetts State also impact 'design codes': *"The state has a building code and then a stretch energy code, which is a stronger energy performance for a building, that a city can choose to adopt as a strengthening for the building code"* (BOS 05).

What this suggests is the despite the Massachusetts Building Codes being revised to LEED performance, there are working practitioners that see this as a limited performance and that LEED gets focused on 'easy win' credits.

> *"We're doing a lot of work on district flood protection. So, neighbourhood by neighbourhood, identifying flood pathways and opportunities to build protection at the coast to protect the neighbourhoods behind. We also have a number of increasing heat programmes with the public health commission, and things like that"* (BOS05).

Working practice seems to be aware of code jurisdictions and that decisions can get overridden. This gives license to use components of codes of practice such as the international building code, which have better requirements. Interviewees suggest that working practice is more advanced of the policies and processes in place.

5.3.6 Boston's practice knowledge of decision-making influences

The analysis of the semi-structured interviews (Section 5.3.5) coupled with the Boston case study (Section 4.8) has led to the observation that there are three critical issues: habitual practice, tax revenue, and political shifts.

Point 1: Habitual practice

Boston's practitioners' main frustrations relate to regulation and that it is out of date or not enabling boundaries to be pushed. BOS02 a global specialist infers that change is difficult and that it that leads to the same decision making process:

> *"it's the mentality and it's a regulatory environment"* (BOS02).

The critical issue is that the Massachusetts State Regulation is not managing sustainability and resilience beyond LEED because there is a limited relationship with the building codes and city context. What is meant is that Massachusetts regulators do not know the issues that affect the city and therefore the CMR 780 code is limited in practice to general knowledge not city specific. Design practice is not supplied with climate projections for scenario planning and it is sought in city policies, so who provides the information and funds it becomes critical. Some practitioners inform their clients and must take them along this process, but really this needs to be a part of policy providing better knowledge to make better decisions. BOS02 states that for some people:

> *"This is just too new to process"* (BOS02).

The issue of Insurance policies (in response to hazard events) incur mnemonic decision making because the forms do not promote better investment, just increase costs. BOS06 a lawyer outlines that because the federal environmental laws have not changed either, the environment that it protects has become polluted and it costs to make changes in decision making towards better designs:

> *"A lot of money has been invested and legal it takes time to change things and that is expensive"* (BOS06).

If policy stipulates a minimum requirements then anything beyond that target is not seen in the same light. Decision making needs to reflect that there are different performance expectations and can be respected for it. Practice considers that organisations needs to broaden out, involve more disciplines and people. BOS04 describes mnemonic decision making in design too, for example, once a solution has been developed it becomes a repeated response:

> *"I've seen that because of a lot of professional pride and years of training, there's a natural tendency where engineers love to optimise their systems"* (BOS 04).

What BOS04 outlines is the practice of optimising building systems to be efficient and operate in stipulated design boundaries to comply with codes of practice. However, when design becomes 'efficient' to fit a space or budget, the capacity to cope with an incremental increase in climate change or emergency event is reduced and lead to failure. Designing of building

systems needs to go beyond the safety factors and build in a capacity to cope over time (Section 2.1). Design practice follows the IBC codes, but it gets adapted to suit projects because the municipal codes are not descriptive or stringent enough. BOS03 outlines that future scenario planning needs to be considered and promoted in codes of practice and regulated.

Mnemonic practice of the scopes of works is mentioned by BOS04 and the frustrations that projects work to perspective scopes:

> *"What kind of things am I authorised to cover? You know, maybe someone's a mechanical engineer but not a water resources engineer and certainly not a meteorologist or a climate scientist. So why should, you know, is it even safe for them to think about contemplating some things that might be viewed by others as treading outside of their legitimate professional authority and their licensing domain?"* (BOS 04).
>
> **Important decisions can fall out of scope and BOS04 outlines that** *"I think drive people to create cracks for communication to fall through, to create breaks between a systems level continuity of planning and analysis and decision process."* (BOS 04).

Such things that go out of scope or ownership of the project is the design and BOS04 describes that design life is not considered when designing "*You get 6years to 'complain' if something isn't right*" (BOS04). This suggests that the scope of works shapes a limited vision to achieve more than the minimum i.e. what is outlined in city policy. There is concern that historically decisions have led to the current situation in Boston:

> *"So, there'll be coastal flooding, there'll be river and storm based flooding, there'll be temperature variations and that's actually beginning to be an issue in the building codes. And there'll be some storm management as well"* (BOS01).

BOS04 considers that there has been a disregard for its ancestral knowledge, because the historical Indian pathways knew inherently where to go and what height to build pathways at to avoid flooding.

Point 2. Tax Revenue

Power and wealth of communities generates political bias when it comes to tax revenue. BOS02 outlined the issues experienced between the closely situated Cambridge and Boston. Cambridge has the desire to do more with regards to climate change because they are ‘at risk’ to the coastal flooding and generate the most tax revenue. BOS02 continues to agree with the CRO (Section 4.8.3) about racial and social inequality in the city and to make it more resilient it needs to be addressed. Tax revenue is the root cause of these dynamics.

Point 3. Bias in Policy

There is a bias towards the carbon reduction targets which generates action towards energy reduction and not sustainable development. BOS01 considered architectural practice and identified that in Boston the glass buildings have created more energy consumption and more MEP bias in design practice rather than passive design (U values).

5.3.7 Cross case comparison of the interpretations and measurement of sustainability and resilience between policy and practice

Throughout Chapter 4 and 5 are themes of the interpretation and measurement of sustainability and resilience in decision-making of both policy and practice for each city (Section 4.9). However, are there similarities or differences in the city strategies? To consider a response, this section presents the theme of interpretation of sustainability and resilience by considering the policy definitions from city strategies (Sections 4.6.3, 4.7.3, 4.8.3) with built environment practice definitions (Sections 5.1.1, 5.1.2).

First are the interpretations of sustainability (Box 5.7), then resilience (Box 5.8). Second, the measurement theme considers the city policy strategy goals that are outlined in the city visionary documents, the100RC measurement characteristics with practice response (Box 5.9). The third theme reviews decision-making in all the cities but because of the complexity, the responses are streamlined in Section 5.4.

Shown in Box 5.7 are the interpretations of sustainability in policy and practice for each city. Recognised in the interpretations are conflicts and synergies between policy and practice. NYC policy and practice interpretations both reflect Brundtland's definitions (Section 2.1.2). Chicago's policy has the essence of Brundtland but has become energy and carbon biased, where practice provides an understanding of Brundtland. There is a conflict here (Sections 5.3.3, 5.3.4). Boston policy considers a more LCA approach and has united sustainability and resilience, practice reflects this collectively through the multiple variations.

Box 5.7 UBE interpretations of sustainability in policy and practice

NYC Policy: (Section 4.6.3):

"***Sustainability means the activities we undertake today will not compromise the present generation's or future generations' ability to meet their own needs***. *It is grounded in the recognition that people, economic development, and the environment are interconnected, and for any to thrive, all must thrive together*" (The City of New York, 2015, p. 162).

Chicago Policy: (Section 4.7.3):

*Sustainability: "**By tapping into energy efficiency as a resource, we will meet the energy demands of a growing city, invest in our infrastructure, save money, and reduce our environmental impact.** Through energy saving retrofits for our businesses, residences, and government buildings, and investments in renewable energy sources, Chicago will improve citywide efficiency by 5 percent, and create at least an additional 20 MW of renewable energy."* (Emanuel, 2015a, p. 4).

Boston Policy: (Section 4.8.3):

Sustainability: *Wor**k with regional and state agencies, and surrounding communities to align and accelerate regional preparedness planning.; Incorporate climate preparedness into existing local planning and community engagement efforts.; Ensure public- and private-sector developments and major capital projects are prepared for expected climate change over their projected life**. Greenovate (Walsh et al. 2014; p7).*

Practice Sustainability Interpretations (Section 5.1, 5.3)

NYC Practice: Brundtland is dominant

Chicago Practice: Brundtland is dominant

Boston Practice: A broad concept: "Sustainability means very specific things and it means that systems and organisations can sustain themselves..[sic]... Sustainability is a step along that way to that kind of regenerative activity." *(BOS02);* "Sustainability, it's a broad umbrella" *(BOS03);* "I like to see sustainability described in terms of efficiency of functions performed based on the efficiency of resources being consumed or used or extended, or replaced and recycled" *(BOS04);* "I see that as a mitigation measure, reducing our carbon footprint, to help in the long run" *(BOS 06).*

Shown in Box 5.8 are the cities' interpretations for resilience. In each city the policy indicates an understanding of systems, capacity and the need to adapt and recover from shocks of stresses. However, a deeper interpretation considers social vulnerability and inequalities (Sections 4.6,4.7,4.8). In each city practice seems to reflect this political view of the need to adapt, recover from climate change and shocks and stresses, however, there are deeper

conflicts especially around adaptation for unforeseen events. Where the conceptual interpretation of resilience is concerned there is synergy, but conflicts with what is happening in practice (Sections 5.3, 5.4).

Box 5.8 UBE Interpretations of resilience in policy and practice

NYC Policy: *"When we speak of resilience, we are referring to the ability of people, the places where they live, and our infrastructure systems—such as transportation and energy—**withstand a stress or shock event, to recover, and emerge even stronger.** Mitigation reduces the impact of a stress or shock event or prevents the impact altogether, such as bolstering the defences of coastal communities to withstand flooding. In response to **future threats, adaptation takes place to change the physical form or function** of a structure, a place, or a community, such as hardening power supplies to withstand the effects of **extreme weather and climate change**"*. (The city of New York, 2015, p. 217)

Chicago Policy: *The report defines resilience as "the ability of its individuals, institutions, businesses, and **systems within the community to survive, adapt, and grow despite the chronic, stresses or acute shocks it experiences.** A truly resilient city is not only expected to perform well in good times but also **recover expediently after challenges**."* (Emanuel, 2019b, p. 9). *It uses resilience agenda to address four critical areas:* (Emanuel, 2019b, p. 7)*: **Reducing disparities between Chicago's neighbourhoods; Addressing the root causes of crime and violence; Ensuring the provision of critical infrastructure; and, Promoting engaged, prepared, and cohesive communities.***

Boston Policy: The Resilient Boston report defines resilience as *"the **capacity of individuals, communities, institutions, businesses, and systems** within a city to survive, adapt, and thrive—no matter what kinds of chronic stresses and acute shocks they experience."* (Walsh, 2017b, p. 9).

Practice Interpretations (Sections 5.1, 5.2, 5.3.2)

NYC Practice: *"For Resilience, we need to be looking at what is a forecast of the future that we need to address?"* (NYC02); *"unforeseeable disruption, with system ability and back into balance, resilience look for way to manage it."* (NYC03).

Chicago Practice: "it has gone from the buzz word about environmental stuff to thinking much more concretely about adaptations" *(CHIC01);* "The ability to respond to an extreme event whether it's a natural disaster or a manmade disaster." *(CHIC02);* "Resilience is the capacity to withstand and respond quickly to extreme events" *(CHIC03);* "you've got houses in a floodplain, you know, you have your high exposure and your high – and depending on your level of income or your ability to like go stay at your grandma's house while your house floods, you know, that's your sensitivity." *(CHIC05).*

Boston Practice: "resilience is by strict definition, is the ability to recover or bounce back and it's been applied to cities in case of a disaster." *(BOS01);* "resilience is about building the capacity within a system. The definition is to help systems build capacity to thrive and evolve in the face of disruption." *(BOS02);* "and don't just think about the lovely sunny days, think about it when there's all kinds of things hitting the fan under current conditions and future condition" *(BOS04).*

The cities' interpretations have informed mission statements, goals and targets. Shown in Box 4.9 are the sustainability and resilience policy goals outlined in the city strategy documents for all three cities. Policy measurement is critical because this how consequences can be evaluated.

Box 5.9 UBE Measurement of sustainability and resilience in policy

NYC Policy Sustainability Indicators

Policy sustainability measurement extracted from OneNYC: (Section 4.6.3)

Vision 3 Indicator Group	Description of Target
1. 80x50	Reduce NYC's GHG by 80% by 2050
2. Zero Waste	Zero Waste to landfill by 2030
3. Air Quality	Best Air Quality amongst US cities by 2030
4. Brownfields	Address contaminated land and convert it to safe and beneficial to low income communities
5. Water Management	To mitigate flooding and provide high quality water services
6. Parks & Natural Resources	All New Yorkers to benefit from useful, accessible and beautiful open space

NYC Policy resilience measurement (Box 4.3):

The 100RC process identified 18 shocks and stresses that applied to the city context which were: **Aging infrastructure**, **Climate Change**, **Coastal/ tidal flooding**, **Economic inequality, Extreme heat,** Homelessness, Hurricane/typhoon/cyclone, **Inadequate educational systems**, Inadequate health systems, Inadequate infrastructure, Lack of affordable housing, **Population growth/overpopulation, Poverty,** Power outage, **Rainfall flooding,** Sea level rise/ coastal erosion, **Severe storms** and **Shifting macroeconomic trends**. (100 Resilient Cities, 2019).

Chicago Policy sustainability measurement: (Section 4.7.3)

Sustainable Chicago (SCAP)(Emanuel, 2015b, p. 24):

"Prepare for the human impacts of climate change by supporting people with information and services, such as cooling centers.; Prepare the natural environment for climate impacts and maintain biodiversity; Prepare the infrastructure for climate change by reducing the urban heat island effect, managing flooding from high intensity storm events, and strengthening resilience to extreme weather."

Chicago Policy resilience measurement (box4.6):

Chicago 100RC profile identified 14 shocks and stresses to the city which are: **Aging Infrastructure,** Crime/Violence, **Economic Inequality**, Financial/ Economic Crisis, **Inadequate Educational Systems,** Infrastructure Failure, **Poverty, Rainfall Flooding,** Riot/Civil Unrest, **Severe storms, Shifting macroeconomic trends, Structural racism, Terrorist attack,** Unemployment (100 resilient cities, 2019).

Boston Policy Sustainability measurement: (Section 4.8.3)

State of Climate; Cross cutting themes; Boston's Carbon footprint; Implementation and next steps; Neighbourhoods; Large Buildings and Institutions; Transportation; Climate preparedness; 80x50

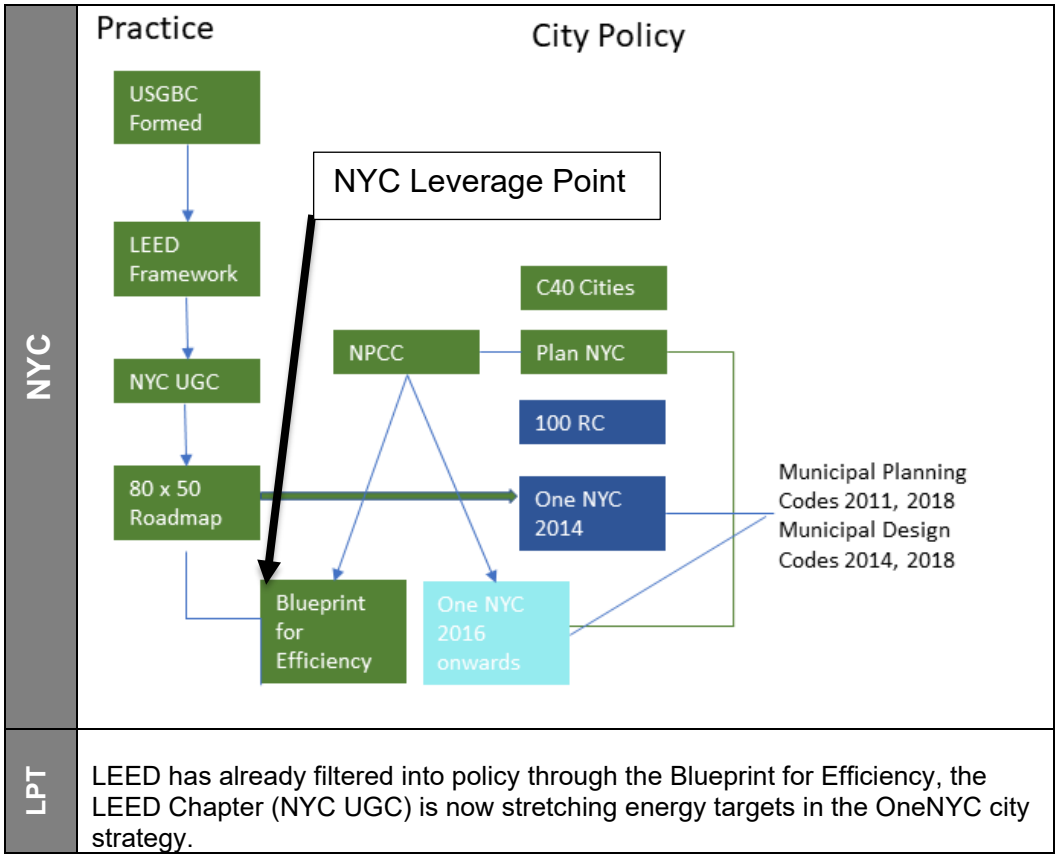
Boston Policy Resilience measurement (Box 4.8):

Boston's 100RC profile identified 20 shocks and stresses to the city which are: **Aging infrastructure**, Blizzard, **Climate change**, **Coastal/Tidal flooding**, Cyber-attack, **Economic inequality,** Ethnic inequality, **Extreme heat**, **Inadequate educational systems,** Inadequate public transportation systems, lack of social cohesion, **Population Growth/Overpopulation, Poverty, Rainfall Flooding,** Sea Level Rise/ Coastal Erosion, **Severe storms,** Storm Surge, **Structural Racism**, and **Terrorist Attack** (100 resilient cities, 2019).

When measuring sustainability there is a tendency towards carbon and infrastructure of transport and energy. Biodiversity and water management is mentioned, but this does not represent ecological systems thinking (Section 2.1.2). Identified previously in Box 4.2 has been the use of 100RC in supporting policy decisions (Section 4.5). The shocks and stresses tend to indicate social and economic bias not necessary ecological systematic changes known as Ecological Based Adaptation (EbA) (IUCN, 2020). In each city, sustainability measurement is encompassing the resilience policy but is bias towards climate change. Chicago does this well "*Prepare the infrastructure for climate change by reducing the urban heat island effe*ct" (Box 5.9), however this does suggest more of a mechanical interpretation of resilience because it is making something more robust yet increasing the roads adaptive capacity to cope with shifts to climate change (Section 2.1.3).

5.4 Streamlining decision-making interplay

Interpretations from each city's practice have constructed a working reality of how these decision-making characteristics produce conflicts and synergies in the built environment. Decision-making relationships have been identified in each city and the relationship between practice and policy outlined (Section 4.5). However, when considering this relationship in more detail, each city has a Leverage Point (LPT) (Meadows, 1999) which are shown in Figure 5.1. Figure 5.1 positions the decision making process between practice and policy and it shows that there is a parallel existence between them, but there is a link through the utilisation of city practice knowledge of LEED. This link provides an opportunity for further thematic study to deduce further causal behaviour (Section 7.6).



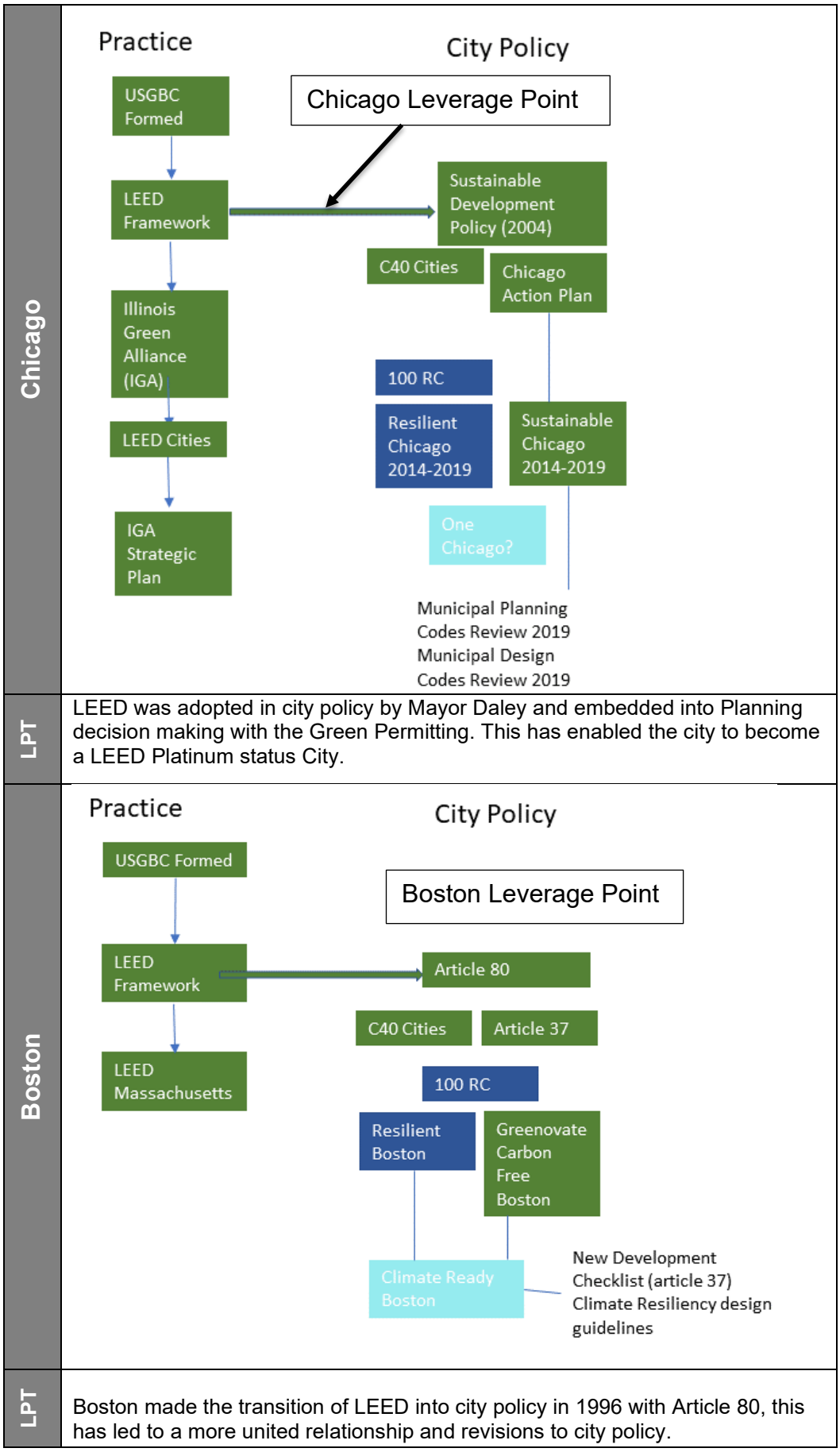


Figure 5.1 Cross case city practice and city policy comparison

Examining how sustainability and resilience have influenced decision making in policy, planning and design practice has generated a total of ten external factors (Section 5.3). The external factors have been collated and categorised with the appropriate level of decision (Table 5.2). Table 5.2 shows that there many external factors relating to decision making of city policy. This relationship is not fully understood, so it is difficult to position and may need further research around each factor before it leads to a causal relationship (Section 7.6).

Table 5.2 Resultant themes in decision-making

External Factors	"process" i.e. Procedural, Factual or metacognitive knowledge	Level of Decision
C40 FEMA Funding and Flooding Political jurisdiction Tax Revenue Emergency response LEED Political shifts	Carbon and Energy FEMA Mapping	City policy
Habitual Practice	City Planning	City planning
Habitual Practice Scope of works	City design codes	City design

The causality of the external factors is discussed in the next three sections. Section 5.4.1 describes the city policy factors which are: C40, FEMA funding and flooding, emergency response, carbon and energy policy (and measurement), political jurisdiction, tax, political shifts. Section 5.4.2 considers the external factors at city planning level which focus on habitual

practice. Section 5.4.3 has two external factors for discussion: the habitual practice of design and scope of works.

5.4.1 Decision-making at city policy level

All three cities provide practice knowledge on decision making and a high proportion were related to city policy. Several external influences are: C40, FEMA Funding, Political jurisdiction, Tax revenue, Emergency response, LEED, Political shifts. The procedural knowledge is mostly connected to carbon and energy, and FEMA mapping.

1. C40 cities

C40 supports mayors to develop GHG emission targets and measurement indicators (C40 Cities, 2016b, 2016a; C40 Cities and Arup, 2016). NYC01, NYC08, CHIC02 consider that over the last decade city policy has become stricter. CHIC04 considers the policy goals are not strict enough which suggests that there is a conflict with the time that it is taking for the policies to be effective. NYC01 indicates that more forecasting of climate change scenarios is required so that energy suppliers can manage the fluctuations in energy demands. NYC01 indicates that city policy is influencing how energy suppliers work but the organisational change that is required is met with resistance by energy suppliers and needs support by city governance resources:

> *"we work with national gas on climate change studies, adaptation studies, we also work with them on our greenhouse gas emission targets"* (NYC01).

As C40 policies trans-descended into city practice to reduce carbon emissions of buildings and infrastructure (C40 Cities, 2016a), the measurement of city policy success is that it aims to lead to carbon emission reduction. NYC08 outlines that city practice have merged all the issues as carbon mitigation (Section 1.1). Whether this indicates that global policy has filtered into practice on this theme will need further detailed narrative (Section 7.6).

> *"Sustainability plans that have resilience elements that are part of it, or strictly just resilience plans or just climate mitigation, however you want to look at it, carbon mitigation"* (NYC08).
>
> *"we tend to frame sustainability in terms, much in the Environment Department, in terms of environmental health and quality"* (BOS05).

As the implementation phase of C40 progresses, there is also a greater conflict with the position of the environment, BOS05 says "*We have city goals, we have State goals, but do we regulate our environment to a place where we can settle needs?"* and then when considering sustainability as a concept, BOS05 highlights that city governance has a different interpretation of environment. This reflects the broadness of the use of the term.

2. FEMA Funding and Flooding

FEMA has provided funding to enable hazards and scenario mapping to enter the decision-making process (FEMA, 2018). NYC03 sees FEMA funding as an enabler to do "*resilience work"* (NYC03). BOS04 and NYC03 highlight that local governance has spent FEMA funding to replace what was lost in due to flooding events and sometimes this does not enable a more

sustainable or resilient decision. Where funding has been spent to ascertain how to increase resilience of infrastructure, NYC03 indicates that existing infrastructure does not meet required standards:

> *"It's turned out that with this those new regulations, the amount of 7,500 dams, like 70% of those dams, so, you know, 5,000 dams are now – they actually – they don't meet the New York State regulation in that sense."* (NYC03).

Due to federal shifts in policy, NYC and Boston have started to finance improvements to infrastructure themselves because they have control over the decisions, yet it is debatable to what standard of practice. There remains a discontinuity between flood level data at national and local level and how this factual data should be used to inform decisions. BOS05 reveals that by 2070, there will be 91.44cm of sea level rise, and NYC03 states that as flooding levels are being considered for new developments, the new infrastructure is being constructed at different levels to the existing infrastructure which creates issues for transport and pedestrians.

Box 5.10 Temporal shifts in decision-making

With new infrastructure investment, NYC01 suggests there needs to be a shift towards medium to long term hazard planning because it is not mutually discussed. Local governance needs to find a way to manage the temporal aspects of making decisions and NYC01 says that: "*why is it only government code and why aren't the financial entities behind the city property planning, they should be asking big questions. They are only looking at it from a short term perspective*."

CHIC05 identifies the codes as a barrier because they are out of date with regards to hazard data and Box 5.10 outlines that the temporal conditions

need to be considered. NYC01 goes into further specifics by describing three issues that the lack of decision-making in codes are creating 1) where to bund against flooding during high tides and consequentially whether relocation is an issue, 2) there is a lack of understanding towards risk and how areas of risk are allocated "*how do you determine in planning what urban areas are what is high risk and very high risk, now, during tidal events" (NYC01),* 3) that there are a lack of planning tools to assist with these decisions. These are real time issues and the planning process is not able to cope with the decisions that relate to flooding and climate change:

> *"there is the real gap in the planning process at the moment within Boston…[sic]… they're having a hard time of climate change projections, when anybody's talking about flooding."* (BOS02).

FEMA has facilitated hazard mapping and future scenarios to be considered in planning and design practice, it has provided much needed funds to start enabling better decision-making. NYC01 says *"we do have something, some prophecies, we use hazard mitigation planning, a FEMA based….".* NYC03 suggests that the funding has filtered through to cities "*I think the US caught up pretty quickly with the resiliency practice and trying to better plan and engineer infrastructure and community*." (NYC03). FEMA funding has enabled change but what it has highlighted is there is a focus on flooding not all hazards. As funding has facilitated organisations to change, conflicts have been created with out of date municipal information and the local governance must process the necessary changes but restrict themselves to short term thinking.

3. Emergency response

BOS02, NYC01, NYC04, BOS03, CHIC02 reflect a position that resilience has come to mean how to manage without power supply and emergency situations. City planning recognises it as hazard scenario planning or mapping, then designers consider how to design for emergency responses by promoting the concept of passiv-survivability (BOS02) and the use of LEED-RELi (Table 2.2). Providing a response to how to manage emergencies response is an area of high tensions in decision-making. Mostly the responsibility and risk for solutions is being shifted onto designers to use their problem solving skills. However, designers are restricted by their scope of works and it is difficult to broaden knowledge and resilience responses at a systematic level (this gets further discussed in the scope of works factor). BOS03 outlines the role of scope of works when dealing with infrastructure emergencies when inadvertently further risks can be incurred by making rapid decisions or building back with the same solution that does not address the failure of build in resilience.

> **BOS03 states that it requires legislation changes to create change:** *"Don't just put it back, you need to put it back with proper regard to current standards and safety considerations"* (BOS03).

Sense of place holds specific constraints, particularly in places like Boston and downtown areas of NYC because of street layouts. BOS 03 outlines that cities have not been designed for the size of modern fire engines to access historical city areas or areas that may experience regular urban flooding and sea level rise and Box 5.11 outlines the challenges for decision-making.

Box 5.11 The reality of flooding decision-making, flooding does not differentiate between rich and poor, but decision-making does.

Sense of place also has social history, BOS02 articulates the social complexity of people and inequality in where they live, "*in Boston is that they're low-lying areas of relatively poor neighbourhoods that will in fact get flooded soon enough"* (BOS02). BOS02 considers that zoning needs to address community cohesion to manage hazard responses, *"Right. How do you merge communities? What does that need to look like?" And then build the zoning around that. Cities still are not doing that."* (BOS02). This is the conundrum; responses need to be dynamic.

Working practice provides some reality and reflects chaotic circumstances. BOS 05 uses two examples to illustrate this issue the first highlights that cities have been designed without regard for no power supply or limited temporary supply, *"After Hurricane Katrina hit in Greater New Orleans there was a huge amount of lawsuits and it was again private architecture firms who designed hospitals where there were no operable windows*" (BOS 05). The second example considers that there comes a point where building systems cannot cope with incremental shifts such as temperature increases and fails:

> *"if it's 140 degree day in Dubai that's exactly when you're gonna have brownouts. That's exactly when the system is gonna be like, whoa!" "You know, my maintenance hasn't been perfect, I'm gonna fail now. So, then what?*" (BOS 05).

Box 5.12 describes that systematic thinking in the built environment can fail because the thought process lacks consideration of multiple failures occurring at the same time. Also, in construction practice, infrastructure of electrical lighting, data, surface water are often constructed using shared

service trenches. So, if a stretch of road gets flooded, all the services are at risk.

Box 5.12 Systems of systems can fail

This focus on emergency response is perceived by NYC02 as positive because new infrastructure is being considered for emergency planning the issue between emergency infrastructure and existing infrastructure is not fully thought out. "*Because, the challenge with infrastructure is that when one system fails multiple system fails."* (NYC02) and this type of failure is not regular practice. BOS03 says "*The building codes are catching up. There is – my understanding is that AIA is in the process of advocating for these policy changes and these building code changes."*

City practice response to recent hazard events have conflated on the principle of 'passiv-survivability' (Wilson, 2006). This type of construction mobilises sustainable building practice such as low U values, low energy consumption, natural ventilation, low water and waste so that power demand is low, and buildings can operate without power or draw minimum demand in case of emergency. BOS02 continues to outline how working with clients and emergency management has led to this response "*we actually kind of characterise emergency response as one thing. It doesn't really matter what kind of hazard you're responding to."* (BOS02). BOS05 adds further confusion to time management, "*But there's also this idea of recovery."*

BOS04 says that the development community is pushing against more resilience regulation that may address medium and long term risks. Some developers consider slow on set risks are not worth managing, particularly when tax revenue starts to come into play (BOS02, CHIC02). BOS04 highlights "*There are conflicts. The development community is somewhat onboard if they want to develop in a location that they know will be flooded,*

they know they have to take measures and design their building a certain way." (BOS04).

It asks the questions: how did buildings get built that aren't sustainable? How did they proceed through planning? And that the need to consider emergency response is paramount, but what about those future scenarios or other types of risk that may shift the building response?

Despite the pockets of good steps forward (availability of hazard mapping and vulnerability data and seeking to upgrade infrastructure), there are some steps back (lack of maintenance and investment revenue, short term decision-making). The understanding exists in pockets of procedural and metacognitive knowledge, but practice is constrained not only by codes of practice, scopes of work, but the policies are also constrained by budget and responding to emergencies in the short term. It is a negative-cycle.

4. Carbon and Energy Policy (and Measurement)

Each city has recently revised its city sustainability and resilience policy; but practice in each city says that these policies are carbon (or energy) biased (Illinois Green Alliance, 2016; The City of New York, 2016b; Walsh, 2019a). Most Interviewees recognise that there is a shift in policy towards energy: NYC has made Energy Conservation Law, Chicago has created Building Energy Benchmarking Ordinance (BEDRO) and Boston has Carbon Free policy; and underpinning the policies is LEED and USGBC Chapters (BPDA, 2019; USGBC, 2018; Urban Green, 2019). However, city design practice debates what the performance standard of LEED means today, so more green building measurement systems such as Green Globe and Passivhaus

are trying to stretch the agenda and in Chicago these changes are creating conflicts as they get adopted by policy practice.

Energy and carbon have become intertwined, but definition of what energy means probably shifted towards emergency management of power infrastructure rather than sustainable design practice as found in NYC. Energy focus in policy is using LEED practice and engaging knowledge towards 'off-grid' solutions and alternative power/energy supply grid because there is now the business case for it. However, NYC01 reports that utility infrastructure organisations have a "*tendency is to ignore*" (NYC01) and need support to progress towards better practice. Setting carbon reduction targets and aggressive carbon reduction goals for power infrastructure also misses the point that "*there is going to need to be a way to constantly adapting right*" (NYC 01).

BOS04 provides an open response "*in terms of climate resilience, the goal is to prepare Boston for the current and coming impacts of climate change"* and provides details on what this means but when discussing city targets said, "*we adopted LEED, basically*." (BOS 04). This has created a huge conflict for city practice and policy makers "*we see developers disproportionately making choices towards the easier, the more sustainable sites, the credits that don't require as much*" (BOS04). This reflects the reality of setting a LEED standard which is low but also allows decisions to be made that are 'easier' because to go further means changing mnemonic practice, although designers want more, to push and innovate (CHIC02, CHIC04, BOS02). LEED practice is merging resilience and with scenario planning incorporated into it and as a city standard:

> *"– and especially in climate resilience, an important piece of the pie that's not getting enough attention in terms of having to get more resilience. So that was an aside. But yeah, I think letting LEED be the standard so that we can innovate on top of it would be awesome."* (BOS03).

Energy ordinance in policy particularly on Chicago has become an indicator for economic benefit, it is a mechanism for developers to satisfy planning, but not for tenants as it has little impact on their rental expenses. Developers need to be incentivised to make changes towards sustainable design practice.

> ***CHIC03 points out that to meet built environment targets:*** *"We would have to renovate 10% a year to get to the place where – to keep it close to the stated 80% in the mission reductions costs."*

This means an investment into 100,000 homes a year, l*et al*one Chicago city - and this must be mobilised by the mayor. Yet the codes stipulate energy performance based on LEED of new build construction not renovations "*The goals of the building code in New York are quite aggressive and they do want to continue to improve. Like I said, a lot of that is geared more towards energy efficiency right now. But there's so much existing building stock that that's only gonna affect the new buildings*." (NYC04).

This shows that target setting of energy and carbon is needed but the policy mechanisms to achieve it aren't really thought out and more cost should be placed on developers and costs not passed on. Then more conflicts occur with policies that are trying to attract economic investment "*The Mayor is reluctant to add cost for owners and for developers who already feel like they*

have a lot of cost here" (CHIC02). NYC04 reports that developers are starting to be incentivised for incorporating renewable energy but also for an allowance of thicker walls that does not reduce square footage and income.

As energy targets tighten, the carbon policy starts to embolden public transport initiatives and shift to public spaces and infrastructures which have lacked maintenance investments - "he *was big into bike infrastructure and so built out our bike share programme, transformed our streets into bike lanes, protected and some just painted but really made Chicago a bike-friendly city*." (CHIC 06). Some say that the carbon policy targets are perceived as delimitators to both resilience and sustainability:

> *"City mandates are so focused on carbon emissions and reducing energy loads of buildings […] that plays into the resilience factor because obviously we wanna be consuming less energy to prevent black-outs or in scenarios when we don't have access to power"* (NYC05).

With this focus on energy and carbon in Chicago and NYC, the Environmental laws and policies start to get neglected and the synergy between both concepts has become focused on emergency planning and leading towards passive house approaches to reduce energy consumption. Boston has an integrated policy of sustainability and resilience with 'Carbon Free Boston (Climate Ready Boston), resilient Boston, Article 37 and new development checklist that are legal requirements of the planning process and work well with the State building codes. The sustainability policy is in the zoning code because the Massachusetts State controls the code "*I know that*

we recently – the State of Massachusetts recently just received a $1.4 billion environmental bond towards climate adaptation." (BOS02).

5. Political jurisdiction

In simple terms, all cities outline political jurisdiction boundaries conflicting with zoning plans. The reality of a zoning plan is that there is an uneven distribution of wealth and tax revenue or financial investments.

> *"Cities also are, they're hamstrung by the power that cities have already ceded to the development process"* (BOS01).

This generates social and political conflicts "*Zoning laws are […] basically an application or compromise between political and economic interests so very look very rarely do they take life into account*" (BOS01). Zoning leads to many conflicts mostly associated with urban flooding, aging infrastructure and watershed issues. Managing watershed needs people to come together to make more effective and better decisions and when they do "*they've already identified repair and strengthening of a particular damn, which is the first thing and most important thing to do as a group."* (BOS06). Chicago is also trying to steer this path "*but because again of the ridiculous jigsaw that is the jurisdictional map of the Chicago area, that's very difficult*." (CHIC01). It is due to the lack of power and knowledge at regional level that is creating problems with decisions around ecosystems management with reference to watershed.

Next complication is social inequality generated by disproportionate attention to tax revenue from development in city zones, which causes vulnerabilities. CHIC01 makes a well-structured point that needs full consideration:

> *"we have a huge urban planning problem in the region that we're in. It tends to affect communities of colour and low income communities more so than affluent communities."* (CHIC01).

This raises attention to the price of land in areas that are flood prone and the fact that mitigation funds are raised from areas with tax revenue. The reality of what this means is outlined by BOS01 "*So it's the mentality and it's a regulatory environment. The poor people and the people with colour are not resilient, they are struggling and on the edge*." (BOS01). Considering flooding exposes that vulnerability is tied up with political jurisdiction because it is an urban planning problem and this relates back to zoning, which relates back to SZEA.

So, when the resilience and sustainability agenda become adopted by city policy, practice can start to challenge policy but "*sustainability policy is in the zoning code because the State controls the code. So, as a city, we don't have any control over our building code*." (BOS05). This outlines that the city municipalities can not change their codes, yet the regional entities have power to change the cities approach without knowing much about the social reality:

> *"the thinking is limited, fragmented, and people are not aligned"* (BOS01).

If changes to practice do filter through the zoning, then they continued to be hampered by political jurisdiction (and tax revenue) "*there also needs to be this bigger holistic vision of everybody coming together to make this really happen*" (BOS03).

To make things happen, the Mayor can override Federal policies and if necessary pay for the 'work' that needs to be done through city finances. However, this can create disparity for those cities who do not have strong mayoral powers, rely on federal funding or acknowledge the agenda. CHIC03 outlines the position that as a regional authority they regularly get sued by the city. BOS06 also supports the view that environmental lawyers arbitrate over archaic environmental laws that are protecting the 'polluted' environment where project work really wants to reduce the pollution not add to it:

> *"We don't have strong county government here, but what we've started to do is work within watersheds"* (BOS06).

What Boston's waterfront development also exposes is that environmental regulation has led to protection, but what creates conflict is when the ecosystem has itself degraded and become polluted and remedial measures need to be put in place - which is at juxtaposition with protection laws and needs people to speak up, "*That place is so contaminated, there's no sea life. Anything you add is going to be better and it's going to be an improvement."* (BOS06). BOS06 continues to outline that focusing on the watershed can lead to changes and empower the municipalities "*each*

municipality now has a source of funding from the State to do municipal vulnerability assessments." (BOS06).

People and communities have a desire to do something about the lack of 'decision' due to jurisdiction and BOS02 outlines that communities are starting to use their own tax revenue weight to create positive changes with strategies for zero carbon, "*And so, had a yearlong process and developed a road map for a net zero carbon city by 2050 or something like that, which is pretty aggressive and pretty interesting*." (BOS02). There is clearly more work that needs to be done but political jurisdiction with regards to watershed is moving forward and if political jurisdiction was recognised as an external influencer to causality then maybe it could be managed.

6. Tax Revenue

Built Environment assets produce finance, not only by the people working within the buildings that drive the economy but also the revenue that can get created by development. Public services that relate to buildings can be taxed, rental income of public buildings, public infrastructure:

> *"Cities live and die on tax revenue. If they're deathly afraid I don't think, I think it's unfounded, but they're deathly"* (BOS02).

CHIC02 discusses that tax revenue is a real issue for Chicago and the Mayor's economic policy because the city has large costs. The policy is trying to reduce tax for developers and businesses because Chicago needs investment "*Chicago is still one of those industrial cities that's not really*

growing, it's getting smaller" (CHIC02). The economic policy is using energy ordinance as a way of mobilising tax income and development.

Boston has an issue with tax revenue from existing buildings because the most affluent areas are the most prone to regular flooding. BOS04 discusses that the city has recognised that to protect assets and city revenue they need to do something about it "*we'll have $85 billion worth of assets at the flood plain. […] We're doing a lot of work on district flood protection. Neighbourhood by neighbourhood, identifying flood pathways and opportunities to build protection at the coast to protect the neighbourhoods behind." (BOS04).* Boston's policies have started to shift towards flooding and managing it with further development known as the waterfront. This issue of tax revenue is a critical cause of conflict in decisions because developments are being steered towards the tax income "*afraid of losing tax revenue. And so, they're not gonna move people out of low-lying areas. What are you crazy? They pay taxes."* (BOS02). Add to this the political jurisdiction between neighbourhoods and vulnerabilities, the cities may favour those who can continue to pay tax.

NYC05 outlines that New York has reached a point where its financial benefits outweigh being in a flood zone and almost overcome the loss of economy from developments in flood areas unless the insurance industry steps in to say no to the costs. Practice is finding a way through the tax and political jurisdiction by shifting attention to smaller municipalities because they can be influenced, "*they may have a tiny taxable base and so their road to catastrophe is much shorter than the city of Chicago's because they can't move money around the same way*." (CHIC01).

7. Political Shifts

Each city experiences political shifts both in bi-elections and mayoral elections. A shift is any change between regional power and mayoral power. CHIC05 discusses the impact of the Daley legacy and left the current policy making foundation due to differences "*I loved Mayor Daley […]. We created a really powerful vision for making Chicago the greenest city in America*" (CHIC05). CHIC01 outlines that policies deflect from the real issues:

> *"in this region, it's a super duper political place and so we end up sacrificing things that probably are more ideal because of the politics"* (CHIC01).

Financing the policies creates conflicts "*There's more granular political challenges that come up, local elected officials, all fighting for the same money.*" (NYC07). Political changes in leadership can lead to shifts in public offices and create personal juxtapositions with the institutions. NYC07 has a candid response to recent local governance shifts and outlines that they simply hadn't implemented adequate policies "*they suffered extraordinary damage from hurricane, and they had done – their planning had been so poorly done over decades that they had suffered tremendous economic losses"* (NYC07).

However, NYC07 indicates that NYC had starting sustainability planning and that instigated learning towards better policies *"NYC first embarked on sustainability planning, there's been a lot of learning that's happened and a lot of opportunities to adapt from that learning."* (NYC07).

Box 5.13 Reality of political shifts

CHIC03 provides insight that sustainability keeps moving its position in local governance, and that it started in the Department of Environment, but it is now in the mayor's office. This departmental move suggests more power and influence in decision-making *"the sustainability office is in the Mayor's office which is you know, they run a lot a stuff in there. The Mayor here is a big deal."* (CHIC03). NYC05 considers that mayoral shifts can be influential but subject to what is happening at the time "*I think so much of city policies are dependent on the policies of it and the mayor at the time*" (NYC05).

This position is supported by CHIC01 who discusses how transportation policies keep changing to chase funding streams and being reframed into something else but really nothing changes, *"the transportation act, so FASTACT is the acronym… […] … It was SAFETY then it was SAFETYLU, then it was – I think it was MAP21 and now it's the FASTACT."* (CHIC01).

When the decision actor of the mayor empowers city governance departments and city communities are engaged, there is a fear that change in decision-making cannot happen fast enough before more hazard disruption. *"We're on the way, hopefully quick enough, but it's going to take a long time and we just hope we don't have any storms before these measures are put in place"* (BOS06).

Mayoral power and policy shifts towards sustainability and resilience has created the circumstances to appointment a 'Chief of Sustainability' or 'chief resilience officer'; all three case study cities have done this, although the internal organisational structure does not always facilitate the 'best' decision outcome. This shows that political shifts can create opportunities for new practice and Institutions can evolve "*Now I believe just by the mayor, creating*

that position on putting somebody of that expertise in the role. I think that demonstrates that they're serious about this issue." (NYC02).

When there is a surge forward in sustainability and resilience a vehicle for change is created; currently in Chicago is the idea of health:

> *"they're pulling on the leash in terms of how they're pushing things in the policy realm and so you're seeing this idea of resilience being led by the Department of Public Health."* (CHIC05).

By policy shifting towards health, it leads to cleaner streets (and less waste), using less water and promotion of public transport to be healthy (and produce less carbon emissions). Under the health umbrella, CHIC 05 also outlines that Mayor Emanuel used a progressive personality in the Department of Transportation who was "*big into bike infrastructure and so built out our share programme, transformed out streets into bike lanes".* This is the reality in Chicago where resilience is concerned, it has yet to consider the concept fully so that it incorporates vulnerability, *"There's a little bit of the resilience sort of conversation in terms of exposure and sensitivity and vulnerability. And I think in terms of policy, that's the best example, at least in Chicago*" (CHIC05).

5.4.2 Decision-making a city planning level

City planning is a process of decision-making between policy and practice. It is a legal process which stipulates certain requirements and compliance with zoning codes, the process results in permits 'to build'. Planning issues encompass spatial, political and temporal boundaries. Departments of

Planning exist as part of the institution of city governance. City planning and regional planning are perceived as separate institutional issues.

Fundamentally, it asks the question of how has it become an acceptable practice for buildings to flood and for existing infrastructure and buildings not to be able to cope with increasing shocks and stresses that are being imposed on them? In response, it suggests out of date planning processes and laws which do not take long-term thinking into account:

> *"There a 129 open building permits open, they don't ask long term questions"* (NYC01).

8. Habitual Practice

BOS06 outlines a developing debate about planning regulations and the need for a shift, but this is opposed by people who follow the rulebook and will not change the rules because it is such a challenge "*these are the regulations that have been handed down to me and I don't have the ability to change it*" (BOS06). With this ongoing debate there is no national mediator or mutual guidance "*As you probably already know, we don't have national planning regulations."* (CHIC01) and for many the view is that "*the State code is the code that works for the whole State"* (BOS05). The case studies show that every city has employed the environmental laws or LEED in a different way.

The reality of changing zoning is also challenging particularly with affluent areas due to tax, but also because communities are suddenly exposed to flooding in a way that they never expected *"the community is out on the*

coast, but for them it's harder economically because bringing something up to code costs money and all of a sudden, now they're in a flood zone that didn't even exist when they bought the place" (NYC06).

Given the issues already outlined, there is the subject of climate change predictions. BOS 04 says that asking questions about "*Will my building survive after 50 years? Can my building withstand a 100 year storm surge event?"* (BOS04) are having to be posed to the client because of lack of information in the planning process. Boston has found that the BDPA checklist is an effective tool to help manage these types of conversations:

> *"climate change checklist that every developer needs to fill out and show that they are aware of the climate resilience and climate efforts"* (BOS03).

Cities are faced with the task of changing processes and because the codes have not maintained pace with practice.

Over time, the process and lack of environmental or sustainable building practice in the planning process has facilitated trends in architectural practice such as an excessive use of glass in buildings. Using high proportions of non-intelligent glass with high U values drives up the need for cooling and the use of air conditioning or mechanical systems to keep these spaces comfortable. However, CHIC02 suggests that it is not subject knowledge that is an issue but the lack of staff to enforce it "*They don't have enough time, they don't have enough people, they don't have the resources to enforce"* (CHIC02). The codes in the planning process for permitting are also locked into a political shift between State codes and city practice, "*we have to work*

with our partners at the State to accomplish that because it's their jurisdiction, not ours" (BOS05).

What is evident is that hazard management and climate change projections are creating havoc with the zoning codes. Yet, Boston has recently managed a change in its planning process "*They have recently completed a planning process, the first […] they've undergone in 25-30 […]. That planning process was really about growth, adaptation and mitigation*" (BOS02). However, when the planning process takes ownership of hazard risks and vulnerabilities there is a lack of appropriate tools for practice "*It is very difficult, there are no good planning tools"* (NYC01). The issue also remains with regards to who can make these changes to managing zoning and the social and economic inequalities as identified by the 100RC:

> *"two individuals [Chief Sustainability Officer and CRO] can only do so much..[…]…but I'm not sure that they have been empowered with that authority"* (CHIC05).

The responses indicate that municipalities need to start planning for sustainable outcomes that also consider sustainable urban drainage, rainwater and storm water management. Perhaps there needs to be more resources to look at the functionality of ecosystems and urban impacts on the ecosystem *"The only way to a proper well executed planning process, does a better job at anticipating what those obstacles and barriers will be*" (NYC07). Planning practice has a limited capacity but are trying to change, improve and incorporate sustainability as well as resilience measures but this is focused on flooding. However, to compensate for lack of human resources in

planning departments there needs to be a shift back towards the all-encompassing Environment.

5.4.3 Decision-making at city design level

City design is representative of professionals who work with built environment projects in cities. Designers manage risks, create sense of place and provide urban habitats for people to live, work and play. A project goes through the planning process to achieve compliance with all jurisdictions from Federal, State and municipal levels and their professional codes of conduct. Most of critical conflicts raised were related to the following points: how hazards are managed with reference to 100 year storm event in flooding, the out of date codes, mnemonic decision making practice in the city planning authorities, lack of consideration to existing buildings and infrastructure, limitations of scope of works where they can only be contracted to deliver defined components. Design practice knows that there is lack of foresight and hazard scenario planning and that policy largely focuses on energy reduction. There is a lack of political motivation to revise codes or change laws, but the increase in frequency of hazard events is triggering the need to review them. This brings the issue of building service design life and the term adaptability into building codes that stratify performance standards.

9. Habitual Practice

Passiv-design strategies and sustainable building practice are still not regular practice, it is alarming that buildings are being processed through planning that do not consider operating without power or with principles of natural ventilation. BOS03, BOS04 and CHIC02, all mention that architectural

practices were sued in the aftermath of Hurricane Katrina for designing buildings without operable windows in hospitals. BOS04 also outlines that design practice has started to change this type of practice:

> *"something as simple as allowing the buildings windows to be operable in case of a storm, to allow some airflow into the building is really critical. So, the Spalding Rehabilitation Hospital did"* (BOS04).

Further to that, CHIC02 outlines that air conditioning is seen as the design solution to designing spaces with increasing air temperatures. This reliance on air conditioning leaves those who are not able to afford it vulnerable, especially if there is no natural ventilation in the design. As the effects of climate change escalate, the changing conditions are not yet managed by codes of practice, they still stipulate a worst case scenario such as the 100 year storm event, but these worst case scenarios are increasing in ferocity and now the codes are at a juxtaposition with their future scenarios:

> *"If you are building a building in a flood plain, then the code will tell you that, the code requires for residential structures to build 2 ft above the flood plain, what we call the 100 yr. flood event, that can't be right, can it?"* (NYC01).

Yet, there is still ambiguity about how to respond to flooding situations. City design practice is aware that flooding events are gaining certainty but is infrastructure focused and not considering buildings. BOS01, BOS06 and NYC06 indicate that the coping strategy for buildings in flooding events is to let their basements flood or not occupied at a certain level. Despite building in capacity to cope better with hazard events:

> *"mechanical systems are elevated on the roof of the building and a lot of various details of the design are elevated to a certain level, so that way, if the water does come in, it doesn't make an impact."* (BOS03).

However, NYC06 suggests the real problem is caused by building occupants changing the ability for a building to cope by occupying basements, removal of walls, and moving building air conditioning units. The issue also remains that businesses benefit too much economically, or some are too vulnerable to have a choice *"some people they'd rather take the risk of being in a flood zone"* (NYC08). To add the financial structures do not support long term choices in property and encourage insurance "*In the US people generally say 30 years because that's normally the longest mortgage and the culture of the US. We're very short-term and we tend to be again absurdly driven by legal considerations" (BOS04).* Fractures start to appear with the local economy and federal governance "*why is it only government code and why aren't the financial entities behind the city property planning."* (NYC01).

CHIC02 and NYC08 discuss that to shift the understanding, social engagement and ownership of building behaviour is encouraged. However, despite a more engaging approach, the right policies are not being created to make decisions on a community scale. Although there is still incentive to consider spatial scale of a community response to buildings because of legal constraints "*I think incentives would help people think more collectively instead of singularly with their building. Even if buildings are touching each other, there's so much – or there's no engagement really at all*." (NYC05).

The city policies to inform better decisions concerning climate change start to become exposed as failures because it has become a social agenda: "*but I don't see a really strong public sector effort right now on that*." (BOS06). BOS01 and BOS02 consider that communities need to be more involved at many levels particularly to build resilience:

> *"You can't hire an engineering firm and say, "oh build me a stronger community," we're just - and it has to in many ways it comes from the community. It's not something an outside consultant can do."* (BOS02).

Design practice needs further guidance to manage the temporal risks of climate change projections, heat predictions and shifts in rainfall. Whilst policies and governance prescribe what should happen through the planning process, design practice remains disengaged where design codes exist: "*our sustainability policy is in the zoning code because the State controls the code. So, as a city, we don't have any control*" (BOS05). BOS04 considers that resilience gets designed out of buildings through optimising systems. "*there's a natural tendency where engineers love to optimise their systems*." (BOS04). Without a shift in the design practice and codes, it will be in constant friction with resilience and sustainable design practice. NYC04 discusses that resilience has been framed as a safety issue rather than being adaptable to cope with future scenarios:

> *"It's more about robustness. And the reason that's the case is because building codes are about safety. […] And so, the adaptation, the resilience issues are rapidly being framed as safety issues and they're gonna rapidly make their way into building codes."* (NYC04).

From this position, the forward looking data or better interpretations of sustainability and resilience have yet to trans-descend into codes of practice and gets tied up in political relationships "*The building code is managed at a State-wide level and so changes to the building code happen much slower. Even so, the State has a very solid energy code and pretty solid water code."* (BOS02). BOS06 describes a legislative situation with the Boston waterfront development and how making improvements has been restricted by existing practice of environmental laws. "*It's considered – the assumption is that it is going to harm ocean resources*." (BOS06), but the reality is that oceans are polluted and they need remediation development.

Box 5.14 Lack of leadership in municipal codes

BOS06's situation highlights that wanting to do better and enhance the environment has to overcome the mnemonic decision making practice and they are not alone in having to create arguments for better practice "*partially because it is new, the engineering industry is not used to having to decide this in their designs*." (BOS02). Personalities and knowledge of decision-makers come into play "*especially in an area where the people that are in power, especially on the public side… […] …they don't really understand, you know, like the resiliency kind of shift that we are seeing."* (NYC03).

Box 5.13 outlines lack of leadership in policy. Sustainable and resilience design practitioners go further to say that innovation has been stifled by policy because they have adopted LEED *"LEED has become sort of a zero sum game, it's really become about compliance*." (CHIC02). The innovators are restricted to do more by the minimal LEED certification targets that are adopted by policy and the municipal codes:

> *"the building codes have been relatively stringent in driving reductions in energy use, driving reductions in water use and improving building envelopes"* (BOS02).

CHIC02 continues to outline it is about how the municipal code is behind optimal practice and if the municipal standards are enforced then projects lose their competitive edge, "*And there's two problems with enforcement. One is that you are – when you're trying to do the right thing and follow the code, we're competing against people that aren't*" (CHIC02). For LEED to become a real LPT, the optimal standards need to be adopted by all decision-makers (Garde and Kim, 2017).

It is evident that there needs to be more of generational design shift and a total upheaval on the design codes. CHIC02, CHIC04, BOS02, BOS04, NYC06 suggests the most conflicts in design practice are due to the city policy being biased towards energy and water "*energy issues – energy and water use are big issues."* (BOS02). BOS05 wants to see earlier design decisions being made but points out mitigation measures in practice reduce the impact of passive design "*they will make design choices early in the stage that would reduce their energy efficiency and then they will claim mitigation to get them back to what might have been"* (BOS05).

BOS02 wants to see the principle of passiv-survivability come to fruition to mobilise both agendas "*passive survivability essentially describes a situation which a building gets unplugged from all its inputs and still manages to be liveable*." BOS02 and CHIC02 want to see natural ventilation principles incorporated into buildings so there is less reliance on air conditioning "*because buildings that aren't ventilated are quite problematic when there's no electrical inputs."* (BOS02). If principles of passive survivability are not incorporated into decision making and design, considering future scenario

data has a limited effect and municipalities need to consider long term decision making of social and environmental conditions in their city plans.

Fundamentally design practice indicates that the laws and codes of practice are out of date in each city, as well as the acknowledgement of habitual practice towards LEED (Sections 5.3.2, 5.3.4, 5.3.6). BOS04 raises the point that the lack of investment in the built environment has led to poor decision-making and that ideas can be restricted due to political jurisdiction (Section 4.8.5). However, the adoption of LEED as a standardised practice develops a minimum performance and provides structure to deliver a better built environment. *"Like I said, the conversation is still kind of new. People are still jumping on to this and I think there are a lot of policies"* (BOS03). However to really create a synergy, it must be acknowledged that the scale of the decision has an impact and that developers must go further than easy win credits "*We have the buildings that are complying because it's the code and we have the buildings that see the value in a sustainable building, both for energy efficiency and good practice." (BOS05).*

Design practice leaders have created a policy shift and starting to change codes of practice "*I do think this city has done a very good job of incorporating design elements into its code requirements and they've addressed a number of issues from the city planning department that deals with the planning and zoning works of the building department, and the building code*" (NYC07). However, BOS02 says there still needs to be more engagement "*The second step is to engage as many stakeholders as possible in whatever this is"* (BOS02). The project scope of works also needs to shift towards thinking of the urban environment and making decisions with

the context in mind *"What are the uses and how do we connect them, which would be again planning or even transportation engineer scale*" (NYC04). However, what affects all practice is the scope of works, project teams can not mobilise their knowledge without it.

10. Scope of Works

Built environment development is affected by clients and how they package work for design teams. Scopes are predetermined by regulation (public works), codes of practice (legal and professional) or by clients (private), but also the City decides what projects are viable development options and they pass on the risks to the design teams without a two way conversation. BOS01 outlines that "*medium to long term decision making is not mutually recognised or discussed"* (BOS01), which suggests a crisis or short term approach.

> **Good and best practice is not regular practice:** *"the types of buildings we do occasionally are connected to trying to make it at its most broad, a better city, a better environment and more directly and more sustainable and resilient one."* (NYC04).

Scope of works become legal contracts (albeit necessary to safeguard costs and legal positions), but it can restrict how planners and designers can resolve some spatial, temporal and social issues concerning resilience and sustainability.

> *"The spatial planning is really an afterthought and that's where the shift if gonna have to happen. And people are beginning to understand that, but that doesn't mean they're doing it."* (BOS02).

BOS06 outlines how they have started to create collaboration of teams to consider watersheds in the Mystic River Authority, but this is not regular practice or easy to convey in a scope of works "*We're looking at 11 towns that surround that, that make up that watershed and trying to coordinate those efforts*" (BOS06).

Using scope of works to manage hazard risks is also limited due to the lack of information and temporal conditions. NYC06 considers that some developers accept the hazard risks associated with site selection, but as city planning builds up the risk scenario information, clients need to be requested to consider how to reduce the risks that the building is creating and then mobilise the design practice to do more. In some instances, city practice is usurping regulation which highlights that regulations that get conveyed in the scope of works needs to be reviewed and revised to reflect the requirements of their climate change projections. Working with out of date information leads to poor practice and a vicious cycle of creating built environment assets that have limited adaptability. If regulation starts to consider future scenarios then potentially decision conflicts can be reduced.

CHIC01 considers the changes required to building resilience into scope of works similar to asset management "*Ten years ago, you really didn't find many local governments using what we call capital improvement programmes, which is a basic asset management strategy"* (CHIC01). Scope of works can cope with asset management but CHIC01 says financial regulation needs to match the shift "*when something comes to bonding, it has to be passed by referendum, or even if it doesn't have to be passed, the*

politicians are so weak that they just do it as a referendum to secure their own re-elections." (CHIC01).

Box 5.15 Temporal constraints with investments of building ownership

The component is that clients may not want to deal with the financial regulation compliance and long term investments "*Well, I think the hard part is that some clients aren't really interested in the long term investment. They want to build it quick and sell out*," (BOS03) and if projects do not consider it we have what we have today a stressed built environment which needs maintaining, but there are no financial funds. NYC03 outlines further constraints for scopes to consider "*to develop infrastructure that can withstand the future risk, but we need a tremendous amount of money, especially because our infrastructures are aging right now, right?."* (NYC03).

For resilience and sustainability success, the scope of works must manage to mobilise practice knowledge and financially the local governance institutions oppose themselves "*sustainability and resilience get managed separately*" (NYC01), yet the practice uses "*sustainability indicators for the purpose of the plan, but the theme that we're using to drive this is resilience."* (CHIC01).

With these complications, scope of works considers how to manage failure and interdependencies because it is more financially beneficial to be efficient and merge systems. Yet, design practice knows "the *challenge with infrastructure is that when one system fails multiple system fails."* (NYC02). Practice needs to find a way through, and policy needs to prescribe certain components of scope of works such as scenario planning to include short term and long term projections, as well as what to do in an emergency and cost benefit analysis for each of these phases. If it is put in a scope of works, then people can take action and mnemonic responses to problems can be reduced.

Finally, the scope of works needs to manage collaboration between disciplines and project team proponents, the design teams have developed standardised responses to design problems and biases may exist. NYC04 considers that LEED practice does not mobilise design teams effectively, "*one of the beautiful things and challenging things about sustainability is that no one discipline can claim ownership, right. Architects can't say that they're going to be the ones to solve it. Mechanical engineers can't be the ones to say that they're going to solve it. I think we all have to work together*" (NYC04).

5.5 Chapter Summary

The thematic responses from practice indicate that the interpretations of sustainability consider Brundtland (1987)(Sections 5.1.1, 2.2.1). However, Boston has taken a more systematic understanding and includes elements of resilience (Box 5.8). Sustainability policy in cities has become biased towards energy and carbon but is neglectful of EbA approaches with causes conflicts in decision-making (Section 5.3, Box 5.7). Interpretations of resilience reflect theoretical understanding of systems of recovery and adaptation but policy is measuring managing shocks and stresses, or even DDR which reciprocates (Achour *et al*., 2015). Practice also seems to reflect the theoretical understanding of resilience but is at conflict about how to adapt or build in capacity and is aware of 'Passiv-Survivability' to reduce social vulnerability (Section 5.3, Box 5.8).

Practice interpretations of the measurement of sustainable development and resilience in cities (Section 5.2) indicate the use of LEED as the most used framework and valuable platform for decision-making (Figure 5.1) but this is not reflected in city strategy documentation (Box 5.8). From the interpretation of semi-structured interviews, each city has revealed its own version of reality of decision-making (Section 5.3) and when consolidated and cross examined led to ten causal points (Section 5.4). Section 5.4 has streamlined the causal themes of: C40 cites, FEMA funding and flooding, emergency response, carbon and energy policy (and measurement), political jurisdiction, tax revenue, political shifts, habitual decision making of planning and design practice and scope of works. The ten points reflect the reality of habitual

decision-making and political bias which suggests that conceptual interpretations have been made to suit politicians.

Narrative themes have now established themselves as previously shown in Table 5.2 follows:

Table 5.2 Resultant themes in decision-making

External Factors	"process" i.e. Procedural, Factual or metacognitive knowledge	Level of Decision
C40 100RC FEMA Funding and Flooding Political jurisdiction Tax Revenue Emergency response LEED Political shifts	Carbon and Energy FEMA Mapping	City policy
Habitual Practice	City Planning	City planning
Habitual Practice Scope of works	City design codes	City design

Chapter 6 Decision-making patterns in cities

An objective of this research has been to generate context to critically assess the decision-making interplay of resilience and sustainability in the UBE and build a new foundation for both agendas (Section 1.5). The thematic narrative has led to an understanding of decision making influencers and actors, as well as considering their effects in policy and practice. Discursive use of conceptual interpretations and measurement frameworks have shifted policy and practice towards carbon and DDR (Achour *et al.*, 2015).

This chapter continues to theorise decision-making from the case studies and semi-structured interviews (Objective 4) and construct a framework to explain interplay of sustainability and resilience in decision-making of cities (Objective 5). This discussion is formulated in two parts: firstly, the discursive use of meanings and measurement of resilience and sustainability in cities (Section 6.1). Key cross references are highlighted in green. The context has been generated by examining the US case study cities for: patterns in policy (Section 6.1.1), planning (Section 6.1.2) and design practice (Section 6.1.3). Secondly, the context of the causal relationships in cities has identified six decision-making junctures (Section 6.2). As a narrative aid the Figures 6.1 and 6.2 have been constructed to consider the relationship of policy and practice of sustainability and resilience in cities (Section 6.3). There are three levels of policy to consider: global, national and state as influencers on city policy. City practice is considered as professionals involved in the UBE industry (Table 3.9). As the discussion unfolds, there are foundations for better decision-making for cities (Section 6.4).

6.1 Sustainability and resilience in theory, practice and policy of cities

Interpretations of meanings have decision-making consequences (Section 2.3.5.3), which leads to blurred lines where practice-led knowledge has become adopted by city strategies but influenced by political bias (Section 5.3.7) . As decisions get made to benefit the majority and to maximise impact, other aspects get marginalised and habitual responses are created and effective change is not created in decisions (Edwards, 1954; Foot, 1985; Norris *et al.*, 2008; Fainstein, 2018).

The examination of three US cities provides insight on the interpretations of resilience and sustainability between policy and practice as summarised in Boxes: 5.7, 5.8 and 5.9. Table 5.2 categorises the decision-making influences and actors along the city pathway of policy, planning and design practice. The discursive use of language becomes evident by the reality of practice (Section 5.4) and that sustainable development needs are not being met as city strategies are measuring carbon (Box 5.9), not systems or even assessing life cycles (Section 2.1). However, understanding which interpretation is being used and how it is being measured helps evaluate decision-making (Section 2.3.5.3) and Table 6.1 shows the policy shifts between 2007-2019.

6.1.1 City governance and policy shifts

A policy shift has been identified by chronologically listing the case studies' city sustainability and resilience strategies (Figure 4.1). The shift is due to

each city being a founding city of C40 and subsequently creating a visionary strategy document and then this shifts rapidly due to 100RC (Table 6.1 and Box 4.2). Each of the three US cities shows a similar sustainability policy pattern, where the decision actor is the city leader (mayor) who has shown a personal initiative to shift environmental policies: Richard J Daley (2008); Thomas Menino (Gibbs and O'Neill, 2014) and Michael Bloomberg (Rosenzweig and Solecki, 2015b).

Table 6.1: City policies extracted from case studies

Critical shifts	NYC	Chicago	Boston
2007-2008	Plan NYC 2030	Climate Action Plan	Article 37 Renew Boston Climate Ready Boston
2014	Plan NYC- a greener more resilient NYC		Climate Ready Boston update
2015	One NYC	Sustain Chicago	Carbon Free Boston
2019		Resilient Chicago Chicago Climate Charter One Chicago	Renew Boston Climate Ready Boston

Recently in 2016, there has been a reinforcement in city policy after the Paris Agreement where the city mayors reinforced their independent voices to oppose President Trump's Federal policies and they created the NACC (C40 Cities and Arup, 2016; Flavelle, 2019). Boston's mayor regularly reinforces 'Climate Ready Boston' in public statements (Chicago Council on Global Affairs, 2018; Walsh, 2019b). In NYC, city governance now mandates local practice through local laws and building bulletins (NYC Buildings, 2019). Mayoral actions also led to the NY Climate Change panel being created by

law, so that it can remain through political shifts (Box 4.4, Figure 4.1, Section 4.6.3).

Policy management of decision-making has been endorsed in each city through a chief of sustainability and chief of resilience (100 Resilient Cities, 2016; City of Boston, 2018; NYC Office of Recovery and Resilience, 2019). However, these decision actors are subject to periodic political shifts (Figure 4.1, Table 6.1, Boxes: 4.1, 4.5, 4.9, Section 5.3). For example, Mayor Bloomberg mobilised the Office of Long Term Planning and Sustainability (OLTPS) until it became NYC Sustainability, and currently Mayor Blasio has placed the agenda under the umbrella of the Office of Recovery and Resilience (ORR). In Boston, it is perceived that it is the 'mayor's' office that makes decisions and the environment department operates 'emergency management' (City of Boston, 2019). Chicago operates a similar model, but sustainable development is mostly recognised as a 'planning and development issue' (City of Chicago, 2019).

Since the 2008 political shift, each city has created a city sustainability and resilience policy (Table 6.1, Figure 4.1). Industry practice in each city says that these policies are carbon (or energy) biased (Illinois Green Alliance, 2016; The City of New York, 2016b; Walsh, 2019a). Most Interviewees recognised that there has been a shift in policy towards energy: NYC has made Energy Conservation Law, Chicago has created BEDRO and Boston has Carbon Free (Sections 4.6.3,4.7.3,4.8.3). However, the foundation of the polices has come from LEED Chapters: NYC GBC, Green Alliance and USGBC Massachusetts (Box 5.1) (IGA, 2016; The City of New York, 2016b; Martin J Walsh, 2017; US GBC Massachusetts, 2019). Boston has an

integrated policy of sustainability and resilience with Carbon Free Boston (Climate Ready Boston), Resilient Boston, Article 37 and the Climate Change Preparedness and Resiliency Checklist that are legal requirements of the planning process and work well with the State building codes (Box 4.9, Section 4.8.4). The sustainability policy is contained in the zoning code because the Massachusetts State controls the code, but the reality remains that the LEED performance standards that are stipulated in city policy represent low certification levels and still do not apply to all buildings (new and existing), nor neighbourhoods (Box 4.10).

6.1.2 Causal Effects of city policy shifts

Shifts in city policy affect relationships with Federal funding from FEMA (Section 5.4). Initially, FEMA funding was released after Hurricane Sandy to rebuild and start prevention measures of flooding, which funded / enabled cities to start a change in both policy and practice (Rosenzweig and Solecki, 2014; Wagner, Chhetri and Sturm, 2014). This has resulted in hazard mapping with regards to flooding (NYC planning, 2019; FEMA, 2019; City of Boston, 2018) and this is creating issues in reality (Box 5.11). This interpretation of resilience has led to the 'Boston Waterfront' project and the launch of Climate Resilient Design Guidelines (Walsh, 2017a, 2019b; Boston Public Works Department, 2018b), the NYC with the Lower Manhattan Climate Project (NYCEDC, 2019) and CMAP in Chicago launching the 'On to 2050' (CMAP, 2018). However, the 100RC process in Boston has raised attention of the risk of social and racial inequality in flooding (Box 5.11), as has Chicago with extreme heat (Klinenberg, 1999a; Martin, 2015; Walsh, 2017b; Emanuel, 2019a).

The three cities recognise that habitual (and mnemonic) decision-making is responsible for un-sustainable development and a lack of resilience in hazard events (Section 5.5). However, climate change is perceived as the "root cause" of the threat of flooding and that climate change is associated with carbon dioxide emissions, but there is lack of association of climate change with how people behave in the built environment (Talen, 2003; Bordass and Leaman, 2013; Fainstein, 2018) (Sections 5.3.1, 5.3.3, 5.3.5). Despite some city policies outlining their indicators for sustainability and resilience (Box 5.9), the evaluation as to which interpretation is being used is problematic because it is happening in real time (Figures 4.4, 4.9, 4.13).

Section 5.4 provides a realistic perspective that there are differences between practice and policy. Practice considers that policy has historically focused on carbon and energy in the cities, but now finds itself at conflict with the spatial and financial scale of decision-making reflected in local political jurisdiction, tax revenue and institutional changes (political shifts) with how to cope with the forthcoming climate change predictions (mainly focused on flooding and emergency response and neglecting extreme temperature and other impacts) (Boxes: 5.2, 5.5, 5.10). Consequently, city planning, city design and scope of works are all out of sync too, with local laws trying to improve municipal codes of practice but lack of updated Federal legal frameworks is impeding processes to move forward as outlined by Boston's waterfront project (Boxes: 5.10, 5.14, Section 5.4). To reduce domestic conflicts with national environmental legislation (Box 5.2), and the requirement to conserve (what is now in need of restoration), points towards

an assessment and review of national law NEPA so that it can mobilise better sustainability and resilience practice.

However, as city energy policy targets tighten, the carbon policy starts to embolden public transport initiatives and shift to improving public spaces and infrastructures that have historically lacked maintenance investments such as bicycle networks and public transport (Sections 4.6.3, 4.7.3, 4.8.3). Setting carbon reduction targets and aggressive carbon reduction goals also misses the point that there needs to be a mechanism that allows adaptation to cope with future scenarios beyond current climate change and flooding predictions that are filtering into municipal codes for practice (Box, 5.11). This points towards city planning to support better decisions, but there is too much political jurisdiction to overcome and lack of temporal decisions being made; NYC response has been to bring in local laws to compensate but how effective this will be remains to be seen by practice.

Despite LEED promoting stakeholder engagement and the initiation of BEDRO, targets also means that people live and work in buildings that are not conducive to sustainable lifestyles and incentivise the developer to build and leave neither a resilient nor sustainable building (Box 5.1). Although city policy targets are helpful, the policy mechanisms to achieve good outcomes are not really thought out and more cost should be placed on developers instead of being passed on to tax revenues (Box 5.15, Section 5.4). In Chicago, the policies are trying to attract economic investment as their economy is shrinking, so the city policy is weakened, despite the Chicago Climate Change Act and political jurisdiction between neighbourhoods (Section 4.7.3).

LEED standards adopted by city policy are also under debate within design practice as more measurement systems such as Green Globe and Passivhaus are trying to stretch the agenda, but these alternatives are new to policy makers (Garde, 2009; Garde and Kim, 2017). Interpretations of LEED as policy targets are creating a conflict for practice (Box 5.5) (Section 2.3.5.3):

> "we see developers disproportionately making choices towards the easier, the more sustainable sites, the credits that don't require as much" (BOS04).

The political reality of the LEED certification is that it has led to energy ordinance, which has become an indicator for economic benefit for the policy makers, a mechanism for developers to satisfy planning, but not for tenants as it has little impact to their lives (Boxes 5.1, 5.15). Ultimately, solely satisfying energy ordinance targets does not represent sustainable development and leads to more national frameworks to measure targets (Bordass and Leaman, 2013; OECD, 2015). When national frameworks are generated through global platforms, they too are optional and debatable between organisations (Box 4.1, Sections 2.3.2, 2.3.5.2).

For some, the policy targets are perceived as antagonistic to both resilience and sustainability, which has motivated design practice to create the concept of passiv-survivability (Box 5.7, Sections 1.5, 2.1.2, 5.4). Passiv-survivability is optimising building performance towards NetZero emissions and promote buildings to be able to cope in emergency situations without power, i.e. natural ventilation, daylighting, stable indoor air temperatures and rainwater.

This is where the synergy between resilience and sustainability is at its greatest. LEED practice has merged resilience and scenario planning with its pilot RELi credits and created LEED Cities and Communities (Champagne and Aktas, 2016) (Section 2.3.5.2). However, these design principles of passiv-survivability in hazard scenarios are not mobilised by policy (or FEMA) nor are they a part of planning requirements.

As LEED practice progresses, emergency scenario data needs to be available and produced, but this is difficult to implement (Boxes 5.4, 5.5). FEMA was supporting this role by providing funding for flood defence and hazard scenario mapping, but its operation is currently restricted by President Trump (Baynes, 2019). Despite this political infringement of FEMA, it could play a more integral role because it works at a national scale and not a local one - but cities must find a way to finance the work required (Box 5.15). However, if the scenario information is funded by cities for cities (For Cities by Cities, 2019), then regional planning needs to be engaged and funded to do so too to provide more of a SES response (section 2.1.2) (Vaughan, 2018; Illinois Green, 2019; IUCN, 2020).

Decision-making reality remains on short term time scales and hazard scenario planning needs to become long term and not subjected to political jurisdiction or shifts (as discussed in more detail in (Section 5.4, Boxes 5.10, 5.11). To date, the consequences of short term thinking have resulted in buildings with no opening windows at a time of crisis (when opening windows would have saved lives for access and fresh air), building systems not being able to cope with increases in temperatures because of factors such as limitations to their design capacity and emergency generators in flooded

basements (Section 5.4.1). This situation reflects the fact that the planning process has not been wholly impartial to political bias or able to implement everyday sustainable building practice because it is not municipal policy (Bosher *et al.*, 2007; Rosenzweig and Solecki, 2014; Vale, 2014). Although LEED has been available since 1993, it is still marginalised and municipal policy has only just started to take its foundations more seriously in city strategies and LEED cities has been created (Bloomberg, 2007a; Burnett, 2007; Rosen, 2017; NYC Urban Green Council, 2018; Emanuel, 2019a)

The city policy must be strengthened as some developers do not consider building in flood zones to be a risk as municipal planning process and city development policies allows it (as described Section 5.4). City practice knowledge tells us that it is tax revenue that is driving the development, not the recovery cost (Section 5.4). City practice states that built environment assets produce finance through rental income and taxes (Sections 5.3.2,5.3.4, 5.3.6). Public services that relate to buildings can be taxed and there is the rental income of public buildings and public infrastructure but responses from practice, indicate the reality the financial investments are political (section 2.3.5.2). In Chicago, this is a real issue because the city has large public costs and the mayor's economic policies aim to encourage developers and businesses by controlling energy ordinance and taxing it (Section 5.3.3). New York has reached a point where financial benefits outweigh development being located within a flood zone and almost overcome the loss of economy from developments in flood areas (Section 5.3.1).

By recognising tax revenue as an issue, Boston's resilience plans consider protecting its built environment assets through flood defence and therefore city revenue. Practice is also finding a way through the tax and political jurisdiction by working at a community scale and engaging with people as demonstrated by the Mystic River Project (Section 5.4.3) and concentrating on domestic projects. However, despite these incentives, there are layers of complexity between social boundaries and decision making that city zoning laws do not reflect. To promote the Climate Ready Vision, Boston has started to create neighbourhood plans and integrate them into the planning process, so they are overriding federal laws (Walsh, 2016).

6.1.3 City policy influences on national policy

There is a clear indication that the temporality and habitual approach of decision-making needs a review (Box 5.10). To enable better practice and policy long term, cities need to create laws that surpass political shifts and invest in institutions that can advise on how to promote sustainability and resilience (section 2.3.5.1, 2.3.5.2). Through the formation of C40 and 100RC, city governance has started to mobilise municipal policy shifts and utilise the mayor's power. However, there is a role for national organisations such as FEMA, as well as national laws such as NEPA to provide mutual policy support but this is difficult is Federal changes oppose the concepts of resilience and sustainability as is the current political situation with President Trump (Baynes, 2019). NEPA could be revised to support hazard mitigation and adaptation beyond its last review of 1993, which would result in FEMA being be less subjected to political shifts. This could provide an opportunity for policy influences on medium to long term planning as part of its

emergency response, rather than coping or responding to flooding (storm event) emergencies and local political shifts (Boxes 5.10, 5.13) . Scenario planning for flooding can consider ecosystem adaptation and restoration as part of the approach to urban land use planning and explore social vulnerability and exposure to risks. Currently, flooding policy is leading to engineering preventative measures like flood barriers and dealing with aging infrastructure rather than employing more sustainable development principles. The Mystic River project in Boston shows the promise of a different approach with community voice and restoration (to support prevention of flooding) (EPA, 2019). Currently, city zoning laws do not consider social components of land use because of the historical use of SZEA (Section 4.2.2). SZEA represents a real challenge for resilience and sustainability because of its habitual applications (Box 5.2). It needs to be revised to consider social and environmental factors between neighbourhoods and communities (Section 4.1, 6.2 and 6.2.5).

Given that the habitual use of national laws may hinder better decision making, cities can act to remove this tie to national law and develop municipal regulations that promote sustainability and resilience in practice. NYC has initiated revising its city charter to make better decisions and adopts creating local laws (Section 4.6.3). Mayors hold authority over the city governance systems and can override Federal policies and, if necessary, pay for the ‘work’ that needs to be achieved utilising city finances. People and communities have a desire to do something about the current situation where it appears there is a lack of ‘decision’ due to political jurisdiction (Box 5.11).

From assessing city policy (Chapter 4 and 5), it would appear that sustainability and resilience have historically not been employed as umbrella concepts but to suit political messages, which supports the position that there are still conflicts in decision-making that need to be addressed (Chmutina *et al.*, 2014; Perelman, 2017). Cities are facing emergency situations more regularly because climate change is happening now, which puts them on the spectrum as vulnerable and in need of transformation.

6.1.4 Habitual planning policy effects planning practice

Transforming cities requires changing the habitual approaches to decision-making for existing buildings and infrastructure where there remains a focus on new development (Section 5.4, Box 5.5). Vale (2014) outlines that political positions shift planning guidance towards a conflict between restorative or preventative measures. As illustrated with the Boston waterfront project and NYC's Lower Manhattan Climate Resilience project, these preventative measures (Boston Public Works Department, 2018b; NYCEDC, 2019) still do not reach the minimal standard of sustainable development in their large development planning policy (BPDA, 2018; NYC Planning, 2019). Either way, both measures need time to be implemented and decisions should not be made on the short term basis (Section 5.4, Box 5.10).

Examining the role of land use is important when considering preparedness for emergencies, attempting to resolve the conflict between preventive and restorative measures and promoting sustainable hazard mitigation (Mileti, 1999; Chmutina *et al.*, 2014; Vale, 2014; Torabi, Dedekorkut-Howes and Howes, 2018; Arneth *et al.*, 2019). Part of the reaction to Brundtland (1987)

was the coined phrase ‘to tread the earth lightly’ but urban development has not - as, for example, surface water runoff is creating problems with existing infrastructure systems leading to the NYC stormwater project (Suarez *et al.*, 2005; Bloomberg, 2007a). Retzlaff (2008) acknowledges that LEED is a supporting tool for urban planners, but credits for planning are not stipulated by policy, and LEED policy is directed towards building standards not city planning (Section 5.4). Nevertheless, local governance recognises that some LEED credits support urban planning which has influenced the city’s infrastructure with regards to ‘location and transportation’ credits (USGBC, 2016b, 2017). It could also be implied that the LEED Cities and communities has been launched to tackle some of the perpetual issues that are the result of habitual decision-making at city planning levels (USGBC, 2019).

Casual patterns have emerged that point towards historic laws and habitual practice (Figure 4.1) which has led to social disparities (Talen, Wheeler and Anselin, 2018). Since the establishment of SZEA (Section 4.2.2), each city has experienced decades of repetitive practice where there have been long periods of time without any changes to municipal planning codes or zoning plans other than more development. For NYC, habitual practice of city zoning has existed for fifty years (between 1961-2011), which has seen the city become one of the wealthiest cities but with the most carbon emissions in the world (Moran, 2018; Everett-Allen *et al.*, 2019). NYC zoning plan was enacted in 1916, which was followed by its City Charter in 1936 (NYC Planning, 2019). In 1961, the city’s zoning was revised but not revisited until 2011 (NYC Planning, 2019). The 2011 Zoning plan was aligned with sustainability and set out an ‘Action plan’ for NYC planning department to be

reviewed annually (de Blasio and Lago, 2019). Consequently, since 'One NYC' and Hurricane Sandy, there has been a further revision in 2018. From reviewing the recent city documentation, there is little reference to NYC regional planning authorities; the city seems to have divorced from its regional planning entity.

Whilst planning is associated with land use requirements, it also has a complex relationship with people and urban spaces, which can also represent a political voice for decision making (Alexander, 1977). In the US, city planning is a legal process that stipulates certain requirements, including a level of political discussion and compliance with zoning codes. The process results in a "permit to build" (Figure 4.5). Departments of Planning (or equivalent) exist as part of the institution of city governance (Sections 4.6.4, 4.7.4, 4.8.4). City planning and regional planning are perceived as separate institutional issues both in Chicago with CMAP and in Boston with Massachusetts Regional Board, but NYC has a limited relationship. However, in Chicago it is CMAP with the resilience and sustainability understanding (Section 4.6.4), but Boston finds it constraining as there is limited understanding of place (Section 4.7.4) and NYC is its own island (Figure 4.2). These conflicts between state and city point towards the idea that indicators of place may support better decision-making as recognised by the DROP model and disparity of country practice (Cutter *et al.*, 2008; Cutter, 2016).

Alexander (1977) suggests that city governance should be decentralised to give communities power to make decisions about their built environment, which would change how decisions are made about urban space. LEED ND is the latest framework for communities to build in sustainability (Smith, 2015)

but there is criticism that the scale of its approach is spatially limited (Knack, 2010). Reading between the boundary lines of LEED, this indicates that sustainability must be applied more broadly to influence communities and lifestyles, and stakeholder engagement is a starting point (Section 2.1).

> *"Decentralize city governance in a way that gives local control to communities of 5000 to 10000 persons. As nearly as possible, use natural geographic and historical boundaries to mark these communities. Give each community the power to initiate, decide and execute the affairs that concern it closely: land use, housing, maintenance, streets, parks, police schooling, welfare, neighbourhood services"* (Alexander, 1977, p. 73).

Considering how people interact socially and relate to their local environment is important to both agendas and what is outlined by current planning practice in all three cities is at a juxtaposition with Alexander's patterns of urban planning, as social voices are only just starting to be considered in city charters (Box 5.11) (The City of New York, 2019a).

This means that since SZEA's enactment most city plans do not involve consultation with people which reduces ownership and responsibility of decision-making. Although Chicago and Boston were chartered cities before SZEA's enactment. Chicago created its city grid master plan in 1830, which was revised in 1909 with the Burnham Plan. Chicago's Municipal planning code was created in 1881 but became under direct local governance in 1939 before a planning department was created in 1959. A 'comprehensive plan' was launched in 1966, revised in 1973, then in 2001 'Chicago Metropolis 2020' was launched before the 2011 Transition plan. These changes have occurred with mayoral shifts, especially between Mayor Daley and Mayor

Emanuel. Chicago has a regional planning authority – CMAP – but this relates to the scale of Illinois State rather than city planning of Chicago. Boston has been a city since 1630, its city planning has been managed by BRA and BPDA from 1957 and it originates from movement of people between areas of Boston.

Since the policy shift in 2008 (Section 6.1.1), each city is currently revising its planning practice to consider hazards, such as flooding and climate change but to what extent cannot be fully examined (Section 7.4). NYC governance is creating local laws to set new targets and it has revisited its zoning compliance (Section 4.6.3). City policies have refocused approaches with exemplary projects such as the Boston Waterfront project and the Lower Manhattan Climate Resilience Project and by producing climate resilience 'design' and zoning guidelines. Chicago has yet to progress its future planning legacy (Chicago Public Library, 2019; City of Chicago, 2019) but has retained its relationship with LEED by piloting LEED Cities and achieving Platinum status (USGBC, 2018). Despite the APA, there is no national planning authority, so there is a reliance on practice to generate their policies with support of the APA. Given this hiatus in planning policy, it is difficult to consider sustainability and resilience, apart from that both have been neglected until the city policy shift created targets. In a way, for example, it is no wonder there are issues with surface water run off creating flooding events (Suarez *et al.*, 2005).

Each case study city has a City Planning Department that sets out the zoning laws and compliance requirements. Development can only occur if 'permits to build' are granted; a permit can only be achieved through compliance with

the stipulated planning process. The planning process is a gateway to managing the local environment, which was established by NEPA in 1971 and should be viewed as an opportunity to prescribe requirements. Each city operates a planning process, but contains differences in the conditions of granting a permit and decisions are made by committee, which means decisions are subject to interpretation (Department of Buildings, 2012; Walsh and Golden, 2014; NYC Planning, 2019).

NYC 2011 recognises an Environmental Review in its permitting process (Figure 4.5), but this process only applies to projects of a certain size, which are the 'large projects', not the small or domestic scale ones. There are also no specific sustainability or resilience requirements as part of the environmental review. Boston enacted article 80 in 1996 and article 37 in 2007, however this process again only applies to projects of a certain size – the large projects and not small or domestic scale ones (Section 4.8.4). Article 37 recognises LEED silver certification and recently there is the Boston new development checklist for resilience, but again this does not apply to all buildings or sites (Box 4.9) (BPDA, 2017b, 2017a).

Chicago's planning requirements are in a state of revision and the existing process does not stipulate either environmental, sustainability or resilience requirements but the Green permitting process outlines LEED requirements (Department of Buildings, 2012). If the city is not stipulating EIA requirements, but is compliant with LEED standards, then it must be presumed that EPA protocol is being complied with and that city practice follows professional codes of conduct. What this indicates is that compliance with NEPA has become habituative by the planning process accepting

standard approaches by practice, which can increase ambiguity around best and worst practice. The habitual practice of city planning has given rise to city practitioners having to mobilise knowledge and LEED (Box 5.3).

Fundamentally, there is a question “how did it get to this point?”, the point at which it has become acceptable for buildings to flood and where existing infrastructure and buildings cannot cope with increasing shocks and stresses that are being imposed on them (Box 5.4)? The city planning process is a custodian of decision-making, and yet the building permitting process does not ask long term questions (Section 5.4). Over time, the process and lack of planning constraints has facilitated trends in architectural practice, which in Boston has been to use an excess of glass in buildings for example. Using high proportions of glass (non-intelligent glass with high U-values) as a facade material drives up energy consumption due to the air conditioning or mechanical systems to keep these spaces comfortable (Section 5.2). With the focus of energy consumption and GHG emissions drawing attention to the planning process and the departments themselves, city practice knowledge indicate that it is a matter of staffing issues in the departments and the political shifts (Section 5.4).

Then the codes in the planning process for permitting are also locked into the political shifts between the State codes and city practice (Boxes 5.8, 5.9). What is evident is that hazard management and climate change projections are creating social voice to react between neighbourhoods, as well as requiring the technicalities to be translated into the city zoning codes and municipal planning tools (NYCPlanning, 2019). Boston has started to accept that it is reasonable to allow certain areas and even buildings to flood up to

the first storey, but where does this leave the issue of land use and building ownership legally? Is this responsible governance?

Add these issues to the decision-making factors of tax, emergency planning and the many issues identified by the 100 RC program, and the planning process clearly has a lot to contend with; there are few tools available that can realistically help other than hazard mapping (Table 5.2). Thus, the municipalities need to start planning for sustainable outcomes that consider sustainable urban drainage, rainwater and storm water management. Perhaps there need to be more resources to look at infrastructure because planning trends have become socially biased towards communities and forgetting the 'space', i.e. functionality of ecosystems and urban impacts on the ecosystem. Can environmental and zoning laws also be mutually updated so that arbitration on NEPA between decision makers can be reduced? Can State and city planning relationships improve to consider spatial impacts and ecosystems thinking? And yield a more specific response to sense of place that is not influenced by political jurisdiction (Box 5.11)? (Cutter *et al.*, 2008; Cutter, Ash and Emrich, 2014; Cutter, 2016). Codes are trying to change, improve and incorporate sustainability as well as resilience measures, but flooding is a tangible starting point (Section 5.4, Boxes 4.11, 5.4, 5.11).

By considering the planning process as part of the decision-making trajectory and more broadly, there seems to have been bias towards economic development rather than community representation and local environments. To compensate for SZEA, zoning needs social engagement not political jurisdiction and the city planning processes need to engage across political boundaries to enable the Ecosystems based Adaptation approach

(Slocombe, 1998; Meerow and Newell, 2019a). City zoning needs to refocus on the environmental legacy, regardless of the project's size or political location. City Environmental reviews should be recognised and include sustainability and resilience requirements, that include LEED- RELi. LEED should be mandated as Gold standard or greater for all scale projects and provide better guidance for domestic scale refurbishments and dwellings (Box 5.7). Above all, the EPA has not been revised since 1993. How can practice and policy improve with federal legislation that mandates based on environmental conditions that have changed?

Even if the city's municipal planning codes were aligned with industry policy and practice; all three cities have an issue with political jurisdiction of decision-making and the socioeconomic demographics created by tax revenue income of built assets (Walsh, 2017b; Emanuel, 2019b). This starts to create Real Realpolitik for the politicians, as seen in Chicago with the new mayor (Sections 2.1, 4.7.1) and potentially steer the narrative away from the domestic Environmental Realpolitik (Section 2.3).

6.1.5 Habitual policy effects on design practice

This research has not specifically targeted best design practice of how to design a resilient and sustainable urban environment because the knowledge and expertise exist (Box 5.7) (Meadows *et al.*, 1972; Dowson *et al.*, 2012; Sullivan, 2012). Habitual decision-making has led to each city having a significant carbon footprint due to its infrastructure and historical buildings, which has been recognised by city policy measuring carbon emissions (Section 5.4, Boxes 5.16, 5.17, 5.18) (de Blasio, 2014; Walsh *et al.*, 2014;

Emanuel, 2015a). Currently ranked 3rd and 8th in the cities for the greatest carbon footprints are NYC and Chicago, Boston is 55th (CDP, 2017) and the USA remains in the top ten counties for carbon emissions (OECD, 2019). All three cities' populations are likely to grow, with NYC predicted to reach a megacity status (World Economic Forum, 2019). The three cities face risks posed by climate change such as sea level rise, coastal erosion, extremes in weather and aging built environment and infrastructure (Box 4.11) (Bocchini *et al.*, 2014; C40 Cities and Arup, 2016; Yin *et al.*, 2017; C40 Cities, 2018b).

Designers manage risks, create sense of place and provide urban habitats for people to live, work and play as well as; they are trying to make cities more resilient and sustainable (Newman *et al.*, 2013; NYC Urban Green Council, 2018). At the same time, it is recognised by city design practice that scope of works, municipal codes of practice and habitual decision-making at municipal planning departments create the most conflicts with implementation of sustainability and resilience (as discussed in Section 5.4). The municipal codes are simply so far out of touch that specific conflicts can not be pinpointed, and departmental teams are under resourced to revise them. From tracking the municipal design codes chronologically in each city, frequent changes towards sustainability and resilience have been lacking in the municipal codes and city strategies (Figure 4.1). Decision-making loopholes have been created when there is a difference between municipal codes with minimum design standards and design codes that stipulate more optimal performance (Figure 4.1, Section 4.6.5, 4.7.5, 4.8.5). These differences in decision-making create frustrations with best design practice in the UBE (Section 5.4) (Chmutina *et al.*, 2016).

As a project goes through the planning process, it has to achieve compliance with all jurisdictions from Federal, State and municipal and their professional codes of conduct (Department of Buildings, 2012; Walsh and Golden, 2014; NYC Planning, 2019). The planning process meets practice because this is where decisions are agreed and consequently the design requirements met. In the US, planning and zoning requirements in cities have suffered from little change (Section 6.2.2) apart from the introduction of LEED as policy (Section 6.2.1). This has led to best practice being perceived as costly or out of scope because it is not stipulated by the planning requirements (Section 5.4) and regarded as 'optional'. To create real transformation, policy needs to stipulate more stringent practice and promote a wider scope of works that allows systems thinking and cross-political jurisdiction (Section 5.3.4). These issues are particularly prevalent when considering watershed management (Section 5.4).

In terms of GHG targets, each city has entered a transition phase and is using practice to inform policy (Section 6.2.1). In NYC, governance has adopted a relationship with the NYC UGC to inform policy and change zoning requirements. Yet there is also evidence that design practice has led policy and informed its policy shift of 2008 onwards. NYC UGC has had its practice adopted by policy in the form of the NYC Roadmap 80x50 and now the blueprint for efficiency (NYC Urban Green Council, 2018; NYCPlanning, 2019). Practice has started to focus on the efficiency of large buildings, a roadmap towards electric power for multifamily buildings, advancing the 80x50 roadmap towards the target of 90x50, building resiliency, and are now informing city policy decisions (Urban Green Council, 2019). However, what

has also occurred is that NYC UGC is producing the city's policy strategies and it is combining sustainability and resilience, and laws are being created to ensure energy conservation to compensate for the shortfall of minimum design standards.

Currently, the USGBC advocates Chicago as the city with the most LEED rated buildings. Realistically, the statistic equates to 172 LEED certified buildings and piloted the LEED Cities Rating system and is now a rated as a LEED Platinum city (USGBC, 2018; USGBC, 2019). Despite this accolade, 172 buildings in a city the size of Chicago does not much of an achievement. However, Boston has raised its LEED performance targets with the E+Green Buildings program.

Literature analysis outlined the line of enquiry to consider how LEED was mobilised in policy. This analysis has found that all cities recognise LEED (or Energy) performance in their policies (The City of New York, 2016b; BPDA, 2017a; City of Chicago, 2017) and policy focuses on energy issues such as 'energy ordinance', submetering, and alternative energy, which are all listed as EA credits (USGBC, 2017). From 1990s to 2008, the USGBC, the LEED system, and international design practice were pushing performance standards because city design and planning codes were out of date. Despite this evidence of LEED systems being operationalised in city policy, it is still marginalised for low performance standards as in article 37 (BPDA, 2017a).

In the US, LEED is the sustainability language for the built environment and recently has been adopted to inform city policy (Illinois Green Alliance, 2016; BPDA, 2017a; NYC Urban Green Council, 2019). This is a reason for

frustration with sustainability in design and planning practice, let alone resilience because LEED has also become habitual in decision-making design practice and starts to optimise energy efficiencies without building in capacity to cope with climatic changes (Section 5.4). Meanwhile, each city has recognised its shocks and stresses in their respective 100RC reports but how does city design practice make decisions based on city policy if there are no municipal codes that reflect what is required? Design practice must relate to international codes of practice and LEED instead (Box 2.6).

Whilst advocated LEED practice is good, it still needs to be scrutinised. Recently the LEED framework has become adopted by policy, which positions the USGBC as a policy actor and could potentially compromise their position. This has led to friction within the design practice community because practice wants to be working towards NetZero and passiv-survivability not minimal LEED practice (Section 5.4). Some design practice groups have stretched into resilience with the RELi framework, albeit where the focus is on energy reduction for passive design and emergency planning rather than on a resilience definition that encompasses the ecosystem scale. Then resilience ideals joined the LEED system through the piloting of LEED-RELi credits (Champagne and Aktas, 2016).

What the case studies collectively indicate is that design practice is leading city policy and that each city has started to revise its municipal design codes (partly because they need to include the most up to date information on climate change predictions and changes in water levels). In all cities, municipal planning and design codes are going through a transition and there are difficulties in measuring what is happening. City policy is trying to supply

more up to date information on sea level rises and climatic changes and this has also led to the 'Climate Resilience Guidelines' being produced (Walsh, 2016; BPDA, 2017a). However, this does not resolve the issue that the municipal design codes must set the future risk scenarios, so that designers can design to these levels of requirements. LEED might promote practice concerning shocks and stresses, but the practicalities of delivering this remains with design practice professionals and the design process.

Design practice knows that there is a lack of foresight in the planning process, a lack of hazard scenario planning, and that there is too much of a policy focus on energy reduction (Boxes 5.16, 5.17, 5.18, Section 5.4). There is a lack of motivation to revise municipal codes because it is lobbied against as being expensive, but the increase in frequency of hazard events is triggering the need to review them as now seen in NYC, Chicago and Boston.

The emergency scenario focus has highlighted that buildings are being processed through planning that do not consider operating without power or with natural ventilation. Design teams should not be allowing this either. As the effects of climate change escalate, the changing conditions are not yet being managed by codes of practice: which still stipulate historical worst case scenarios such as a one in a 100 year storm. What may be considered worst case scenarios now and in the future appear to be increasing in ferocity, which makes the codes at a juxtaposition with their future scenarios.

This has a compounding conflict effect as practice starts to adopt rebuilding or preparation for future hazard events, the city planning department outlines

improved infrastructure plans, but this then places it at juxtaposition with its existing infrastructure and buildings. The existing building stock capacity to cope with flooding events is to let them flood as a coping strategy, but over time this knowledge is forgotten and building occupants reduce this capacity to cope by changing the conditions (i.e. occupation of basements and removal of walls, moving building air conditioning units). Is this just bad design and bad scope of works?

Design practice needs further guidance to manage the temporal risks of climate change projections, heat predictions, shifts in rainfall. This data exists but has yet to trans-descend into codes of practice. New York has mobilised a Climate Change Panel into its decision making process, but not everyone wants to adapt. To add to the temporary ownership of built assets, the financial structures do not support this type of decision making because building retrofitting is seen as expensive for short term leasing (Section 4.7.6). To shift the understanding, social engagement and ownership of building behaviour is encouraged. Better known future scenario data is required to inform better long term decision making and municipal information more prevalent in design practice, so that buildings mutually support community cohesion and passive survivability.

As noted in Section 5.4, development projects are not being evaluated for sustainable outcomes and that communication between the scales of decision-making is not frequent. This highlights that the sense of place is important and that municipality codes need to shift towards the city managing local issues and the state managing environmental context issues, but both must communicate to create the best outcome at both city and state scale.

When considering environmental context of the scale of an ecosystem or river drainage basin, the best outcomes may need discussions at inter-state scale (Cutter, Ash and Emrich, 2014)

Practitioners are aware of the gaps that need addressing and, if they are considered, then better decisions can get made. Whilst policies and governance prescribe what should happen, practitioners remain disengaged where design codes exist due to external decision makers not having local context knowledge; without city governance taking ownership of the municipal design code (with regional context). Design practice is in constant tension because there is a bias towards delivering cost efficient buildings that are efficient, use complex interdependent systems (such as smart technology) and are not designed with long term building occupancy in mind (Bordass and Leaman, 1997; Clements-Croome, 1997).

However, coping with incremental shifts in temperatures or extreme days means building service systems need capacity built into them to cope and the adoption of passive design principles (Phillips *et al.*, 2017). This is the design practice conundrum because over the years, it has been cost efficient construction (through design and build contracts) to adopt shared building service systems and civil infrastructure (power, water, telecoms) along transit routes and then suddenly in hazard scenario events it all fails (Section 5.4). The question of long term building service systems and services infrastructure becomes salient for the scope of works; but how can a scope of works manage failure and interdependencies as it is more financially beneficial to be efficient and merge systems? This is where scenario

planning starts to come into play and systems like the LEED-RELi credits can help.

However, what affects all practice is the tendered scope of works; project teams are prescribed to tender to a scope of works and not often given the opportunity to redefine it. Built environment development is affected by clients and how they package work for design teams. There is the planning process to obtain a permit to build. However, the way people operate in this process is questionable; design teams want more of a role to play and even within the design team there are roles that may have a better understanding of how to profile risks and scenario planning. However, no one can be mobilised to consider work at a 'systems' level, i.e. watershed or ecosystem unless it is in the scope of works. Then another critical issue is how to scope work that considers future unknown needs?

Scopes are predetermined by regulation (public works), codes of practice (legal and professional) or by clients (private), but also the city decides what projects are viable development options, and it passes on the risks to the design teams without a two way conversation. Good practice and best practice may be side-lined for the option perceived as being lowest cost, and what gets delivered may be in constant conflict with the scope of works. This approach (albeit arguably necessary to safeguard costs and legal positions) restricts how planners, designers (or 'city practice') can resolve some issues concerning resilience and sustainability. State-wide codes are restrictive and less affected by city practice, which has led to shifts in local policy and hence legal challenges. In some instances, city practice is usurping regulation, which highlights that regulations or scope of works need to be reviewed and

revised to reflect the requirements of their climate change projections. Working with out of date information leads to poor practice and a vicious cycle of creating built environment assets that have limited adaptability. Another part of the scope of works jigsaw is the role of regulation and policy. If regulation starts to consider future scenarios then potentially conflicts can be reduced. If the scope of works can be correctly defined then exciting improvements can be made, but financial regulation needs to match the shift. Clients may not want to deal with the financial commitments that come with long term ownership and maintenance costs (these are currently optional LEED credits) (USGBC, 2017).

Then, finally, the scope of works needs to manage collaboration between disciplines and project team proponents; the design teams have developed standardised responses to design problems and biases may exist. If these components of the scope of works align, are there still remaining issues between what is resilient and sustainable design? Every member of a project team has a difference of opinion on these terms and codes of practice can inform it, but institutional knowledge can be used to educate and debate.

Practice can work through these obstacles by prescribing certain components of scope of works such as scenario planning to include short term and long term projections, as well as what to do in an emergency and cost benefit analysis for each of these phases. If it is included in a scope of works action can be taken and habitual responses to problems can be reduced.

Sustainability and resilience in policy is being measured by LEED. However, practice wants to go further towards NetZero and passiv-survivability to manage emergency scenarios, yet LEED Gold or LEED-RELi practice is not mandatory for all buildings accordingly to municipal policy. Providing information such as future flood mapping and climate change predictions takes time to produce and to filter into municipal codes of practice. NYC has started this through its NPCC, but not every city has both the finance and resources to support this change in municipal practice.

Historically, urban environments have had the ability to cope with hazard events, but today these cities report regular urban flooding, storms, and weather changes because sustainable development policies have not been implemented enough or reinforced (Linnean Solutions, 2013; Rosenzweig and Solecki, 2014; 100 Resilient Cities and Walsh, 2017; Chicago, 2019 a).

6.1.6 Galvanising interpretations of resilience and sustainability in cities

Chmutina *et al.* (2016) describe the political restrictions to employing resilience and sustainability as umbrella concepts; the city context confirms that policy is going through a transition and policy has started to merge resilience and sustainability (Section 6.1.1). Section 5.4 identified that habitual decision-making still does exist in the policy system and supports that historically sustainability and resilience principles have been manipulated to suit political messages rather than support Brundtland (1987) and the Rio Declaration Act (Box 4.1). In order to reduce the political bias, measurement

indicators and their evaluation support making the necessary changes in the system (Box 1.1) (Suárez *et al.*, 2016; van de Ven *et al.*, 2016).

City practice currently indicates a wide range of responses on understanding resilience (Boxes 5.7, 5.8, 5.9, Section 5.1). There is recognition of the importance of social voice in reducing vulnerabilities as part of city resilience strategies. City practice recognizes that there are no suitable tools available to assist with decision-making and have mostly developed their own (Table 5.1, Section 5.2). It appears that this is early stages of implementing policy and feedback has yet to be formalised (Box 2.2, Section 2.1).

The US city practice acknowledges Brundtland's interpretation of sustainability (Sections 2.1.1, 5.1) and LEED as the most recognised sustainable development platform (Table 5.1). LEED has evolved into thinking about cities and communities and resilience (Section 2.3.5). The implementation of LEED in Chicago has created a policy framework and planning processes (Section 5.3.4). If the knowledge of LEED has crossed societal-governance boundaries and incorporated resilience with LEED-RELi, why not use it more? Garde (2009) has already identified limitations with LEED ND in the decision-making process, can LEED-RELi overcome these barriers?

There is a practice debate about LEED and how it has become adopted by policy because it is not mandatory for all buildings or applied to infrastructure and this provides opportunity for loopholes in decision-making (Section 5.4). Garde (2009) reports that in the pilot LEED-ND scheme that there were few points awarded for LEED-certified Buildings. Smith (2015) outlines that USA

City practice still needs to progress with LEED, in particular LEED ND because it unifies policy makers, urban planners and designers but LEED ND is underrepresented in policy. This suggests that LEED and LEED-ND are under- utilised (Garde, 2009; Smith, 2015).

LEED should become mandatory policy for all buildings (new and existing) and filter it through the whole decision-making process. However, adopting Passivhaus standards, passive-survivability would be welcomed by practice and support NetZero Frameworks (UK Green Building Council, 2019; Wilson, 2006; Wilson, 2018). The design and operational outcome of building performance is debatable as level of certification prescribed in policy is not platinum or gold standard but the minimum standard of certified or silver (Box 5.2). Passivhaus design standards can push sustainable design practice further towards achieving NetZero performance and promote natural ventilation, and passive heating and cooling, which are better in emergency scenarios (Section 5.4) - but this is not yet the city policy (Garde and Kim, 2017). Therefore, all these frameworks need to consider better sustainable development practice and evaluate their environmental context (Sections 2.3.1, 2.3.4), as well as taking into account the temporal shifts of constantly changing environmental conditions. Policy and practice need to find a way of getting ahead of predictions and not allowing responses to become standardised. Can policy make this step into radical changes and use the foundations of Realpolitik to bring policy and practice together to address critical issues?

Fundamentally, the laws NEPA and SZEA represent environmental failures, although NEPA's enactment was progressive towards better environmental

practice. The case studies show that codes of practice are out of date in each city and design practice is frustrated with lack of progressive policy with reference to the identification of LEED being used as a carbon emissions tool. A reliance on LEED restricts practice and existing codes of practice restrict better ‘passive energy’ practice. However, LEED practice yet to filter fully into the design of public realm and perhaps has not reached its full potential in planning processes (Retzlaff, 2008). Despite the conflicts between how policy and practice use LEED, their adoption of LEED as a standardised practice develops a minimum performance and provides structure to deliver a better built environment.

Policy shifts in working towards resilience being employed as an umbrella concept has been mobilised by the 100 RC framework and World bank Indicators, but these are currently targeting policy and policy needs to trans-descend its decisions into city practice (World Bank Group, 2017; 100 Resilient Cities, 2018). When resilience as a concept is implemented, it supports those who are vulnerable from hazards and increasing stresses of climate change (Mileti, 1999; Wisner *et al.*, 2003). Yet, what is rarely said in theory or practice is that building occupants and owners are responsible for their carbon footprint (both operational and embodied) which leads to cumulative poor knowledge transfer and policy implementation of sustainable development (Cutter *et al.*, 2008; Bordass and Leaman, 2013; Bahadur and Tanner, 2014; Bahadur, Tanner and Pichon, 2016). Social engagement must happen to find ways to cope with the increasing risks and implementation of sustainable- resilient development.

Chmutina *et al.*(2016) unpacked the resilience policy discourse and identified that there is a disconnect between the interpretations of resilience at different societal and governance decision-making levels: "*local communities' resilience is about mobilisation, whereas local authorities' resilience overall is about preparedness and response*" (Chmutina *et al.*, 2016, p. 78). Cities have started to recognise this: NYC, Chicago and Boston all show an element of community stakeholder engagement in their resilience policies (100 Resilient Cities and Walsh, 2017; Chicago, 2019b; NYC Office of Recovery and Resilience, 2019).

As cities have started to adopt the version of resilience established by the 100RC framework (Box 4.1, Section 5.3), what is recognised at city level decision-making is different from the global policy makers because the UN GA and UNDRR have different interpretations about meaning of resilience and sustainability (Section 2.3). There are also differences between what is being measured and the theoretical position (Box 2.6, Sections 2.2.3 and 2.2.4). If resilience continues to have many meanings (Reghezza-Zitt *et al.*, 2012; Alexander, 2013; Levine, 2014; Meerow, Newell and Stults, 2016) and the discursive debate of definitions continues (Kim and Lim, 2016; Meerow and Stults, 2016; Roostaie, Nawari and Kibert, 2019), how can decisions improve concerning resilience in the built environment? There needs to be feedback from policies and practice to make better policy. This has started to occur in NYC as OneNYC has gone through several iterations and is tracking its performance using indicators (Table 6.2) (de Blasio, 2018c)

Regardless of the issue that there are many meanings of resilience, sustainable development policy implementation is not mandatory or law in

many countries and is still marginalised in city practice (Section 5.3). The rise of resilience in popular discourse has been necessary as human-induced threats and natural hazard occur more frequently and the effects of climate change increase, but the missing link is in implementing laws at planning stages of the urban environment to mitigate these effects (Section 6.2). The case studies are only representative of three US cities, but an interpretation of resilience has led to a focus on emergency of sea level rise, flooding and hazard management (Sections 5.3). The planning regulations and design codes do not reflect this status, nor does environmental regulation, although there is recent acknowledgement of a shift in practice (Section 6.2). City policies have accelerated their decision making process (Figures 4.4, 4.8, 4.11 and 4.12) and generated multiple versions of city strategies before finding a version that tracks indicators (Section 4.6.3). Governance of US cities have made legislative changes towards carbon emissions and enacted the NACC (2018) to ratify the Paris Agreement. The reality is that cities are starting to become more responsible for their decisions by using their political power but their voice needs to be acknowledged by global governance (Bahadur and Tanner, 2014b, 2014a).

City resilience and sustainability policy represents the tangible components of both concepts through the emphasis on carbon and energy policy and risk reduction (Section 5.4). However, as local governance shifts, the discursive interpretations of meaning and measurement shift too, which cumulatively create barriers for better decision making as identified in Box 4.1 and Table 6.1 (Schwieterman and Caspall, 2006; Smith and Stirling, 2010; Chmutina, Lizarralde, *et al.*, 2014; Smith, 2015; Chmutina *et al.*, 2016).

By assessing city context, a response to how resilience and sustainability have been interpreted in practice has been established (Boxes 5.7, 5.8). What has been recognised is that cities have a fragmented response or alternatively that individual responses have been outlined in their city strategies (Section 6.2.1). The latter suggests that sense of place and social voice have been a part of practice, and policy changes because a customised response has been generated, so discrepancies remain on what is being measured in the long term and how decisions are made (Section 5.4). What has been consistently recognised is that LEED has been adopted as a sustainability policy framework and resilience has led to scenario planning as cities prepare for emergency (Achour *et al.*, 2015). Sustainability and resilience have not been employed as umbrella concepts but more to suit political messages, which supports the position that there are still conflicts in decision-making that need to be addressed (Chmutina *et al.*, 2014; Perelman, 2017).

Due to decades of habitual decision making in cities, environmental laws need to be revised to accommodate sustainable development and resilience in practice, and to manage uncertainty (Dovers, Norton and Handmer (1996) (Section 2.1.1). Even with the UK's new net zero emissions target for 2050, Sir Ian Boyd (DEFRA chief UK scientist) says in his exit interview,

> *"that persuasive political leadership was needed to carry the public through the challenge." (BBC News, 2019).*

Scientific organisations like the RMI [15] also have answers on how to reduce emissions at a multitude of scales and C40 want action and working towards a common goal (C40 Cities and Arup, 2016). To succeed, the actors and influences must galvanise the political, social and environmental discourse in theory, policy and practice to reduce the deadlock of knowledge transfer to make better decisions (Mileti, 1999; Gibbons *et al.*, 2006).

The foundations of Realpolitik emphasise the importance of ideas and idealism as "*forces of change and transformation*" (Bew, 2016, p. 302) which has similarities with sustainability and resilience (Section 2.2) and as the interpretations and measurement systems can be unified between theory, policy and practice then there is a clear foundation to move forward. However, what can cities do if they generate their own rules, policies and practice?

6.2 Decision-making junctures in cities

Meadows (2008, p. 177) describes that systems thinking needs to "*make feedback policies for feedback systems*" and outlines that feedback, is encouraged to locate responsibility in the system but warns that,

> *"sometimes blaming or trying to control the outside influence blinds one to the easier task of increasing responsibility within the system"* (Meadows, 2008, p. 179).

[15] Rocky Mountain Institute in Colorado, established by Amery Lovins, provides a technically conscious voice on sustainability-resilience issues.

City practice recognises that decision-making feedback into the system is compromised by political shifts and habitual processes of city zoning, municipal planning and municipal design codes of practice (Sections 5.3, 5.4). Understanding decision-making is complex (Section 2.3) and the evidence created through this research is limited to the stakeholders (Table 3.6).

Figure 4.1 outlines critical events in the sustainability and resilience of the case study cities decision-making pathway with global policy and recognised on this timeline are periods of stability and rapid action. Capoccia (2015) describes these fluctuations between stability and change as a critical juncture. The case study narrative and semi structured interviews identify political shifts or habitual behaviour as issues in decision-making (Table 5.2). Figure 4.1 has been reviewed for rapid shifts and long periods of time, which has resulted in six decision-making junctures in interplay of decisions in cities (Table 6.2, Figure 6.1). Figure 6.1 is a timeline that annotates the six junctures and Table 6.2 provides the timeframe to each juncture. The six junctures are described in Section 6.2.1, Section 6.2.2 then builds an explanation of the causes of these junctures in the context of city reality.

6.2.1 Six identified junctures

Six critical junctures have been recognised as indicated on Figure 6.1 and Table 6.2. Each decision juncture has represented a shift or a decision in the narrative that has consequences for the policy and practice of sustainability and resilience in the UBE.

Table 6.2 Chronological listing of critical documents

	Time	Global Actors, influences and policy	USA Actors, influences and policy	City Governance	City Planning	City Design Practice
1	1924-1928		President Coolidge and Hoover (Republican)	SZEA and SCEPA	SZEA and SCEPA	SZEA and SCEPA
2	1992	Rio Declaration			Article 80 (Boston)	USGBC
3	2007	1997 Kyoto protocol		C40 cities		
4	2008-onwards			City strategic plans on climate change, sustainability and resilience		
5	2018		NACC	NACC		
6	2018			City strategic plans	Municipal codes LEED Cities	Municipal Codes

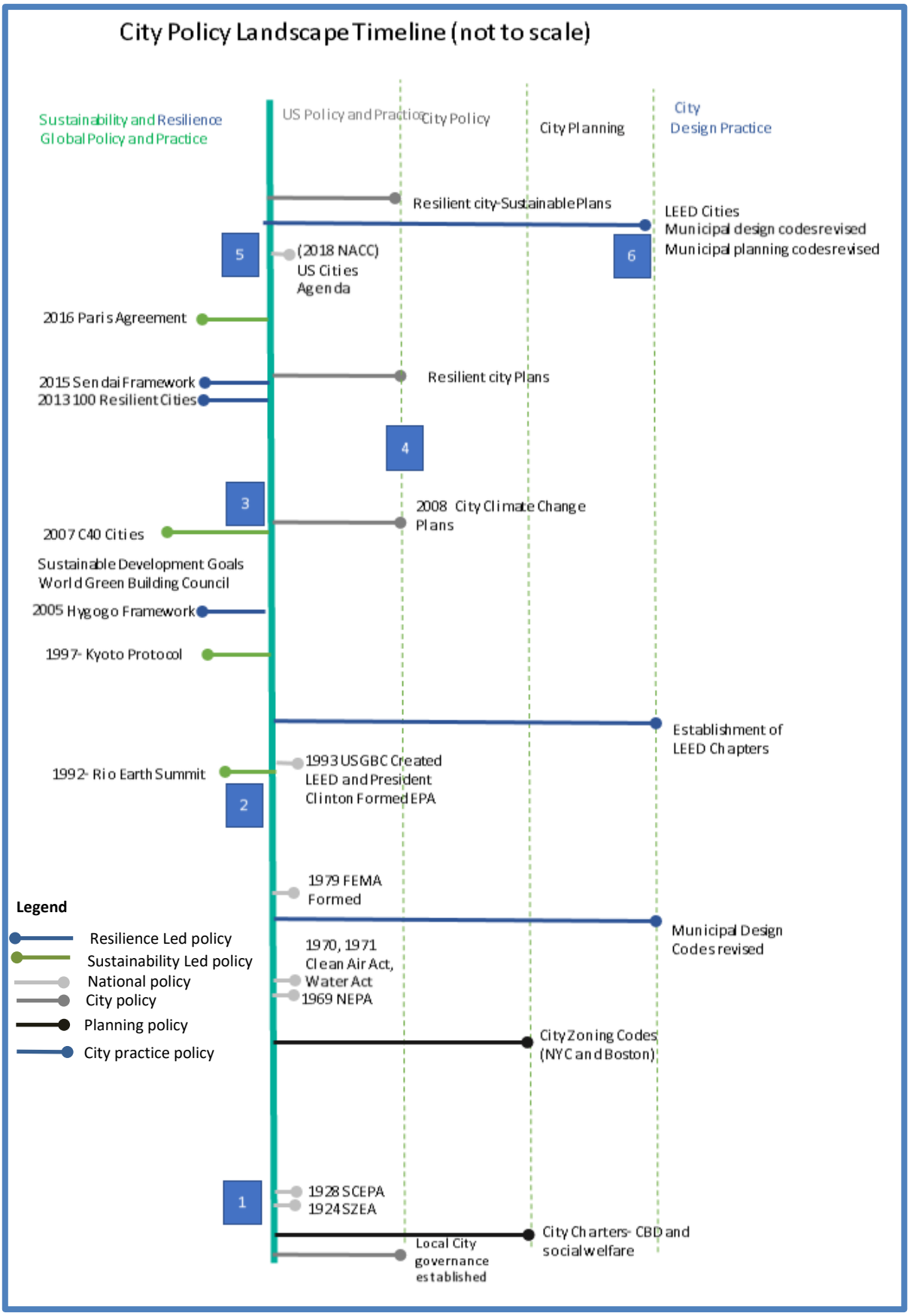


Figure 6.1 Generalised city Interplay timeline

1. City Zoning Laws

Presidents Coolidge and Hoover (Republican, Massachusetts state) introduced City Zoning to promote commercial districts in cities and control the impacts of social immigrants on urban development (US Department of Commerce, 1926). Minimum design standards for social housing were initiated. In doing so, the precedent was set on urban infrastructure and political behaviour and social inequality (Vaughan *et al.*, 2005; Talen, 2012; Philips, 2015; Vaughan, 2018). Talen (2003) has already explored the reality of Chicago's urban morphology and raises points around social inequality and the precedent of context is needed to understand a decision, not necessarily measured frameworks. Decisions concerning sustainability and resilience raise issues with Zoning and relevant codes because the context of the decision needs constant mapping and scenario planning. LEED-ND would assist with some of the linkages in decision-making between policy, planning and design practice (Garde, 2009; Smith, 2015).

2. Ratifying global policy

Since new environmental laws were created in the 1970s (EPA, 2019), carbon emissions have continued to rise with urban development (Olivier *et al.*, 2016). In 1992 the Rio Declaration act unifies countries to reduce GHG (Section 2.3.3). This notion led to the mobilisation of sustainability practice and creation of the USGBC and LEED Design framework. The Rio Declaration could be classified as a global success as it was ratified by many countries (including the US) to reduce GHG, but why did it get to this point? Subsequent decision-making suggests Realpolitik (Section 6.4) is an issue

because different interpretations and measurements of terms are subjected to politics (Heller, 1996; Bew, 2016). Many of these political issues still remain and discussing resilience has brought them back into focus (Schwieterman and Caspall, 2006; A. Bahadur and Tanner, 2014; Vale, 2014).

3. C40 cities and power decentralisation

In 1997 the Kyoto protocol was created, but not ratified by the USA by President Bush (Hovi, Sprinz and Bang, 2012). Up until then a democratic presidency saw the most recent revisions to Environmental Laws in the US (EPA, 2019). Cities like Chicago responded and created their Climate Change plan in 2004, PlaNYC in 2007, and Boston's Article 80 in 1996 and 37 in 2007. Other cities needed to be rallied by the creation of C40 Network. After C40, the case study cities produce city strategic sustainability plans. These city plans need further policy evaluation with regards to their effects on their cities (for example how does the carbon performance relate to city zones, surface water runoff, volume of flooding events) and evaluate the city data that has been collected. This would provide a benchmark for evaluating sustainability and resilience measures that are occurring today.

4. Too many city visions

Conveyed in the case studies were the changes that have occurred in city policy over time (Figure 4.11). There have been many iterations since in 2008. Whether this is because it has taken time to understand and respond to the global and political issues or that policies should be continually updated can only be verified by the Mayors. Some city strategies are tracking

their changes by their own indicators (Box 4.11), but the city data needs to be examined and evaluated for actual measures of either adaptive capacity building or transformation (Box 2.4). Currently, cities are projecting an understanding where resilience means responding to emergencies and vulnerabilities (Boxes 4.11, 5.16, 5.17, 5.18).

5. Rise of city power

The 2018 NACC is a testament to the differences between federal and city power. NACC ratifies a commitment to reach targets set out in the Paris Agreement and in doing so, defies the current President's conflicting position. This is evidence that cities can harness their collective power in decision making at a global level, which is fascinating. When does the power and population of city overcome a national voice? With the rise of megacities and the fact that GHG can be more easily quantified in cities, can cities ratify their own GHG emissions and environmental commitments? This would shift power and policy dynamics between national, regional and local scales. It could also consider an EBA approach to environmental decision-making, i.e. unite regions and cities to think on an ecosystems scale. Cities have expressed their frustrations with regional policies and the way decisions are made (Section 5.4).

6. Policy meets practice

After the development of city policies (2008-2018), there is a shift towards changing municipal codes in planning and design beyond any previous measures (Table 6.2). What the outcomes of these decisions lead to is currently unknown because this is real-time. 100RC is in the process of

evaluating its findings, but by withdrawing its funding (Berkowitz, 2019), who can provide support to continue this progress? The CRO is one person in local governance to manage decision making reformations, but city governance offices keep shifting (Box 5.13).

6.2.2 City reality

Decision-making explanations have been provided by examining the case study cities for decision-making patterns in policy, planning and design practice (Sections 6.1.1, 6.1.2, 6.1.3). Recently, visioning of what cities will be like in 2050 depict flooding and social isolation. However, what is not yet recognised is the influence of uniting the environmental voices of cities to be politically powerful (Vidal, 2019). The US cities have a lot of responsibility to address; the country is ranked 8th in the global carbon emissions, with cities in the top ten global carbon emitters (CityCarbonFootprints, 2019); 15 US cities actively participate in C40 (C40 Cities, 2019) and 24 US cities have participated in the 100 Resilient cities (100 resilient cities, 2019). However, every time there is an emerging key global policy, the US has not ratified it: for example, the Kyoto Protocol and the SFDRR (Hovi, Sprinz and Bang, 2012; Peters and Tanner, 2016).

The decision-making interplay for US cities has been discussed and timelines have been constructed to form an overall pattern (Figures 4.1, 6.1). However, Section 5.3.7 outlines a relationship between policy and practice in each city that creates conflicts and synergies in decision-making. Figure 6.2 provides an explanation of critical relationships between policy and practice for further development (Section 7.6). First, global policy (*such as the Rio Declaration,*

Paris Agreement, SDGs, SFDRR) trans-descend through a variety of scales of decision making (*national, regional, local*) before appearing either in law *(NEPA)* or policy (*GHG emission targets, EIS*). The policy target is then established by the city governance, and the city planning department (or equivalent such as a building department) stipulates the policy requirements.

Identified in Figure 6.2 are two critical observations of actions by US cities: the first was the Home Rule Movement created by city charters and the other more recently, the NACC. City charters were established in each city at different times (Figures 4.1, 4.4, 4.9, 4,13), but in 2018, Chicago's city governance orchestrated the US Cities to form an alliance to enact the Paris Agreement, which has created a direct legal relationship to GHG targets (Chicago Council on Global Affairs, 2018). Second, city policy meets practice with the municipal policies of zoning, planning and design. City design practice has described that the municipal policies are out of date (Section 5.4). City design practice has had to rely on international codes of practice and professional standards to implement legal requirements such as LEED and SEAs. City policy has started to adopt the practice created USGBC LEED for policy standards and practice. Unless a city has a specific set of requirements similar to Boston's Article 80 and 37 (Walsh and Golden, 2014), this creates conflicts for urban planning practice and municipal planning departments to communicate on what laws need to be revised and establish which interpretation of sustainability-resilience should be measured (Vale, 2014).

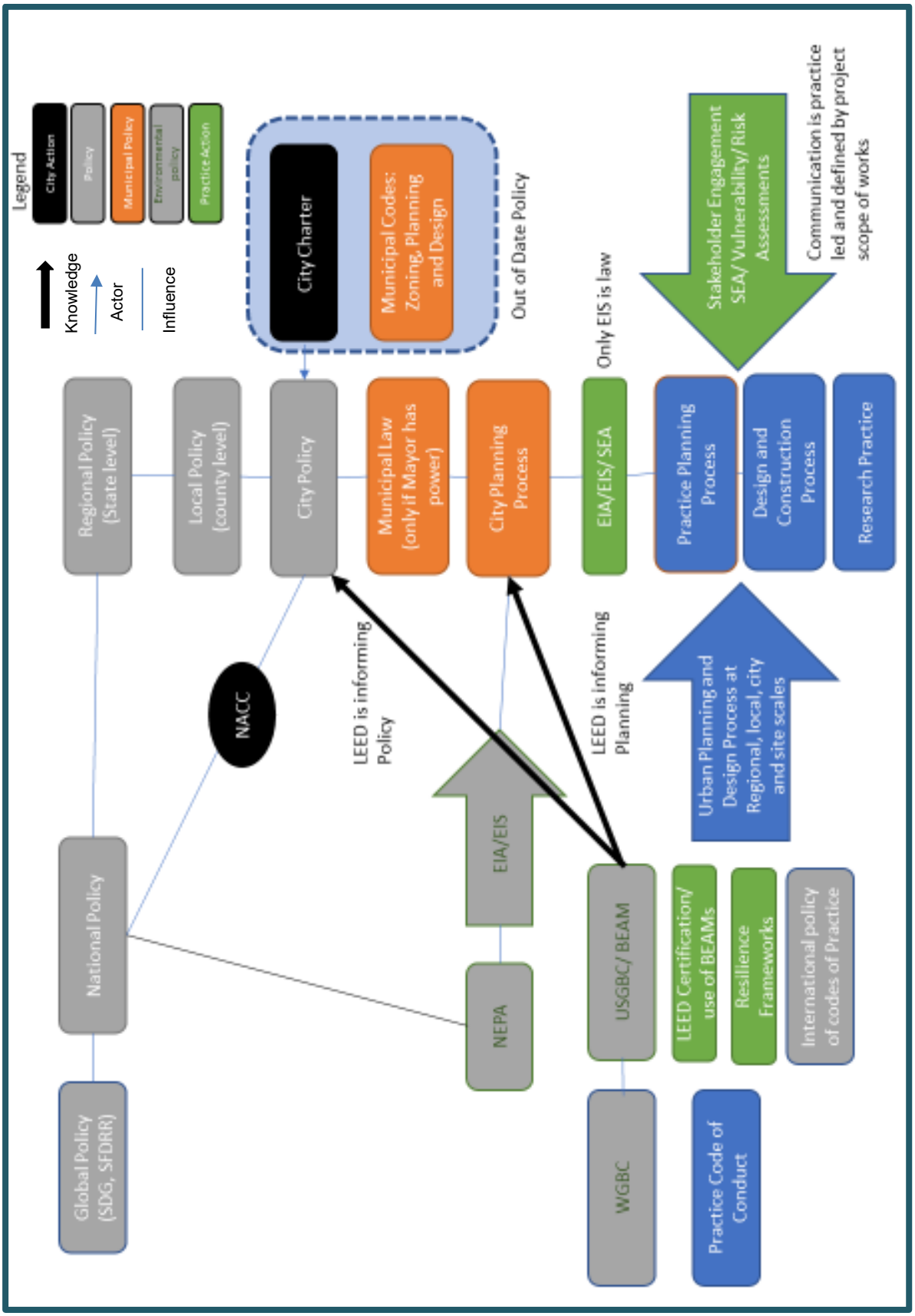


Figure 6.2 Interpreted overview of the causal relationship of policy and practice at varying decision-making scales (global, national, regional, local, city).

Figure 6.2 links policies at varying scales with key practice components. By linking the decision flow between policy and practice decisions start to converge at city level. This reflects the reality that city policies have recently entered a stage of constant flux as they make a transition from the C40 position of climate change and sustainability and to the 100RC position of resilience. It is here that political shifts need to be overcome so that both preventative and restorative measures can be enacted without political bias (Vale, 2014).

It has been identified that there is a policy bias focussing on carbon and energy (Section 5.4). Through the case studies, two critical legislative instruments have been recognised that need revising, the US environmental law EPA and city zoning codes (Section 4.2). Good urban environment practice has mobilised sustainable building assessment methods and progressed the SEAs to manage social vulnerability and hazard risks, which is a similar finding to Achour *et al.* (2015). The difference is that a SEA includes social assessments of vulnerability and exposure to hazards, and EIS in accordance with EPA does not (Fischer, 2003; Balfors *et al.*, 2018). City Zoning laws enacted in 1924, have a history because they have created social and economic inequality (Martin, 2015). The zoning response is fracturing how to consider sustainability and resilience in practice unless the city municipal planning department can override its own zoning and find its social voice allocated to neighbourhoods (Alexander, 1977; Cutter *et al.*, 2008; Bordass and Leaman, 2013; Cutter, 2016) (Section 5.4). Cities are starting to move towards revising their city charters and zoning codes to promote community land use (The City of New York, 2019a).

Codes of practice do not stipulate that people should be consulted in how their building or community operates, but LEED promotes it as an optional credit known as stakeholder engagement (USGBC, 2016b, 2017). Section 5.4 identified the causal theme of energy and carbon in policy, which has recognised LEED as a framework to set energy and water reduction targets (Section 5.4). Resilience and sustainability experts have generated a synergy by merging them to create the measurable concept of passiv-survivability by using LEED-RELi and Passivhaus standards (which lead to NetZero) Deconstructing this term means that the design and construction of buildings should perform at Passivhaus standards and be able to survive off grid in emergency scenarios of storms (Section 5.4). However, this has not been adopted by city policy or municipal codes (Box 5.14).

City practice has recognised that policy shifts occur (Section 5.4). The municipal codes of planning and design practice get stuck between this ebb and flow of policy phases of agenda setting and formulation and implementation (Knoepfel *et al.*, 2011) (Figure 4.1, Section 6.2.1). Eventually practice informs policy and adopts its evaluation methods such as LEED (Figure 5.1). City practice knowledge collected from the semi-structured interviews illustrate many frustrations with the whole decision-making process (Section 5.4). This is most evident when design practice policy does not encourage better standards of practice despite policy itself starting to embed resilience and sustainability knowledge into recent revisions. Recognised by assessing the context of cities, the causal relationship between policy and practice of resilience and sustainability is no longer stagnated and is currently under a political shift (Section 6.2.1).

6.3 Sustainability and resilience in US Cities

The generation of three US cities has allowed theory, policy and practice to be examined and recognises that sustainability and resilience are mutually influential (Section 6.1). Sustainability is the stabilising force whereas resilience builds in capacity to cope and if necessary transform (Brundtland, 1987; Folke *et al.*, 2002) but unless they are fully mobilised in policy and practice, how can better decisions be made?

In recent times, theoretical interpretations of resilience have become more prominent and its application dissected by Carpenter *et al.*, (2001) who raised the issue whether resilience should be measured; Reghezza-Zitt *et al.*, (2012) who considered several connotations of resilience terms that are divergent of an encompassing sustainability and resilience foundation and Meerow, Newell and Stults (2016) who discussed urban resilience and its multiple meanings. However, city practice indicates that sustainability has maintained its original understanding and led to building environmental measurement systems (Sections 5.1, 5.2), whereas measuring resilience has led to a diverse multitude of frameworks indicating that resilience means many things and perhaps should not be measured (Levine, 2014; Schipper and Langston, 2015).

It has been evident that practice recognises that sustainability matches something akin to Brundtland's (1987) definition, whereas policy interprets it specifically as a measurement of energy consumption and carbon emissions (Section 5.4). Practice's interpretation of resilience is more diverse with an understanding of risk and vulnerability, but policy interprets resilience in the

narrower sense of how to cope with emergencies. These findings reflect similarities found by Achour *et al.*, (2015) that sustainability was found to be measurable by frameworks and that resilience was focused on DDR. However, there are places where the relationship between policy and practice start to intertwine, particularly with LEED practice significantly informing policy as found with the NYC Blueprint for efficiency. Although there is a bias to measure sustainability by imposing targets of carbon emissions, the LEED framework also supports meeting the environmental impacts of built assets. However, the reduction of environmental impacts is often side-lined for credits that have a high score such as energy reduction (Section 6.2).

Design practice use of the term passiv-survivability and formation of the LEED-RELi framework has generated the greatest synergy between sustainability and resilience in decision-making (Champagne and Aktas, 2016; Wilson, 2006). However, the LEED-RELi credits (Box 2.2) have only just been accepted as part of the LEED framework and not yet filtered into policy or practice (Wilson, 2018). Practice has also created the 100RC framework, which has informed policy and created revised city policies to consider a broader interpretation of resilience and social voice (Walsh, 2016; de Blasio, 2018b; Emanuel, 2019b). However, what type of resilience the 100RC framework is measuring has yet to be assessed and quantified (Section 7.4). Global policy has also made steps towards unifying sustainability and resilience in practice and local policy with the recent GAR 2019 report, which considers that all development should be 'Risk-Informed Sustainable Development' (UNDRR, 2019a). If this is acknowledged both in

policy and practice, this should reduce the likelihood of resilience being wholly considered as just a DDR approach as outlined by Achour *et al.*, (2015).

By considering the causal relationships of decision-making in cities for policy, planning and practice, ten causal themes were recognised from which seven are political, one relates to planning and two in design practice. The causal themes identified were predominantly political (Section 5.4). Both planning and design practice had issues with the habitual decision-making process: firstly that municipal policies concerning planning and design codes were out of date; second reliance on LEED EA credits to reduce energy performance which are only a marginal improvement in design standards; and finally, that scopes need to consider how projects can consider a multitude of spatial and temporal scales to promote better design solutions that can be preventative and restorative (Vale, 2014; Achour *et al.*, 2015; Chmutina *et al.*, 2016).

From identifying causal variables (Table 5.2), the implementation of sustainability and resilience in policy has relied largely on political actors or influences to initiate them as recognised by Mayors Bloomberg (NYC), Daley (Chicago) and Menino (Boston). Sustainability has been mobilised by the Rio Declaration and Brundtland (BPDA, 1996; Richard J Daley, 2008) but not necessarily galvanised until the C40 Network was formed in 2007, then cities responded with city sustainability visions (Bloomberg, 2007b; Emanuel, 2015b; Walsh, 2019a). Then Hurricane Sandy occurred which influenced NYC and Boston, and more broadly the response to this natural hazard event initiated the 100RC framework to be created (2013) and policies in the cities shifted towards resilience (The City of New York, 2014b; Walsh, 2017b;

Emanuel, 2019b). From the case studies, each city has identified its shocks and stresses and partly engaged with the city's social voice (100 Resilient Cities and Walsh, 2017; Chicago, 2019; NYC Office of Resiliency, 2019). Each city has created a city framework, which had merged sustainability and resilience, but in doing so, made a local interpretation and measurement of what sustainability and resilience means to them, which suggests in the least that local context has been considered. However, at this juncture the biases towards energy consumption and carbon emissions regarding sustainability and DDR regarding resilience remain. Although resilience may be unquantifiable to a certain degree (Section 2.2.3), there remains the situation that policy must be informed by theory and practice knowledge. It is considered that global and regional indicators may be necessary to deliver risk-informed sustainable development and override political shifts in governance (Vale, 2014; Cutter, 2016; World Bank Group, 2017).

Figure 5.1 shows that LEED is a decision-making platform between policy and practice and from the data set collected is most common measurement platform (Table 5.2). However, recognised by design practice was that the LEED design standards being stipulated in policy are not enough and would prefer for more stringent targets to be applied such as NetZero (Section 5.4). Policy needs to reduce the scenario of easy wins for credits as well as facilitate decisions between LEED-ND and NC versions (Garde, 2009; Smith, 2015); it must broaden the use of LEED away from its interpretation of an energy reduction tool towards the broader concept of sustainable development of land use and communities (Brundtland, 1987). In all three cities, LEED targets are not applied to all buildings and target new

developments, and not stating Gold or Platinum as a minimum standard. The LEED performance standard expectation in policy needs to be both raised and applied to all buildings (new and retrofits) so that the platform can improve decision-making. In Chicago, LEED has been recognised as a policy framework to drive planning and design (USGBC, 2019; RE Journals, 2019), yet it has only yielded 172 LEED rated buildings across Chicago. These LEED performance ratings are below the Gold or Platinum standard and the number of certificates is minimal for a city the size of Chicago.

From considering the decision-making pathway of three cities, two national laws have been identified as root causes to habitual decision making: SZEA (US Department of Commerce, 1926) and NEPA (EPA, 2019). SZEA links how cities have managed urban development and it is fundamental to planning regulations. Consequently the use of SZEA over time has created social and economic disparity and decision-making conflicts with tax revenues and political jurisdiction (Talen, 2012). SZEA does not align with social practice of how people live in places and should no longer been seen as a legal requirement to fulfil or promoted by APA (APA, 2019). Cities have started to engage with their social voice but to what extent will shift the habitual decision-making that exists with city zoning and city charters remain to be evaluated (Martin, 2015; Walsh, 2017b). City zoning plans need to constantly be evaluated at a municipal level to make more informed decisions at neighbourhood and community scale and represent social voice at local governance levels. Currently, procedural knowledge has identified that political jurisdiction is a limiting factor when considering improvements to

the watershed (surface water runoff) into existing infrastructure (Section 5.4, Boxes 5.11, 5.12).

NEPA has not been revised since 1993 and it is a global policy issue. The US is globally ranked 8th for its GHG, the US has continued to not ratify global policy, some of the US cities have carbon footprints as large as countries (OECD, 2009; Hovi, Sprinz and Bang, 2012; CityCarbonFootprints, 2019). NEPA needs to be sensitively reconstructed and aligned with modern day environmental situations with progressive protection targets for land use, air and water pollution.

Global policy remains an influence on local policy, as demonstrated by the formation of NACC (2018) to ratify the Paris Agreement. To making better decisions, it is critical that cities have a social-political voice at the global policy level of decision-making, because cities represent 66% of the global population and a high proportion of carbon emissions (Cohen, 2014). Strategies that are being played out within governance structures are an important part of progressing both preventative and restorative planning because of their role in global society (Barkham *et al.*, 2014; Vale, 2014).

Sustainable decision-making in cities is still represented by C40, which has had a bias towards carbon emission targets of energy and power infrastructure. However, Cutter *et al.* (2008) and Cutter (2016) recognised that communities have a role in hazard preparedness, but this position could be further enabled if the social voice becomes political within a city. Alexander (1977) outlines that social representation should occur in neighbourhoods and communities, which would enable cities to become

decentralised. However, the case studies identified that US cities have already experienced decentralisation of power by the Home Rule Movement, but their city charters are out of date. NYC has started to review their city charter with more social voice (The City of New York, 2019a).

The theme of political shifts is important to recognise, as decisions relating to sustainability and resilience need to be mindful that the two modes of preventative and restorative resilience do create political challenges and it is difficult to plan for what might not occur (Vale, 2014). This gives notion to sustainability and resilience being planned for long term restorative decisions and become meta-resilient to political shifts. Mileti (1999) identified that decision-making needed to be improved concerning planning practice, these findings are echoed by the causal theme of habitual decision making. Realistic insight provided by the Boston case study highlighted that the relationship between regional (state) and local (city) policy is subject to political shifts and that decisions that get made at a regional scale do not reflect the local environment. This is a critical conflict in decision-making (Chmutina *et al.*, 2016). Handmer and Dovers (1996, p. 491) considered that "*we need decision-making and management strategies that can cope with, and readily adapt to, new or unexpected circumstances*" and, if city mayors have longer terms in local governance than national leadership, then cities should be better at committing to medium to long term decisions at global levels. As this is currently the case with the mayors in Boston and New York, then city governance should be making decisions alongside national interests at COPs.

6.4 Foundation of Realpolitik in cities

Bew (2016) outlines that reformation of Realpolitik will generate: "*an enemy of* "*habitual self-delusions" and "naively accepted catchwords" from wherever they come*" (Bew, 2016, p. 301). Following the establishment of these cities through their city charters, Boston (1630), Chicago (1837) and NYC (1916) were not formally zoned until the SZEA in 1928 and Mayors and the Alderman [16] provided local governance over the created districts. The result is that today NYC has been enduring urban, political and economic growth converting its islands to support a population of 8.537m over 5 districts with 59 community boards (NYC Office of Mayor, 2019); Chicago endured unprecedented growth, which at times rivalled NYC to support a population of 2.72m and 77 districts (The Chicago 77, 2019) and Boston has grown to become a regional city with a population of 0.669m and 11 city council districts (City of Boston, 2017). The volume of neighbourhoods and communities in cities that require political representation have a multiplicity of diverse objectives and needs, but this is the root cause of difficulties in political jurisdiction (Section 5.4). NYC has tried to engage with the social voice by its 8.6 voices campaign (City of New York, 2019), Chicago through 'Resilient Chicago' (Emanuel, 2019a), but Boston has recognised this through the establishment of BRA – now BPDA – who operate 'Engage Communities' (BPDA, 2019).

Sustainability and resilience policies at city level were initiated by influential actors (Table 6.1). NYC had a shift between Mayors Giuliani and Bloomberg

[16] An alderman is a member of council to represent their community

(Rosenzweig and Solecki, 2015b), Chicago with between Mayors Daley and Emanuel (The University of Illinois Library, 2019; Loomis Mayfield, 2019) and Boston between Mayors Menino and Walsh (Gibbs and O'Neill, 2014).

As the political shifts resonate with the deep-rooted relationship of city planning and zoning with commercial (and city governance) entities, the habitual practice of decision-making gets more pronounced. The scale of habitual practice is evident through how decision-making manifests itself in working practice of city policy, city planning and city design (Section 6.1).

Providing context for these issues has built the understanding that sustainability and resilience have been manipulated by politics, and that planning is subjected to political shifts (Vale, 2014; Chmutina *et al.*, 2016). There is now recognition in cities that municipal practice of planning and design needs to be revised, but what *type* of resilience and sustainability is being promoted has not been formally evaluated yet (Box 5.9). Until then, buildings delivering LEED remain the only measurable entity.

Speaking pragmatically, the majority of population migration anticipated by 2030 will be to urban areas or mega cities (Cohen, 2014). Some cities have bigger populations than countries, yet cities have a limited political voice at global platforms where policy decisions are created. Cities need a voice because they represent 66% of the global population (Cohen, 2014; Lloyds and University of Cambridge, 2015; World Bank Group, 2017). C40 provides governance with support by networking and C40 conferences, but this also causes a disconnect between what is happening at a global scale (Box 1.1, Figure 6.2). C40 is being effective at creating transitions but needs to

accommodate resilience and broader environmental or sustainable development objectives. This has been recently recognised by cities with their campaign of Urban 20 (U20, 2018).

The loop between cause and effect of global policy needs to include cities, as then cities can influence regional and national policies, as enacting the NACC to comply with the Paris Agreement has demonstrated (Chicago Council on Global Affairs, 2018). Enabling cities to utilise their political proportional representation of social voice from communities and even neighbourhoods could promote more galvanisation between social and environmental responsibility (Bahadur and Tanner, 2014).

Two critical pieces of legislation are also in need of examination, the SZEA zoning and city charters. It must be recognised that NYC is currently reviewing its city charter (The City of New York, 2019b). Climate change and its effects creates friction socially, spatial and temporally with these old laws. Recognised in the city case studies is the root cause of economic zoning by SZEA and the zoning precedent it set. Environmental and social context needs to come back into the decision-making of cities (Box 1.2).

Land use planning needs to accommodate how a city can 'plan' and adapt, not just cope with emergency of flood events. Carbon reduction policies need to include everyday design practice. Environmental requirements for all projects must be mandated for best practice not just those of a certain size. Municipal codes need to go beyond stipulating minimum LEED performance requirements for some buildings, as a minimum making it mandatory for all

buildings with stretch targets to NetZero. This would revolutionise the construction industry and green the economy.

Bew's (2016) “Enemies” of the Realpolitik foundation have been recognised in three US cities with the discursive use of resilience and sustainability in theory, policy and practice (Section 2.2, Boxes 5.7, 5.8, 5.9). To address this, there is an action agenda to reduce global policy debate, the GAR 2019 (UNDRR, 2019) actively discusses sustainable development as a part of resilience.

Rosenzweig *et al.* (2010) outlined that cities have a pivotal role to play, and advocated the WMCCC, which has created the foundations for the ICELI to create the New Urban Agenda with the UN Habitat. Barnett and Parnell, (2016); and Parnell (2016) express that the post 2015 Agenda will reconfigure debates and although Cities are still categorised as urban, there is recognition of the urban agenda in the SDGs;

> **However,** *“within the multi-lateral system and will also frame the next decades of sustainable urban development thinking and practice around the world, making the precise formulation of the global urban agenda a matter of the gravest intellectual and pol- icy concern”* (Parnell, 2016, p. 530).
>
> **Previously, the UN Habitat reports stated,** *“The empirical link between democratic governance and social inclusion highlights the need for institutions and enforcement mechanisms that favour participatory decision-making.”* (Habitat, 2011, p.25).

Yet, there is plenty of empirical evidence available from the World Green Building Council (2017), representing sustainable measurement frameworks in 39 countries and provide an existing framework with empirical evidence in

the form of building certification data. The 100RC framework have city resilience frameworks to evaluate and track. Chmutina *et al.*, (2016) acknowledge the societal-governance disconnect of knowledge transfer, but to resolve it means returning to the origins of sustainable development (Section 2.5). The question then becomes about how the New Urban Agenda will become incorporated into city policy and practice. It is too early to tell.

Historically, there is a relationship between Brundtland initiating the Rio Declaration and the global agreement on GHG but the US, has had issues with ratifying subsequent protocols in Kyoto and Paris (Hovi, Sprinz and Bang, 2012; Peters and Tanner, 2016). In response the NACC was created, and leading cities are rapidly revising their city policies and committing to reducing GHG at a city level. The C40 network has also created a manifesto to represent 20 cities at the United Cities and Local Governance (UCLG) summit titled: “U20”, which advocates that cities need a voice at global policy levels (Section 2.6).

Realpolitik of cities galvanises all that has been learnt about causal behaviour that can accompany U20 and C40 (U20, 2018) manifestos towards a more resilient and sustainable urban environment that support Environmental Realpolitik (Section 2.3). There is already movement where US cities have decentralised themselves to ratify the Paris Agreement the NACC and the case study cities indicate city policies have shifted (Section 6.1.1). It must be noted that some NACC cities (2018) are at a juxtaposition with Federal politics and a Realpolitik based on the ideals of sustainability and resilience needs to further promote powers to cities. City policies can start to galvanise communities socially and connect them back to the

environment by completely disbanding SZEA zoning practice to reflect city neighbourhoods and reform decision making power structures (Alexander, 1977; Elder-vass, 2010). City decision-making needs to be further pulled together and aligned with its interpretations and measurement of sustainability and resilience to generate Real Realpolitik for Cities that benefits the global environment (Section 2.3.5.3).

Miles, Hubermann and Saldana (2014) outline that causal explanations lead to expansive outcomes and can make transformational changes; this research needs further investigation, and a transdisciplinary approach, to galvanise cities (Gibbons *et al.*, 2006). In May 2019, C40 outlined that cities must have a global representation to meet the Paris Agreement and SDG commitments. Realpolitik provides a way to use the ideals of unite resilience and sustainability and using passiv-survivability and risk-induced sustainable development is a starting point. When political influences align, change can happen; since Brundtland's report (1987) it took only five years for the Rio Declaration (Sands, 1992) to be signed and unify countries to reduce greenhouse gases and their impacts. For the USA, this meant that sustainable development became a measured entity in the form of the USGBC LEED platform (Figure 6.1). Today, this is the most recognised sustainable development platform (Section 5.2), and the USGBC recently incorporated pilot credits on resilience and broadened into cities and communities (USGBC, 2019; Wilson, 2018). The U20 agenda suggests that city governance wants a voice at a global level (UNFCCC, 2019; Urban 20, 2019) and practitioners of the built environment have declared ‘climate

change’ emergencies (Engineers without Borders, 2019). This is the case for Realpolitik of cities.

Globally, cities need to continue to work together using the C40 network with their manifesto (U20, 2018). Cities can act on what the UN has failed to deliver in forty years; a reduction of the impact of the built environment to reduce climate change and vulnerabilities of all living species.

6.5 Chapter Summary

Realpolitik of the interpretation of terms and their influences (Section 6.1) has been discussed and there are differences between current GAR 2019 (UNDRR, 2019b) and the reality of city practice which concentrates on energy and urban flooding (Section 6.1). It must be recognised that this is not new knowledge (Mileti, 1999; Folke *et al.*, 2002), but by considering the decision-making relationships, it structures how better decisions could be made in municipal policy, planning and design practice of cities. The issue is that through C40 and 100RC city practice has already implemented many decisions in city strategies (Sections 4.6.3, 4.7.3, 4.8.3) and work together using the C40 network (Rosenzweig *et al.*, 2010). The result is the C40's Urban 20 agenda (Urban 20, 2018) and the NACC which advocates climate change for Northern American Cities (Chicago Council on Global Affairs, 2018), but there is the UN's New Urban Agenda (United Nations Habitat III, 2017) which is probably different to the cities interpretation (Section 6.3).

Yet, **Realpolitik of the causal behaviour** of decision-making (Section 6.2) has been recognised (Section 5.4), and in cities has led to separate journeys between policy and practice (Section 5.3) but an identified leverage point is the LEED framework. LEED has never been fully mobilised in policy and mostly manipulated to suit energy demands (Section 5.4). Previously sustainability and resilience have been manipulated for political means (Chmutina *et al.*, 2016) and some habitual power structures in decision-making still exist. When sustainability and resilience become law, targets can be stretched towards or beyond LEED-RELi and passivhaus standards

(Section 5.4). The three cities have authority to generate their own laws and can provide localised responses to the historical national laws (NEPA and SZEA) which need revising because since their enactment the global environment has changed (Figures 4.1, 6.1).

Habitual patterns in behaviour have been identified (Figures 4.1, 6.1). Both Figures indicate generations of little action, then rapid transitions. In each city the city strategies have been revised three times between 2014-2019 (Table 6.1). The new ISO 37120 and ISO 37123 for sustainable cities and resilience provide indicators and this creates a unified approach to measurement from policy (Suárez *et al.*, 2016; Standards, 2018, 2019). However, what remains a significant issue is the result of what is being measured in the reality of practice and that sustainability and resilience are still being treated separately by policy. These issues create the further Realpolitik (Box 2.7) and lead towards the generation of a causal network (Section 7.6).

Chapter 7 Real Realpolitik

The decision-making interplay of resilience and sustainability in urban environments has been critically examined abductively to create a foundation for better decision-making in policy and practice (Section 7.2). From the thematic narrative reviews of the city landscapes of policy, planning and design practice, political behaviour and habitual decision-making have been identified as the main contributing factor to why better decisions are not being made in the built environment (Table 5.2). Figure 7.1 summarises the thematical journey of decision-making from Chapter 1 and 2, with the research findings. Figure 7.2 summarises the critical interpretations and measurement findings which have led to Realpolitik in cities (Section 6.4). The themes of 'interplay of resilience and sustainability in conceptual interpretations', 'measurement' and 'decision-making' are concluded in Section 7.1.

Section 7.2 outlines the principles for action base on the implications of the research. Section 7.3 outlines how the research aims, and objectives have been achieved and further limitations acknowledged in Section 7.4. Original contributions to knowledge are described in Section 7.5. However, to establish the case of Real Realpolitik in cities there are further steps to be taken to politically mobilise cities (Section 7.6).

7.1 Real Realpolitik Foundation

A foundation of real Realpolitik has been identified which shows that the consequences of habitual decisions in policy and practice are adversely affecting peoples' lives (Vaughan *et al.*, 2005; A. Bahadur and Tanner, 2014; Talen, Wheeler and Anselin, 2018) (Section 6.4). Built environment practitioners (Table 3.6) have identified that social and financial inequalities exist due to tax revenues, political shifts fracture the long term benefits of policy, and that Environmental and Zoning laws and municipal practice have not kept up to date with the changing environmental world (Figure 7.1). Critical junctures of political shifts have been recognised (Table 6.2) and generational decision-making has occurred (Figures 4.1 and 6.1).

However, there are decision-making consequences because sustainability and resilience have been interpreted to mean many things and politically manipulated towards carbon targets and to manage shocks and stresses (Boxes 5.7, 5.8, 5.9 and Figure 4.2). City strategies measure the tangible threads of both concepts and create goal-based decisions, that compromise on what really needs to be achieved to protect future generations. Figure 7.1 provides an overview of the influences of political and habitual behaviour and recognising Realpolitik can lead to making better decisions in policy and practice of the built environment.

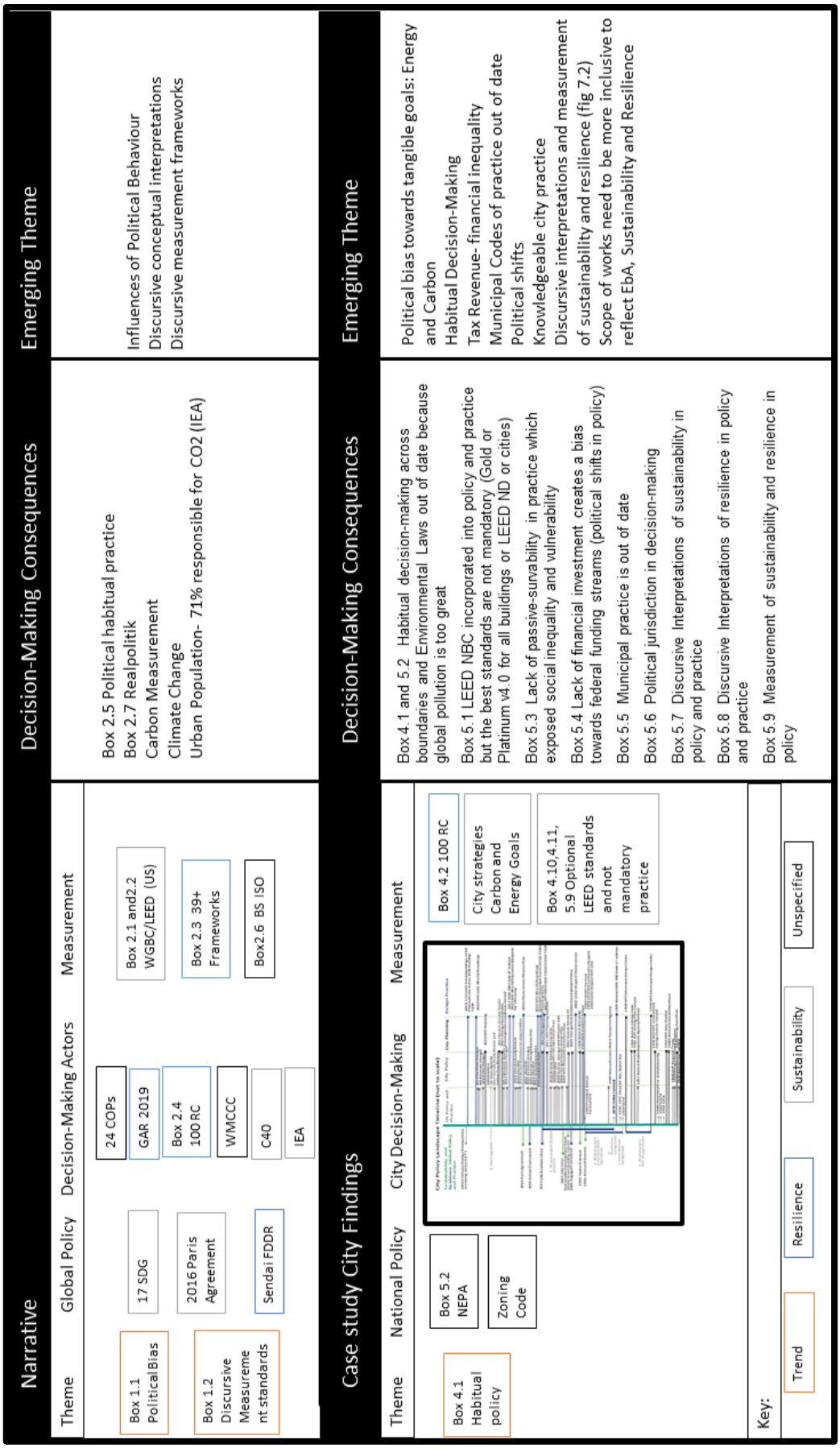


Figure 7.1 Thematic summary of decision-making

The discursive use of interpretations and measurement of both concepts has been influential in decision-making. Figure 7.2 outlines the key interpretations of both concepts from theory to city application. Despite the etymological journey of sustainability and resilience, today's conceptual origins for the built environment are based on Our Common Future and Holling's ecological systems thinking (Holling, 1973; Brundtland, 1987; Folke *et al.*, 2002; Alexander, 2013). Yet decision-making practice of both concepts has been fractured by political behaviour (Vale, 2014; Talen, Wheeler and Anselin, 2018; Chmutina, Meding and Bosher, 2019; Meerow and Newell, 2019b)(Section 5.4).

City policy has interpreted sustainability to mean carbon management and resilience as DDR (Achour *et al.*, 2015). City practice has a good understanding of the conceptual origins but is limited by what has been interpreted in policy (Section 5.3.7). Decision-making consequences have resulted in an uneven **reality** of political jurisdiction, tax revenue, political shifts, bias in policy and habitual practice (Section 5.4)(Talen, 2003; Talen, Wheeler and Anselin, 2018). **This reflects the effect of Realpolitik.** The GAR 2019 report has recognised these issues and aims to unite interpretations in policy and practice by the term "Risk-Informed Sustainable Development" which is an exciting prospect.

		Interpretations	Measurements
Literature	Sustainability	WCED- Brundtland TBL Systems- WCED	Environmental Impact Assessments LEED Triple Bottom Line
	Resilience	Ecological Systems Social-Ecological Systems DDR	LEED- RELI 39 Frameworks
Case study City Findings	City Policy	Carbon and Energy	Carbon and Energy LEED Cities LEED NBC
	City Policy	DDR 100 shocks and stresses	DDR 100 shocks and stresses
	City Planning	NEPA Zoning	NEPA Zoning
	City Planning		
	City Practice	Brundtland	Climate Change Checklists Passivhaus LEED RELi Passiv-survability 80 X50 Roadmap
	City Practice	Systems thinking Recovery, Adaptation Vulnerability	
Realpolitik in cities		**City Policy for global actions:** SDG Goal 11 New Urban Agenda World Council of City Mayors C40 and 100RC in Cities collaboration GAR 2019 "Risk-Informed Sustainable Development" Become more inclusive of social and environmental land use	**City Policy for city action:** Renew city charters with transdisciplinary approach Mandatory use of LEED Platiunum or Gold across the boundaries of LEED Cities, LEED-RELi, LEED ND, LEED for Buildings Review municipal codes of practice and zoning on an annual basis across political boundaries. Promote passive-survability in design practice and planning to reduce social and financial inequalities and vulnerabilities Zonal Mapping of social-ecological systems

Figure 7.2 Thematic Summary of critical interpretations and measurement for city policy

The measurement of "what" (Carpenter *et al.*, 2001) remains critical to the narrative of sustainability and resilience because of the discursive use of conceptual interpretations (Chmutina *et al.*, 2017; Chmutina, Meding and Bosher, 2019; Meerow and Newell, 2019a; Wang *et al.*, 2020). Sustainability in the built environment is being measured by building frameworks and restricted by zoning regulations, however, procedural knowledge platforms

such as LEED NBC, ND, Cities and RELi provide frameworks for decisions across policy, planning and design practice (Figure 5.1).

Resilience has become too complex to measure because the discursive use of interpretations has created conflicts in understanding and application (Levine, 2014; Perelman, 2017). Resilience in policy has become a measurement of shocks and stresses (Box 4.2) but in practice it is about hazard scenario planning, passive-survivability to reduce vulnerability and inequality but there are regulatory conflicts (Newman *et al.*, 2013). Realpolitik of measurement has lead sustainability to focus on carbon and resilience as DDR, however, these conceptual interpretations only measure what is tangible and have started to avoid what is considered as unmeasurable (Levine, 2014; Achour *et al.*, 2015; Quinlan *et al.*, 2016b; Talen, Wheeler and Anselin, 2018).

Patterns of political and habitual behaviours have been recognised along the decision-making pathway between theory, policy and practice of cities (Tables 5.2 and 6.2, Figure 6.2). Political shifts have been established in the city narrative and biases exist towards the rational entities (Boxes 5.7,5.8,5.9). Political influences and actors have created habitual decision-making, which over time have constructed a reality that indicates social and financial inequality, vulnerability and exposure to risks (Table 5.2, Section 5.4, Figure 7.1). A critical resistor to generating changes in policy and practice, is the measurement process of the tangible entities (Figure 7.2). For example, generating a measure of resilience and sustainability has led to the use of the terms “shocks and stresses” because uncertainty, risks and social-ecological systems are difficult to rationalise as goals in decision-making

(Kasperson and Kasperson, 2001; Sekerka and Stimel, 2012; Levine, 2014). However, when creating standard codes of practice, sustainability and resilience targets are measured separately (British Standards Institution, 2018, 2019). Measuring the unquantifiable affects practice too as design briefs become legalised documents for tangible deliverables of cost and scale of action in a scope of works (Section 5.4).

When examining the three US city narratives to explore and understand why or how the built environment is neither sustainable or resilient, remaining apolitical or neutral is difficult because the solution to better decisions is political. Real change needs to happen in the policies which means practice becoming politically active in an a-political way. City practice has generated procedural knowledge and understanding which is only now creeping into decision-making with 80 x 50 Roadmaps (Section 5.3.7). City politicians need to act as real change agents to support the transformation of organisations. Decision-making needs to become more inclusive of society to reduce inequalities, as well as create more sustainable and resilient built environments. Political leadership would unite decision-makers and society to be make more sustainable and resilient decisions (IEA, 2019; UNDRR, 2019a). To overcome resistors, laws have been made in NYC and sustainability and resilience threads are coming together in policy. This is real time Realpolitik.

In the case of the three US cities, the decision-making pathway shows evidence of top-down political leadership with the NACC and that there have been numerous revisions in city strategies in a short space of time (Table 6.1). However as cities consider resilience, this leadership style has shifted to

engaging with city inhabitants to creating a more inclusive society with the role of city charters (Clegg, 1994; Chicago Council on Global Affairs, 2018; Fainstein, 2018; The City of New York, 2019b; Walsh, 2019b). Equally capillary power is important to support better decision-making concerning planning as shown in the Mystic River community and NYC revised city charter (EPA, 2019; Starkey, 1997; Flyvbjerg and Richardson, 2002). Recognised in the narrative has been the issue that Environmental and Planning laws are out of date because the global environment has become so polluted. These laws need to be revised to allow for the future global predictions and facilitate thinking in local, regional and national ecosystems scales.

As global policies continue to be developed the concepts sustainability and resilience remain fractured, where practice unites them (Figure 5.4) (UNDRR, 2015; Barnett and Parnell, 2016; Peters and Tanner, 2016). This discursive interpretation leads to fractures in decision-making and the habitual decision-making does not get broken. Habitual practice is an enemy of Realpolitik (Bew, 2016) and it is woefully evident in the history of how decisions are made in our cities (Figure 4.1 and 6.1). However, cities have started to recognise the need for codes of practice to be revised and rethought, but in doing so, what is being measured and which interpretation of sustainability and resilience remains critical (Sections 7.1.1, 7.1.2). Today, there is a real opportunity for the Realpolitik of cities to provide proportional representation on the global political stage with the Urban 20 Agenda (U20, 2018), to use the incumbent political shift to present better sustainability and resilience

policies across decision-making boundaries, that are made with the people and meet the needs of future generations.

7.2 Principles for Action

Cities have a decision-making emergency (Boxes 5.7,5.8,5.9). Berger's (1960) generational gaps have been identified in the decision-making landscape between policy and practice by creating interplay timelines (Figures 4.1 and 6.1). Within these generational gaps there have been discursive shifts between meaning of environment, resilience, sustainability and sustainable development (Sections 2.3 and 6.1) which has led to the recognition of Environmental Realpolitik (Hecht and Cockburn, 1992; Bew, 2016) (Section 7.1). Through the research design contextual landscapes have been generated that have allowed dialogues between disciplines to be considered. The implications have led to identifying that practice and policy have been working in tandem but are rarely integrated (Figure 5.4). This limited integration reflects that sectors have been working towards certain goals that have been generated in silos which is an example of Mode 1 thinking (Gibbons *et al.*, 2006). The critical junctures recognise the actors of C40 and 100RC working on city strategies which created a shift in 2014, and LEED practice (Section 5.4) became the vehicle of the Leverage Point (Meadows, 1999). Given that policies have entered a phase of rapid shifts and transient city strategies (Table 6.1), can policy start leading practice and stretching measurable targets?

In response, this section identifies the specific learning or action points for theory (Section 7.2.1), policy (Section 7.2.2), practice (Section 7.2.3) and how to move forward.

7.2.1 Implications for Theory

Inductive research of historical context of cross case studies can lead to insightful outcomes that reveal more about current decision-making relationships (Miles, Hubermann and Saldana, 2014). The differences between how sustainability and resilience are managed in policy and practice have incurred discursive fractures which have led to the conceptual differentiation and understanding (Figure 7.2). Sustainability and resilience are mutually supportive and this knowledge foundation needs to be reinforced because the origins of the issues have not been systematically addressed in decision-making of the built environment (Mileti, 1999).

Principles for action are:

Realpolitik of discursive interpretations and measurement need to unite sustainability and resilience in the built environment (Folke *et al.*, 2002, 2010; Childers *et al.*, 2014; Achour *et al.*, 2015; Bew, 2016; Folke, 2016; Zhang and Li, 2018; Hewitt *et al.*, 2019). Stratified ideas should be fed back into the conceptual interpretations that construct a better system which inform policy and practice (Meadows, 1999, 2008; Knoepfel *et al.*, 2011); and transdisciplinary thought is critical for power and social construction for decision-making (Starkey, 1997; Ahern, 2013; Chmutina *et al.*, 2016; Felt *et al.*, 2016).

Mode 2 thinking is important and should not be marginalised by Mode 1 knowledge (Gibbons *et al.*, 2006). More understanding of causality along decision-making pathways is required, which needs transdisciplinary approaches. The role of urban planners is more critical than ever before to provide social, political and environmental understanding (Fainstein, 2000, 2005; Flyvbjerg and Richardson, 2002; Talen, 2003).

Identifying that policy is critical to create change (Section 7.1), the understanding of social dimensions and role of capillary power is essential to better decision-making (Starkey, 1997; Flyvbjerg and Richardson, 2002). Decision-making must address the issue that sustainability and resilience are concepts with utilitarian ideas that cannot always be quantified into rational goal orientated indicators and targets (Foot, 1985).

7.2.2 Implications for Policy

Historical relationships have influence over existing policies. Now both global and city policy is not where it needs to be to support changing conditions (Figure 7.1). Currently there is a power fracture between global policies because cities have generated their own knowledge platforms through C40 Cities and 100RC. However, city strategies have become influenced towards goals and targets that measure resilience and not necessarily reflect sustainability and resilience. The recent GAR(2019) report is the most cohesive approach for sustainability and resilience to date which leads to the following actions:

Global policy needs procedural city practice knowledge to inform policy development and should facilitate the U20 Agenda, after all cities represent

over 60% of the global population (U20, 2018). Policy practice must enable transdisciplinary knowledge in decision making, as already started with the revision of the NYC City Charter (The City of New York, 2019; (NYC Office of Recovery and Resilience, 2019). Political jurisdiction needs to reduce so that systematic responses such as EbA and passiv-survivability can be implemented and not be fractured by tax revenue or spatial boundaries (Section 5.4). These principles need to be reflected in city zoning guidance.

City policies also need to consider city practice knowledge, so that best planning and design practice becomes normal policy such as passiv-haus standards and, net zero. This new normal policy needs to be mandatory for all buildings and infrastructure. Policy then needs to provide stretch targets and provide municipal guidance that consider ecosystems, temporal and political shifts. A starting point are the mandatory credits of LEED-RELi (Champagne and Aktas, 2016), but policy must no longer differentiate between standards.

Sustainability and resilience must be at the root of decision-making. Organisations must be supported to overcome resistance and there should no longer be compromise on environmental legislation. This means considering more feasibility studies that include stakeholders, climate change modelling and scenarios in the early stages of developing a scope of works for a project, until the outcome becomes a NetZero and a positive contribution to the system (Section 5.4). Environmental laws need to be updated to reflect the existing and future degenerative position of the global environment. Habitual practice needs to be reduced by not standardising practice but providing overarching guidance which reflects hazard scenarios

and the continual tracking of municipal codes of planning and design practice (Box 5.14).

7.2.3 Implications for Practice

Practice needs to become more a-politically engaged in political decision-making. Practice knowledge generates procedural feedback into the knowledge systems. The use of measurement and frameworks alone do not deliver sustainability or resilience in the built environment. Cities and Urban Environments are becoming more dominant in policy, and therefore need to become more social and environmentally responsible as described by Raworth (2013). Fainstein (2005) considers that social diversity in the planning of cities should be called “just city”, this has been reflected in the city policy narrative as resilience has become incorporated into goals and targets (Chapter 4). As this shift occurs in city policy, Fainstein (2018) discusses that cities are planning for prevention not adaptation. This aligns with how practice perceive the DDR interpretation of city policy, when decisions should be considering the principle of ‘passive-survivability’ (Figure 7.2). Although resilience and sustainability have informed a shift in recent city policies, the discursive interpretation and measurement of the terms lead towards the rational decision-making targets such as prevention and carbon reduction (Figure 7.2). Best practice knowledge exists but best practice is not mandatory and this needs to be put into action across boundaries.

Existing frameworks need to become normal practice such as: Zero waste, Net Zero and positive impacts (IEA, 2019; UK Green Building Council, 2019). In the US cities, even the best of LEED is not mandatory practice such as

LEED Gold or Platinum performance standards across the LEED platform (LEED ND, v4.0, RELi and Cities) (Box 5.14). Use of LEED-RELi credits and the USGBC should make more mandatory credits (box 5.1).

Decision-making needs to describe sustainability and resilience outcomes better, by carrying out more feasibility work so the conceptual interpretations can become more incorporated into the scope of works. Scope of works must address temporal and ecosystem scale of decision-making, so that there is a focus on achieving sustainability and resilience. The feasibility work needs to inform the scope. Practice needs better policies and to be engaged with, sometimes the best solutions take time and need more initial investment (Box 5.7, Section 5.4). The codes of practice must reduce habitual decision-making and needs leadership to generate even better practice that can override political shifts and standardisation of the scope of works (Boxes 5.10, 5.14, Figure 4.11).

Fainstein (2000) outlines that the role of planning in urban environments is critical, a position supported by CABE "*Using the planning system effectively to create the conditions for better urban design requires positive management, meaningful collaboration and the right skills*." (DETR and CABE, 2000, p.10). City planners need to become more political and act a-politically to override the political shifts and discursive use of measurement towards providing adaptation of future environmental and development scenarios (Vale, 2014; Meerow and Newell, 2019a). The critical action for city planners is to recognise the political shifts and not compromise on sustainability and resilience in decision-making (Mileti, 1999; Talen, Wheeler and Anselin, 2018). Zoning needs to unite areas by cutting through political

jurisdiction, in doing so better temporal, ecological and social responses can be envisioned and actioned. Collaboration needs to occur on how to manage local practice within the SES and zoning boundaries.

Codes of practice need to consider the uncertainty of climate change, need to enable local knowledge in decision making. Local codes need to be produced, but also endorsed by professional bodies who provide overarching support (Box 5.13). Transdisciplinary practice should be promoted - stakeholders and social voice need to be listened to and involved to generate ownership and responsibility of their local environment.

Imposing performance standards, there needs to be a minimum but also a way in managing temporal shifts of uncertain outcomes, and can this approach be standardised? The policies need to impose stretch targets and create decision making that have positive inputs into the system, more refurbishments and retrofitting rather than new. Finding ways of managing the ecosystem and urban environment so that flooding and heat island effects can be reduced.

7.3 Achieving the research aim and objectives

Established in Section 1.3 were the aim and five objectives of the research, a description of how they have been achieved is provided as follows:

The aim was to generate context to critically assess how sustainability and resilience interplay in decision-making of urban environments, which was focused on cities. The historical, theoretical and subject knowledge of the resilience and sustainability agendas has not created a new foundation but

reaffirmed the existing theoretical knowledge platform (Section 2.3.4). Contextual understanding has been provided by three US city case studies, which has led to the examination of decision-making in cities between policy, planning and design practice. By considering this context responses to how sustainability and resilience have been interpreted and measured have been provided (Section 7.2).

Objective 1 required a review and appraisal of literature to analyse and then synthesise the use of resilience and sustainability in urban environments with a focus on cities (Chapter 2). Theoretical and practice literature has been analysed and synthesised but also policy, planning and design documents have been appraised by a narrative review, which informed the case studies (Chapter 4). Through the examination of the existing theoretical foundation of resilience and sustainability, the narrative continued to indicate that the concepts are mutually supportive and converge (Dovers and Handmer, 1992; Handmer and Dovers, 1996; Kohler, 2018), but what had not been fully translated was whether the resilience component of this relationship should be measured; and knowledge transfer between decision actors of policy and planning was still an issue (Mileti, 1999; Carpenter *et al.*, 2001; Levine, 2014). By reviewing the historical context many interpretations, definitions and measurement frameworks of resilience were recognised, but when global policy organisations such as the UN (United Nations-General Assembly, 2016) and UNDDR (2019) are not working to the same definition, knowledge transfer is conflicted. This gave rise to the notion of too many meanings (Section 2.1), measurement frameworks (Section 2.2) and the

need to understand the reality of decision making specifically in context of the urban environment.

Despite the literature confirming that sustainability and resilience are broad concepts, what became apparent was the variety of meanings and resilient measurement frameworks (Sections 2.2, 2.3.5.3) were creating fractures between each other (Reghezza-Zitt *et al.*, 2012; Meerow and Stults, 2016; Meerow, Newell and Stults, 2016; Schlör, Venghaus and Hake, 2018). Sustainability in practice has generated measurement frameworks and resilience is considered as the umbrella for DDR (Achour *et al.*, 2015; Chmutina *et al.*, 2016). Methodological decisions were made so that preliminary narrative reviews of city context were carried out. This informed that decision-making pathways between policy and practice are critical (O'Connell *et al.*, 2015); and that carrying out research to compare the frameworks to inform further measurement systems should not be the focus of the research.

Objective 2 presented the greatest challenge because it required the establishment of a methodological approach to evaluate interpretations that have varying measurement frameworks, and generate context to examine them (Chapter 3). Perelman (2017) and Chmutina *et al.* (2016) identified that sustainability and resilience have been interpreted in such ways that have resulted in conflicts at varying levels of decision making. Instead of adopting a deductive approach on why a particular conflict might exist, an inductive approach was adopted to maintain a level of openness and go to broader levels of context to examine their interpretation and meaning (Foucault, 1972). Critical themes were identified to examine which were: which

interpretations had been adopted and how they had been measured; and the causal effects of decision-making in urban environments. Supportive research methods were established: narrative review and thematic analysis. Both methods were flexible enough to examine literature and still yield specific learning of how cities were considering sustainability and resilience. However, context needed to be generated to represent an urban environment. The spatial boundary then became cities and case studies were adopted (Yin, 2003). The result was three US case studies considering policy, practice and design practice in cities.

Examined in Section 6.1 have been the conceptual interpretations of resilience and sustainability and 'which' interpretation has been measured (Figure 7.2). All three cities portray that local policy is critical to practice as design and planning processes will only deliver best practice if policy stipulates it. Sustainability has been interpreted to mean carbon emissions and to be measured by the outcomes of the LEED design process. Resilience has been incorporated into policy due to the 100RC framework and the DDR position. These interpretations are subject to political shifts (Vale, 2014; Achour *et al.*, 2015).

Objective 3 required the examination of the cause and effect relationships of decision-making in the case studies (Chapter 4). Both resilience and sustainability are social subjects because they involve people making decisions to lead to successful outcomes (Ainger and Fenner, 2014; Green, Hope and Yates, 2015). To examine why, how and what the conflicts and synergies are between the agendas needed practice knowledge from experts (Section 3.4.3), although there were limitations in the sampling of planners

and policy makers (Section 7.4). However, the procedural knowledge gained through semi-structured interviews led to understanding there are causes and effects to decisions being made about sustainability and resilience. This led to the importance of causality, but the most poignant advice was learning that causality can be used with inductive reasoning and social knowledge, it just leaves the knowledge with the researcher at the end of the process (Miles, Hubermann and Saldana, 2014). Through the evaluation of the cause and effects of interpretations, measurement and decision making, ten causal themes were established at varying levels of decision making: C40, FEMA Funding, Political jurisdiction, Tax revenue, Emergency response, LEED, Political shifts, scope of works and habitual decision-making.

Objective 4 is reliant on the outcome of objective 3 (Chapter 5). Section 5.4 streamlines the causal themes and identifies that the majority of these were policy based and generate conflicts with practice (Section 6.2) (Mileti, 1999; Chmutina *et al.*, 2016). This process has identified some root causes of decision making conflicts such as SZEA and NEPA which relate to zoning and environmental measurement. Other critical conflicts are associated with tax revenues, social (and racial) and economic disparity and how decisions are subjected to political shits and jurisdiction. However, to truly theorise, this work needs further verification and insight with urban planning specialists, politicians and social experts. This is a limitation of the research but suggestion for further work is given in Section 7.3. Theorising causal relationships has relied on the researcher to interpret knowledge and not imposing limits too soon to advance theoretical knowledge but progress understanding through context. From generating context, Interplay timelines

(Figures 4.1, 4.4, 4.10, 4.14, 6.1) and explanations have been provided (Sections 4.6.7, 4.7.7, 4.8.7 and 6.2). The Interplay timelines have allowed patterns between policy and practice to be recognised and explained (Section 6.2).

Objective 5 to construct a theoretical foundation to explain interplay of resilience and sustainability in urban environments has been achieved, from critically examining sustainability and resilience in cities (Chapter 4,5 and 6). The theoretical outcome is that there is a case of Realpolitik for cities and that a level of responsibility of city policy has been established (Section 6.2.4) (Meadows, 2008; Bew, 2016). Bew (2016) describes a successful foundation of Realpolitik requires the distribution of power to shift away from economic conditions. This can be achieved if revisions to city zoning (SZEA) and city charters occur with the inclusion of social voice and consideration of the environment. Transformational changes can occur if the ideologies of resilience and sustainability create changes to the habitual decision-making of urban environments in policy, planning and design practice. If further work relating to revising zoning laws was carried out "*to identify where power, socioeconomic conditions and ideas [sustainability and resilience] overlap and converge*" (Bew, 2016, p. 304) then there can be a new foundation. Cities are responsible for the majority of the global population, so why are they not responsible for their commitment to global policies?

7.4 Research limitations

This section discusses limitations that are reflective of the whole research process, and specific to the scope, research design and the researcher.

Specific research method limitations have been previously described (Section 3.5.5).

Given the findings of the research, it would be helpful to expand the volume of interviews with policy makers and planners (Table 3.6) and to consider focus groups to expand on the findings. This research process does not represent a transdisciplinary process or focus groups with city governance, departments of planning and engagement with social groups. This process has required the researcher to undertake a significant volume of interpretative work across sectoral disciplines. This is particularly prevalent with regards to the researcher making abductive interpretations. For example, if the same dataset was given to a similar researcher and they followed the same protocols, they may achieve similar results, but the interpretative component is subjective and, only through further repetition, refinements can be made to the coding framework (Section 3.4.2). Focus groups could provide some further validity to the findings.

Miles, Hubermann and Saldana, (2014, p. 235) outline that generating a causal network with cross case analysis is "*perhaps the lengthiest and most complexly described of the analytic methods*". To expand the decision-making timelines into causal fragments does need further focus groups and more interviews. Section 6.2 discusses the themes and patterns which been established in policy, planning and design practice to the point where responsibility has been located in the decision-making system (Meadows, 2008). Logical patterns have been presented by the Interplay timelines (Figures 4.1,4.4,4.10,4.14,6.1) and an overarching discussion about policy and practice (Section 6.2), but what is not fully achieved is a causal network.

This is simply because there is more work to be done which is currently beyond the research scope (Section 1.3) and that building a causal network needs to be established from the outset (Miles, Hubermann and Saldana, 2014).

Defining a scope for contextual research is a necessity (Section 1.5) but difficult to define because there is limited knowledge on what the research design process will lead to, so there is a reliance on the research methods to provide constraint. The case study protocol (Table 3.5) provided limitations to context, the thematic analysis represents the decision-making pathway and together they provide context related to cities. The thematic analysis could be expanded to include other decision making levels such as construction, operation and community engagement but the volume of interpretation would be overwhelming unless there was a research design to build from. Literature narrative was very broad, seeking critical junctures but could not go into everything in detail, as this is not a longitudinal analysis of narrative: urban policy theory, urban resilience and urban sustainability- further work would need an extensive systematic review of literature in theory, policy and practice.

The case study design and semi-structured interviews support abductive reasoning but the answers for this research design presented themselves at the end of the process and knowledge constructed (Miles, Hubermann and Saldana, 2014). The limiting factor of this, is that further understanding becomes expansive towards creating causal networks and further deductive thematic narrative. Also, as knowledge starts to connect to its theory and identify possible causal actors, it has not been possible to deductively check

and verify through further social knowledge or literature to confirm it. Particularly as the narrative of this research is broad, it would benefit from more transdisciplinary design and action research on discipline specific issues in a future casual network. This is particularly relevant for the Chicago case study where the discursive use of sustainability, climate change and resilience seem to merge into one. Also, the optimal operation of the LEED framework is not fully understood without further investigations with Illinois Green Alliance and Mayor Lightfoot's office.

This research is reliant on the researcher and interpretations of literature, and data collected; this is not to say that there may be unintended bias of thought or that the research design could have been simplified.

7.5 Original Contribution to knowledge

Today the real risk to sustainable development and resilient cities is being created by political jurisdiction, habitual decision making of design and planning codes of practice with little relationship between knowledge and practice – and this in itself is the risk. The interplay between resilience and sustainability is reminiscent of the description of the conversations between John Muir (John Muir Trust, 2020) and Gifford Pinchot (Forest History Society, 2020) about 'conservation' and 'preservation' in the book "A history of environmental politics since 1945" (Hays, 1982). Is it time to simplify and unite the Sustainability and Resilience to address Goal 11 of SDGs through everyday working of knowledge with policy and practice? And to use the existing practice systems to work better together to override the poor

decision making and reduce the fracturing identities of both terms (Bradley, 2016; Kelly, 2018)?

In my professional capacity as a sustainability consultant and structural engineer, I have seen many organisations work towards creating a more sustainable and resilient world. There are a variety of international reporting mechanisms such as the GAR, the COPs, emission protocols and WGBC. These institutions and reporting mechanisms exist to steer policy and practice towards more informed decision making. Sustainable development has become well quantified but there is limited consensus on how to measure resilience and there is still a need to make better decisions that reduce the impacts of climate change. However, in a recent review by the ODI and Members of Resilience Measurement Evidence and Learning Group (COP, 2016), 39 resilience frameworks were analysed. Yet, what is not clear from their analysis is which interpretation of resilience was being measured and why there was so little urban context or sustainable development in the frameworks.

Given the importance and global status of climate change, this research suggests that sustainability and resilience are mutually beneficial agendas and that successes rely on the engagement of urban environments. In 2018, C3 Living project and USGBC launched the LEED-RELi (Wilson, 2018) framework resilience credits in the US LEED sustainable building measurement system. More recently in 2019, the USGBC has launched LEED Cities and Communities (USGBC, 2019). With all these measurement frameworks, how do we know whether the encompassing resilience and sustainability agenda is being achieved?

My contribution to knowledge is providing a revised foundation to consider how to improve decision making that incorporates better practice and policy. An opinion piece was written for the IREC 2019 conference titled "*A Comedy of Errors"- An Environmental Metaphor*" which explored this precise dilemma. The Environmental laws created in 1970 designed to protect the Environment no longer fulfil their original agenda due to political interference, and the world still experiences high levels of air, land and water pollution.

My research methods quickly aligned themselves with the interplay of decision-making pathways (O'Connell *et al.*, 2015) and asking how do we really know what interpretation of sustainability and resilience is being employed through city practice unless we ask them? (Bhaskar, 2008; Bryman and Bell, 2015). The research objectives construct knowledge from original sources such as systematic literature reviews of city documentation and semi structured interviews with sustainability and resilience specialists from built environment practice. How and what to ask was supported by the adoption of the case study method and supporting work in how to choose which cities in which country (Appendix 3.1). Discussed in Chapter 3, is the methodological approach which has deliberately steered away from deductive approaches or longitudinal strategies and not further developing existing theories but finding new territory (Gibbons *et al.*, 2006).

Delivering a thesis titled " *Investigating the interplay of sustainability and resilience of the built environment*" became the focus of the PhD but this only became apparent due to the open and broad approach to the research methodology. Real understanding of the research was not fully gained until the case studies (Chapter 4) and the results (Chapter 5) were produced.

Wanting better decisions in engineering practice has led to getting political. Acknowledging the importance, global policy has also had a role in both agendas, but as the broader concept of sustainable development became more neglected in policy, the need for more resilience in decision making has become more pronounced. However, the reality of the situation was brought to the surface by the interview responses; it is from their experience that the frustrations within the systems were able to surface. Although the US was used for the case studies and their use of national laws was examined, it is not to say that other countries are in similar situations. Realpolitik offers a foundation of thought to consider cause and effects in decision-making of sustainability and resilience in the built environment.

During the time of this research, Greta Thunberg initiated school strikes with regards to the impacts of climate change for her generation and her cause has started to gain momentum socially and politically. Equally at this time, President Trump is a climate change denier and has reduced FEMA powers and climate change rhetoric in the public knowledge. However, to produce real change still points towards the relationship between practice and policy and revising the following: NEPA and Zoning laws, municipal codes of practice between regional and local scales for both planning and design disciplines; and funding streams to carry out the necessary work to revise policy to enable better practice. Sustainable development needs to be mandatory and go beyond the LEED certified standard towards Gold, Platinum or NetZero or other building measurement systems that currently have filtered into city policies. Even though climate change is law by convention in some countries, building capacity and resilience are not

possible until the root causes of the habitual policy and practice are tackled in decision-making.

The Interplay timelines that connect knowledge are distributed through the thesis to provide historical understanding of the influences on decision-making. The three city case studies are a precursor to establishing root causes of actors or influencers in other cities (Chapter 2). Uniting theory, policy and practice is critical to reduce fractures in the agendas, and this is the new foundation of Realpolitik. This means environmental knowledge, sustainable development and resilience practice need to come together to move forward and reduce the stagnation that is faced with current climate change policies in practice.

7.6 Future Steps

The result of the methodological process has been the research design (Figure 3.1), which can be replicated for other cities or decision-making pathways and expanded into a causal network (Miles, Hubermann and Saldana, 2014). This can be considered in four ways:

- Examination of city zoning for further decision-making conflicts to consider how to reduce political jurisdiction to promote social voice and consider environmental land use;
- Continue to evaluate the optimisation of the combination of the LEED foundation (cities, ND, LEED-RELi, v.40 for all buildings) to understand what the remaining issues would be if the built

environment achieved LEED gold or platinum across sectoral boundaries, then address the gaps in procedural knowledge.

- Replication of the case study process with other cities to define their Realpolitik and consider similarities.
- To consider the extension of decision-making interplay timelines into a causal fragments to build a causal network for the built environment.

The research design would expand to include participatory and action research methods. This would include using specific design disciplines, policy makers and decision makers at national, state, urban and city level to ascertain how their working knowledge of the concepts leads to discursive irregularities in meaning and measurement. Causal maps could be incorporated into semi-structured interviews and focus groups. This would create a transdisciplinary decision-making pathway and new knowledge. To progress into a transdisciplinary network for cities there are four further steps:

1) Transdisciplinary:

Asking the same questions in the three cities to specific discipline stakeholder groups which represent a design team such as: project managers, building energy specialists, structural engineers, civil engineers, environmental specialists, water engineers. Then consideration of the policy decision makers, USGBC, C40, governance, institutions, lawyers, planning agencies, regional planners and communities. This would build a detailed transdisciplinary response and could influence how decisions are made and identify laws that need to be revised. This knowledge would emphasise the interpretations of sustainability and resilience and confirm existing measurement platforms. Power and knowledge of the stakeholders could

lead to an interesting dissection of whose knowledge is employed and provide more detail on the practice and policy relationship (Figures 5.1,5.2,5.3).

2) Repetition:

Overall the triangulation of the case studies and thematic narrative analysis with semi-structured interview methods in the research design can be replicated on other cities to build a database of Realpolitik of cities. This could consider other political boundaries such as regional and national (Appendix 4.1). This would expand the methodological process to include pattern matching between countries and cities of different population sizes; what is their Realpolitik? By understanding the characteristics of how sustainability and resilience interplay in decision making means that root causes can be identified more easily from practice knowledge than measurement frameworks.

3) Comparison:

Through the literature review, city frameworks were identified (Section 2.3.5). Currently in practice the City Resilience Framework (Da Silva and Moench, 2014) has started to underpin how cities and other institutions view resilience but how do their results compare with other frameworks? Can comparisons be made between the frameworks? It is vital that the impact of the existing decisions are evaluated for causality of strategic decision-making to provide an understanding of whether resilience should be measured. The Rockefeller foundation has collected data on cities from its 100 RC program (Leitner *et al.*, 2018; Flavelle, 2019), and it would be an interesting comparison exercise to see what Realpolitik is revealed from their datasets.

4) Casual Network:

The Interplay timelines of Figure 6.1 indicate that changes are occurring between policy and practice. Although practice may be informing policy, how does theory improve practice? Practice has developed its own responses to measuring sustainability and resilience (Section 2.2) but the theoretical foundation has only been partially interpreted or implemented. Questions remain about the use of resilience terms: adaptive capacity and transformation in an urban context and LEED performance in policies and municipal codes of practice.

Chapter 8 References

This section has provided literature references and web references in two sections.

8.1 Literature References

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Chapter 9 Appendices

Appendix 3.1 Ethical Approval

Appendix 3.2 Case Study Decision

Appendix 3.3 Case Study Document Lists

Appendix 3.4 General Questions

Appendix 3.5 Data Analysis

3.5.1 Initial Coding

3.5.2 Coding Table

3.5.3 Data collected for secondary analysis

Appendix 4.1 Cities Interplay timeline