

ANGLIA RUSKIN UNIVERSITY

**EXPERIMENTING WITH METHODOLOGICAL  
ADVANCEMENTS TO THE TRANSITION MANAGEMENT  
FRAMEWORK: A CASE STUDY ON CITY-REGIONAL  
HOUSING AND FUTURE WELLBEING**

LAUREN STABLER

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FACULTY OF SCIENCE AND TECHNOLOGY

DOCTOR OF PHILOSOPHY

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## **Abstract**

In the field of Transitions Research, the governance and analytical framework, Transition Management (TM), has received wide criticism for its top-down, technocratic nature and overreliance on the evolutionary function of variation and selection. The original aim of my research project was to offer methodological advancements to the TM framework that address these criticisms, and to investigate their impacts in an experimental, action research project. To investigate their impacts, I conducted a deductive, qualitative analysis of pre- and post-participation survey data and an inductive, qualitative analysis of observation notes and audio recordings from multi-stakeholder workshops.

Having confronted several barriers throughout the project, the scope of my research project evolved. Several of these barriers are cited in the literature on applied TM (e.g. lack of political buy-in and resource constraints), but others, to my knowledge, have not been reported (e.g. recruitment challenges resulting in lower representation). These barriers make up my first set of findings, resulting in a number of recommendations for TM scholars attempting to close the gap between theory and practice. The second set of findings relates to my proposed methodological adaptations. Given the preliminary nature of these findings, recommendations are made for their further investigation.

Finally, I found that participants, particularly commercial actors, are unlikely to invest in an iterative process of 'learning-by-doing' and 'doing-by-learning'. Moreover, if the short-term costs of intervention outweigh the short-term benefits, then partners will abandon multi-stakeholder initiatives, regardless of the long-term benefits. This third, and final, set of findings suggests that the transformative capacity of TM, which relies on stakeholders to co-govern sustainability transitions through voluntary partnerships, is significantly limited in practice. My findings have led me to echo conclusions that the absence of power and politics in TM's theoretical foundations has produced significant blind spots in its conceptualisation.

**Key Words:** Transition Management; Socio-technical transitions; Governance for sustainability; Participatory systems modelling; Housing; Future wellbeing



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# 1 CHAPTER 1: INTRODUCTION

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This chapter introduces my doctoral thesis in the context of the social-scientific problem it seeks to address (Section 1.2) and the societal context that motivates this scientific inquiry (Section 1.1). In Section 1.3, I present the structure of this thesis alongside a list of associated appendices to help guide readers. Because my thesis structure deviates slightly from the norm, Section 1.3 also explains and briefly justifies this deviation.

## 1.1 AN ENVIRONMENTALLY AND SOCIALLY UNSUSTAINABLE HOUSING SYSTEM

In 2017 a new subnational governance institution was formed: The Cambridgeshire and Peterborough Combined Authority (CPCA) (Institute for Government, 2019). As part of the devolution deal with local authorities, the UK national government devolved a significant housing and transportation infrastructure budget and decision-making powers to the newly formed CPCA to unlock economic growth in the city-region. In a unique policy window provided by English Devolution, this action research project aimed to respond to the societal problem of unsustainable housing development in Cambridgeshire and Peterborough – the geographical jurisdiction of the CPCA. This normative aim was pre-defined by the funding body, Sustainability East, a social enterprise advancing governance solutions for sustainability in the East of England.

My research thus began with a sustainability review of housing in the city-region, considering the long-term social, economic, and environmental impacts of the current housing system. As a Science and Technology Studies (STS) scholar, I adopted a ‘socio-technical’ conceptualisation of the housing system under study, i.e. one that is comprised of intrinsically linked, co-evolving technologies, supply networks, infrastructure, maintenance networks, regulation, cultural meaning as well as user practices and markets

(Geels, 2005, Geels, 2018). For the sustainability review, I also adopted the Brundtland definition of sustainable development<sup>1</sup>, with a focus on inter- and intra-generational equity.

The review of past and projected trends revealed numerous threats to future wellbeing as well as present, unmet need<sup>2</sup>. From a review of government statistics and reports, and the subsequent, qualitative systems analysis, I concluded that economic and housing market trends are amplifying poverty traps in Cambridgeshire and contributing to the growth in health, education, income, and other housing-related inequalities. Rather than address the underlying causes of this problem, local district councils have agreed to concentrate a greater share of housing development in surrounding, rural areas including the development of new towns, threatening socio-ecological resilience (Colding, 2007, Ahern, 2011, Ernstson et al., 2010).

## **1.2 INNOVATING GOVERNANCE STRUCTURES TO ADDRESS THE ROOT CAUSES OF UNSUSTAINABLE DEVELOPMENT**

The grand societal challenges of climate change, biodiversity loss, and resource depletion continue to motivate a diversity of social science research in the interdisciplinary field of Transitions Research. A central aim of the field is to understand how ‘sustainability transitions’, or radical shifts toward sustainable consumption and production patterns, can be brought about (Elzen et al., 2004, Grin et al., 2010). One of the research agendas within Transitions Research is ‘Governance for Sustainability’ or “governing transitions” (Köhler et al., 2019, p. 1). Within this literature, there is a consensually held view that existing governance structures: (i) are very poor at coordinating trade-offs between conflicting development goals

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<sup>1</sup> “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs” BRUNDTLAND, G. H., KHALID, M., AGNELLI, S., AL-ATHEL, S. & CHIDZERO, B. 1987. Our common future. *New York*, 8.

<sup>2</sup> I captured much of this information in public-facing ‘Risk Cards’ (see Appendix C) for use in the research project (see Section 4.2).



(e.g., pursuing continuous economic growth vs. observing environmental limits to growth) and (ii) actually contribute towards institutional rigidity (Pierre, 2000, Jessop, 1997, Mayer and Gereffi, 2010). Responding to calls for a more *adaptive* governance approach, governance scholars have attempted to define institutional characteristics that would enable government to provide opportunities for reflexivity and contestation of existing regimes (i.e. configurations of dominant technologies, supply chains, user preferences, etc.) and successfully govern transitions toward sustainability (see Section 2.3).

From this theoretical literature, 'Transitions Management' (TM) was born – a prescriptive governance and analytical framework designed to help steer society towards sustainability (Loorbach, 2010) (see Section 2.4). Despite its promise, Transition Management is a framework in need of methodological advancement. As described in the literature review (Section 2.5), the top-down, technocratic nature of TM may jeopardise its legitimacy and innovative potential. Second, TM's over-reliance on the evolutionary function of variation and selection may backfire if political and financial capital are spent on failed interventions that deter future action.

The aim of my research project is thus to offer methodological adaptations to the TM framework that address these two criticisms and investigate their impacts on governance for sustainability in an action research project on housing and future wellbeing in Cambridgeshire and Peterborough. Over the course of my research project, I was confronted with a number of practical barriers that prevented me from executing and investigating my methodological innovations to their conclusion. Still, I present my original research questions at the end of Chapter 2: Literature Review, so that the reader may better understand how and why the research project evolved. Whilst these research questions were only partially investigated, they did reveal useful findings in relation to my proposed adaptations and recommendations for their further investigation (Sections 7.2.2, 7.3.2, 7.4.1, and 7.4.2). In addition to findings generated by my original research aim, the *evolution* of my research project also revealed a number of independent

findings related to the gap between TM theory and practice commonly cited in the literature. The first set of independent findings relate to the practical barriers and are accompanied with a set of recommendations for TM practitioners wishing to overcome these barriers (Sections 7.2.1, 7.3.1, 7.5.1, 7.5.2). The second set of independent findings relates to barriers created by TM's inherent theoretical limitations, or blind spots, that are also responsible for the gap between theory and practice (Section 7.5.3).

### **1.3 THESIS STRUCTURE**

The structure of my thesis, including the aims of each chapter and associated appendices, can be found in Table 1. Chapter 2: Literature Review introduces the reader to the analytical and governance framework, Transition Management (Sections 2.2, 2.3 and 2.4), including debates around its methodological weaknesses and knowledge gaps in overcoming them (Section 2.5). In the final section, Section 2.5, I introduce my original research questions developed to guide my investigation of methodological adaptations I have proposed and trialled in my Cambridgeshire and Peterborough Housing & Wellbeing action research project. In Chapters 4 and 5, I present findings from the visioning workshops and co-modelling exercises, respectively. When it came to utilise the outputs of these two workstreams in the final phase of my research project and, more importantly, investigate their impacts on the intended outcomes of TM, practical barriers stood in the way. As such, their investigation was partial. I present these partial findings in Chapter 6: Findings from the frontrunner workshop. However, the barriers themselves presented new findings and considerations for Transition Management as a practice-based methodology. Despite falling outside my original line of enquiry, I discuss these findings in Chapter 7 alongside partial findings to my original research questions. Although this creates a slight awkwardness for the reader, this decision was made consciously, as key findings related to the gap between TM theory and practice lie in the evolution of my research project.

Table 1: Thesis structure

Chapter title	Aim	Associated Appendices
<b>Chapter 1: Introduction</b>	Identify the problems, both societal and scientific, my thesis aims to address.	NA
<b>Chapter 2: Literature Review</b>	<ul style="list-style-type: none"> <li>- Present the theoretical foundations of Transition Management (TM) (Section 2.2)</li> <li>- Situate TM within the wider fields of Transitions Research (Section 2.3) and Governance for Sustainability (Section 2.4),</li> <li>- Delve into debates around TM's methodological weaknesses (Section 2.5).</li> <li>- Introduce original research questions (Sections 2.5.1 and 2.5.3)</li> </ul>	NA
<b>Chapter 3: Methodology</b>	<p>Present:</p> <ul style="list-style-type: none"> <li>- How my adoption of a critical realist philosophy of science has influenced my research aims and design (Section 3.2);</li> <li>- Why a single case study, participatory action research design is appropriate in relation to my research questions (Section 3.3 and 3.4);</li> <li>- Why the analysis of qualitative data is necessary to answer my research questions (Section 3.5);</li> <li>- What methodological adaptations I have put forward for investigation (Section 3.6);</li> <li>- And how ethical considerations informed my research design (3.7)</li> </ul>	Appendix A (in relation to ethical considerations)
<b>Chapter 4: Findings from the visioning workshops</b>	Present findings from the two visioning workshops in Peterborough and Cambridge cities.	Appendices B and C
<b>Chapter 5: Findings from the co-modelling process</b>	Present findings from the process of building a large, qualitative systems model using interview data and findings from academic and grey literature.	Appendix D
<b>Chapter 6: Findings from the frontrunner workshop</b>	Present findings from the multi-stakeholder workshop in which the qualitative systems model was reviewed by the region's frontrunners in the housing, environment, transport, energy and community development sectors.	Appendix E
<b>Chapter 7: Discussion</b>	Discuss the methodological and theoretical implications of my findings for applied TM. This discussion is of greatest relevance for TM	NA

	practitioners and academics working in the wider field of Sustainability Governance.	
<b>Chapter 8: Conclusions</b>	Provide: <ul style="list-style-type: none"> <li>- Recommendations to continue the investigation of methodological advancements to the TM framework that address its aforementioned criticisms, including further investigation of and improvements to my proposed adaptations (Sections 8.1, 8.2, and 8.3)</li> <li>- Further reflections on TM's theoretical blindspots</li> </ul>	NA

## 2 CHAPTER 2: LITERATURE REVIEW

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### 2.1 INTRODUCTION

Whereas historical transitions (e.g., in transport and energy systems) are ‘emergent’, sustainability transitions are ‘purposive’ (Smith et al., 2005). As history shows, socio-technical transitions have not tended toward a more sustainable society (Rotmans, 2005). This is mainly due to the fact that historic innovators (e.g. entrepreneurs exploring commercial opportunities for new technologies) lack incentives to provide public goods such as sustainability (Geels, 2011). Furthermore, governments responsible for providing public goods are often deterred by the collective action problem associated with the provision of global public goods, such as climate change mitigation (Olson, 1965). It is within this context that the field of ‘Transitions Research’ was established. Transitions scholars analyse successful and unsuccessful transitions toward more sustainable means of production and consumption. The normative aim of this research is to uncover knowledge that may help accelerate present-day transitions toward sustainability (Sengers et al., 2019).

Throughout its lifetime, Sustainability East (SE) – the funding body of my doctoral studentship – shared the normative aim of accelerating present-day transitions toward sustainability, albeit through their engagement with local authorities in the East of England. The organisation was nearing its end around the same time the UK national government devolved a significant budget and decision-making powers to the newly formed Cambridgeshire and Peterborough Combined Authority – the only sub-regional government to be formed in the East of England as part of English devolution as of June, 2019 (Institute for Government, 2019). English devolution was perceived by SE board members as a window of opportunity for sustainable innovations in sub-regional housing and transportation infrastructure development and policy-making – the governance areas included in the first round of devolution. As such, SE established a legacy grant to

investigate these opportunities and potential barriers to transition in the East of England. Along with project funding, SE offered and encouraged the use of its regional network of local practitioners committed to sustainability.

Much of this research, however, would have been speculative. Although Manchester provided a mature case study<sup>3</sup> for the role of English devolution in sustainability transitions, the aim was to study opportunities and challenges unique to the East of England through, for example, interviews with SE's regional contacts. Instead, it was decided that the window of opportunity be utilised by local stakeholders through their participation in an *action* research project. In other words, it was decided that the research project would bring together a diverse group of stakeholders who could, themselves, propose Combined Authority-led interventions and investigate the 'accelerating' potential of these interventions for achieving sustainability transitions.

Transition Management (TM), a framework developed within the field of Transitions Research with both analytical and operational governance applications, seemed very well suited to this this project. TM is a multi-stakeholder governance framework designed to facilitate visioning around sustainable futures as well as real-world experimentation with socio-technical innovations that have the perceived capacity to accelerate sustainability transitions. It provides a process methodology to guide action research with a network of innovators committed to the sustainability agenda. Moreover, it relies on the participation of Government as a convening body and key stakeholder for realising sustainability transitions. Although the framework was first utilised in a national setting, its application at the local level has significantly increased in recent years (Frantzeskaki et al., 2018b).

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<sup>3</sup> The Greater Manchester Combined Authority was established first in 2014, followed by a 3-year lull before the next round of English devolution deals were agreed INSTITUTE FOR GOVERNMENT. 2019. *English devolution: combined authorities and metro mayors* [Online]. Available: <https://www.instituteforgovernment.org.uk/explainers/english-devolution-combined-authorities-and-metro-mayors-2019>..

This chapter presents findings from a review of TM literature beginning with its theoretical foundations (Section 2.2), situation within the broader Transitions literature (Section 2.3), unique contribution to Governance and Transitions Research (Section 2.4.1), process methodology (Section 2.4.2), and recent turn towards local transitions (Section 2.4.3). Criticisms of TM are also presented (Section 2.5), specifically problems associated with its process methodology that may be restricting TM's ability to facilitate accelerated transitions. In Chapter 3: Methodology, I propose two major adaptations to the TM framework in response to these criticisms, one of which includes the integration of System Dynamics Modelling, summarised in the last subsection (Section 2.5.3).

## **2.2 THEORETICAL FOUNDATIONS OF TRANSITION MANAGEMENT**

This section presents the theoretical foundations of TM, namely complexity theory (Sections 2.2.1) and the Multi-level Perspective (MLP) on socio-technical transitions (Section 2.2.2).

### **2.2.1 Complex systems approach to sustainability transitions**

#### **2.2.1.1 *What are complex systems?***

According to complex systems theory, complex systems are said to be comprised of numerous, self-organizing subsystems, interconnected in a complex web of nonlinear interactions and feedback loops driving chaotic system behaviour (Capra, 1996). The theory encompasses social, ecologic and technical systems and is thus found in a wide range of disciplines from biology (Kauffman, 1995) to economics (Arthur, 1997). While originating from general systems theory originally published in the 1930s (Von Bertalanffy, 1968), the integrated nature of social, economic and ecological process did not enter into the theoretical perspective until the 1970's and 1980s with integral systems theory (Holling, 1978, Rotmans et al., 1990, Hordijk, 1985).

Based on insights from complexity theory and evolutionary economics, Transitions scholars understand societal transitions from a quasi-evolutionary (path-dependent) perspective (Van den Bergh et al., 2011). From this perspective, social and technical innovations are either rejected or selected for scale-up and, in turn, transform the dominant 'socio-technical systems', or 'regimes', that mediated their selection. Regimes are stable, society-wide configurations of *inter-related* (and *co-produced*) social and technical factors, e.g., social norms, rules, procedures, knowledge and material artefacts. As such, transitions, in both evolutionary economics and Science and Technology Studies (STS) traditions, are understood as resulting from the *co-evolution* of system components (Rip and Kemp, 1998), the analysis of which encompasses system actors (e.g., individuals, businesses and civil society organizations) and their networks, social institutions (e.g., common practices and legal institutions), material artefacts and knowledge. (Markard et al., 2012)

Whilst a single complex systems theory does not exist (Rotmans and Loorbach, 2009), a set of "understandings" of the *characteristics* and *behaviour* of complex systems has been articulated and applied in transition research (Prigogine and Stengers, 1984, Holling, 1978, Kauffman, 1995, Holland, 1995). First, complex systems are said to be *open* systems and thus interact with their environment. Second, they are composed of nested subsystems with diverse, interacting components. These interactions are non-linear and comprise feedback loops, both positively re-enforcing and negatively damping, resulting in *dynamic* system behaviour that is somewhat predictable in periods of relative stability (or 'dynamic equilibrium') and unpredictable in periods of chaos ('punctuated equilibriums'). Chaotic behaviour emerges when relatively stable, goal- (or equilibrium-) seeking systems cross the so-called 'chaotic edge' due to external stimuli or internal system failure. 'Internal system failure' refers to the system's failure to resolve increasingly critical persistent problems due to system 'lock-in'. Many transitions scholars argue that existing governance institutions are unable to overcome system lock-in (Loorbach et al., 2011), motivating



the development of TM as an alternative governance framework to coincide with existing institutions. The following subsections provide a summary of system lock-in as theorised in the literature.

#### **2.2.1.2 Causes of system rigidity and lock-in**

Natural systems undergo continuous and abrupt changes as a result of human intervention, often with largely unpredictable consequences. Resilience thus depends on actors' ability to 'expect the unexpected' (Kates and Clark, 1996). In complex systems theory, this can be understood as 'system adaptation'; i.e. the ability of micro-level agents to recognize socio-ecological landscape pressures and self-organize to transform unsustainable modes of operation, e.g., in production and consumption. Adaptation is not a swift and simple process, however. In this section we present sources of system "rigidity" (Olsson et al., 2014, p. 2), namely *homogenization*, *complexity*, and *power dynamics*.

In complex systems theory, 'rigidity' is said to increase over time as systems mature reducing their ability to adapt to landscape pressures and thus undermining their resilience (Gunderson, 2001, Carpenter and Brock, 2008, Boonstra and de Boer, 2014, Tidball et al., 2016). Rigidity traps are rarely owed to a lack of resource. Rather, financial and social resources that have accumulated over time are bound up in institutional arrangements designed to advance incumbent regimes (Carpenter and Brock, 2008).<sup>4</sup> The release of these resources for system transformation is prevented as a result of (1) system homogenisation; (2) complexity; and (3) power dynamics.

As regimes mature, they build highly connected, vertically integrated, and specialized "cliques" (Turner, 2017, p. 6) designed to improve the effectiveness and efficiency of goal pursuance. Over time, this process has a homogenizing effect on actors' expectations, goals, strategies, and modes of operation, thus undermining the capacity for innovation. With repeated social interactions, network 'clique' actors

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<sup>4</sup> Although, systems may be deficient in resources such as political will or public support MOORE, M.-L. & WESTLEY, F. 2011. Surmountable chasms: networks and social innovation for resilient systems. *Ecology and society*, 16..

eventually develop and institutionalize ‘standard’ practices that go unchallenged. For example, process patterns in the housing sector were once “‘very jumbled”, process segments “loosely linked” and management challenges “dominated by bidding, delivery, product design flexibility, scheduling, materials handling and shifting bottlenecks” (Vrijhoef, 2011, p. 40) with few repeated interactions among firms<sup>5</sup>. Although inefficient, these polycentric network structures support innovation and learning. With time, however, vertical integration has led to a sector dominated by large firms with control over several aspects of the development process (CPRE, 2014, Vrijhoef, 2011). Over the past three decades, the share of homes constructed by SME house builders in the UK dramatically decreased from 66% in the 1988 (PBC Today, 2019) to less than 13% in 2018 (Clark, 2018). This vertical integration produces cognitive homogenisation that stifles innovation, as “discrete clusters of partnerships” organize around rigid, single project types (Turner, 2017, p. 6).

System homogenisation goes beyond shaping the character and operations of supply-side actors. Repeated interactions with banks, planners, engineers, home-buyers, and other system actors inform their beliefs, expectations and practices, also organised around particular project types. For example, system homogenisation has led to a reluctance of banks to lend to small and medium-sized enterprises (SMEs); an increasingly complex planning system less accessible to SMEs; a ‘compliance’ engineering culture that automatically assumes higher costs associated with more sustainable design; and locked-in community visions of status quo development strategies and building designs (Coiacetto, 2006, Allen, 2014). Not only does this trend threaten innovation by denying entry to new firms, it also increases the cost of sector reform. The adoption of sustainable design standards requires major institutional reorganization, both in finance and delivery – a process that incurs greater losses to highly mature, homogenous, connected and

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<sup>5</sup> As compared to process-based sectors such as manufacturing which homogenize sooner SCHMENNER, R. W. 1993. *Production/operations management: from the inside out*, Macmillan Coll Division..

focused systems. Large construction firms report that alternative design adoption would require a complete overhaul of supply chains and business models (Rudel et al., 2011).

How does TM combat this first source of system rigidity? System homogenisation encompasses regulatory frameworks, citizen's preferences, and decision-makers' understandings of what alternative realities are attainable. As such, democratic governance institutions perpetuate unsustainable systems by creating regulatory and normative barriers to transition. Although, not seeking to replace democratic institutions, Transition Management (TM) is designed to create space, or a so-called 'transition arena', for social and technological innovators operating outside the system. In this space, sustainability challenges can be reflected upon and radically alternative realities can be envisaged and experimented with via multi-stakeholder initiatives. Through reflexive, experimental and inclusive governance, TM is said to help innovators intervene in rigidity traps – both material and socio-cultural.

Complexity is an additional barrier to change. Tackling sustainability challenges requires coordinated action from a multitude of actors operating at different spatial and time scales with diverse interests, knowledge, and values. For example, in the housing sector there is little incentive for developers to 'design-out' environmental costs such as storm water runoff, as they are largely external to development transaction costs (Turner, 2017). Indeed, several studies have shown that sustainable development practices (i.e., those that safeguard ecosystems services and public benefits) provide no significant financial returns to land developers, as these services (with the exception of open, natural space) are not captured in the real estate exchange value (Lutzenhiser and Netusil, 2001, Geoghegan, 2002, Song and Knaap, 2004, Pejchar et al., 2007). Shearer et al. (2013, p. 45) conclude that this problem of "short term commitment versus long-term consequences is fundamental to the issue of sustainability in property development." Bounded tenure of land developers protect profits from mid- to long-term sources of land devaluation and thus prevent sufficient feedback to provoke changes like adopting [sustainable] development [practices]"

(Turner, 2017, p. 8). As such, degradation of land, water and other natural ‘amenities’ that provide value to a given development are distributed to homeowners and municipalities rather than the land developers that engaged in unsustainable development practices.

Complexity also increases the likelihood of blame avoidance. In the housing sector, “(1) home builders can build sustainable buildings but developers do not commission them; (2) developers would commission them but investors will not finance them; (3) financial institutions would finance them but market demand is not proven; and (4) end users, e.g., homeowners, would occupy them but home builders introduce few options to the market” (Turner, 2017, p. 5). This “vicious cycle of blame” is characteristic of problems arising in complex systems with a high level of ‘subsystem’ interactions and interdependencies.

In the government sector, complexity often produces governance ‘mismatches’, or spatial and temporal misalignments between constitutionally rooted governance scales and problem scales (Cumming et al., 2006). This is because governance scales are determined based on several logics (e.g., economic regulation, spatial planning, etc.) which often conflict with other logical scales (e.g., for nature conservation). In social-ecological systems, “temporal mismatch” occurs when *temporal* scales of management and those of ecosystem processes are poorly aligned (e.g., when bureaucratic processes are too slow to react to rapid ecological change or when an incumbent government pursues solutions that outlast an administration’s lifetime). Spatial mismatch, on the other hand, refers to misalignment between *spatial* scales of management and ecosystems that provide critical public goods and services such as clean water, air, biodiversity and climate. Spatial mismatch also occurs between the scale at which decisions are made (e.g., local adaptation decisions) and the scale at which knowledge is produced (e.g., global climate change models) (Termeer et al., 2010). Problems resulting from spatial mismatch, e.g., governance redundancies and ‘institutional voids’ (Hajer and Wagenaar, 2003), are well documented in natural resource management literature. In their analysis of social-ecological problems unique to metropolitan

areas governed by a multiplicity of federal, state, city, and district level authorities, Ostrom et al. (1961, p. 831) highlight the commonly found paradox whereby “too many governments” fail to provide “enough government”. In other words, additional layers of government may actually produce, rather than alleviate institutional voids.

How does TM combat this second source of system rigidity? To break the rigidity caused by complexity, a great deal of coordination between a diverse set of stakeholders is needed to achieve system change. The assumption here is that governments cannot achieve system change on their own, and actually require a diversity of actors with a willingness to experiment and shared vision of a sustainable future. TM offers a governance framework to bring these individuals together; translate sector logics; build a multi-dimensional understanding of the complex, sustainability challenge; resolve conflicts arising from divergent interests; and coordinate actions to test socio-technical innovations. This is the second way in which TM addresses rigidity traps associated with the unsustainable development of complex systems.

Finally, incumbent regimes distribute power nonuniformly, thus producing uneven power dynamics. This process is self-reinforcing given the positive relationship between power and steering capacity. Assuming self-interest, power dynamics are strong inhibitors of change. Even significant negative social, economic and environmental consequences of unsustainable development may not be sufficient to trigger societal transformation, as powerful actors continue to benefit from the incumbent regime, at least in the short-term (Gunderson, 2001, Carpenter and Brock, 2008). This is additionally concerning, given the ability of powerful agenda-setters to prevent opinion shifts by neglecting the problem or by competition for attention to other issues and problems that take place simultaneously (Scheffer et al., 2003).

How does TM combat this final source of system rigidity? Although democratic governance institutions provide opportunities to challenge the status quo, representative democracy forwards the most popular opinions and dominant narratives over which powerful actors have significant influence. As

such, democratic institutions, themselves, replicate unsustainable practices and are an integral part of the complex system that is developing unsustainably. From this perspective, governance institutions are more likely to optimise unsustainable systems, e.g., by legislating plasters for the symptoms of unsustainable development, than actually challenge or deconstruct them. In contrast, TM specifically empowers dissenting voices to shift power dynamics so that innovators may disrupt the status quo.

#### **2.2.1.3 What are self-adaptive systems?**

As was previously stated, these sources of system rigidity can produce ‘internal system failures’, resulting in chaotic system behaviour. As complex systems approach the so-called ‘chaotic edge’, they either adjust, collapse, or abruptly shift developmental trajectories toward entirely new attractors (Kemp et al., 2007). Minor adjustments made to highly mature systems typically fail to resolve the underlying causes of internal system failure, resulting in the delayed, re-emergence of chaotic behaviour. The only resolution to this chaotic behaviour is system collapse or system transition – both of which result in irreversible patterns of change. In both scenarios, new properties (e.g., higher level structures, patterns and behaviours) emerge that are impossible to predict given the complexity of interactions (Goldstein, 1999).

When complex systems transition, they are said to do so from within. They are *self-adaptive* in the sense that subcomponents, also referred to as ‘agents’, *self-organize* in response to changes in the environment (Macías-Escrivá et al., 2013). Because the response of one agent inevitably impacts upon others, these responses create knock-on effects and eventual chaotic system behaviour. During this period of disruption, nested subsystems may *co-evolve* toward new attractors (Gerrits, 2012, Room, 2011). The development of individual subsystems cannot be fully understood in isolation, given the interconnectedness and co-evolution of subsystems.

### 2.2.2 The Multi-level Perspective on sustainability transitions

The Multi-level Perspective's (MLP's) model of system evolution can be seen as a "concrete operationalization of complex adaptive systems" (Van den Bergh et al., 2011, p. 9), as MLP is situated within the 'grand theory' of complex adaptive systems, but also takes from innovation systems theory, evolutionary economics and neo-institutional theory. According to the MLP, systemic change (either toward or away from sustainability) is *dynamic* and *multi-dimensional*. Transitions are *dynamic*, as they involve changing trajectories of various sub-regimes (natural ecosystems, science, technology, politics, markets, user preferences and cultural meanings), which are distinct but interconnected (Geels, 2011). Transitions are *multi-dimensional* in that they are the product (and determinant) of (future) innovations.

To illustrate the multi-dimensionality of socio-technical transitions, the MLP identifies three analytical levels: "*niches* (the locus for radical innovations), *socio-technical regimes* (the locus of established practices and associated rules that stabilize existing systems), and an exogenous *socio-technical landscape* (Rip and Kemp, 1998, Geels, 2002, Geels, 2005)" (Geels, 2011, p. 26). At the niche-level, human actors are understood as agents of change, with the capacity to reflect, learn from experience, change patterns of behaviour and reconstruct socio-economic systems. It is theorized that the actions which redirect socio-economic systems toward new 'attractors' are initially taken by a small group of agents deviating from the regime<sup>6</sup>. Together, these agents develop 'niche innovations' in response to landscape pressures. If these innovations mature into alternative, socio-technical configurations, they compete with incumbent socio-technical regimes, compounding landscape pressures for change.

The landscape, as conceptualized by MLP, operates at the *meta-level* (the highest conceptual level of the MLP) and changes only slowly over time, based on developments in the niche (micro-) and regime

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<sup>6</sup> Conceptually similar to socio-technical imaginaries from the field of Science and Technology Studies (STS)

(meta-) level<sup>7</sup>. The socio-technical landscape forms the context for niche- and regime-level developments and thus influences their dynamic interaction. Landscape tensions (e.g., anthropogenic climate change) put pressure on the regime and elicit adaptive responses by niche (micro-level) agents (e.g., political pressure to reduce greenhouse gas emissions), the actions of whom feed back into meso- and meta-level processes in a rather complex manner (Geels, 2010, Schot and Geels, 2008). If pressure is sufficient, the regime begins to destabilize, creating a window of opportunity for niche-innovations to ‘take-off’, ‘accelerate’ and potentially replace the incumbent regime (Geels, 2002).

Because these niche developments operate in an environment largely governed by incumbent regimes, however, they require some form of alignment to produce ‘configurations that work’ (Rip and Kemp, 1998). In System Dynamics Theory, this concept is more broadly discussed in terms of system resilience. Because systems are said to be self-organizing to maintain ‘dynamic equilibrium’, any abrupt forcing of the system to an entirely new attractor would create backlash (Rotmans and Loorbach, 2009). As such, radical transition progresses via incremental, albeit significant, change, allowing time for the construction of new structures (e.g., networks, norms, material infrastructure, etc.) that support new configurations.

Relating again MLP’s account of socio-technical evolution to System Dynamics Theory, system adaptation is thus “the result of human action – the outcome of conscious or largely conscious thought” (Stark, 2009, p. 13). Through cultural memory, communication, foresight, mobility and technology, humans can abstract themselves from the systems in which they are embedded, reflect on human behaviour that impact larger systems, and choose to modify that behaviour. It is through *reflexivity* that humans adapt to

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<sup>7</sup> For the debate on an alternative ‘flat ontology’ of transition analysis, see JØRGENSEN, U. 2012. Mapping and navigating transitions—The multi-level perspective compared with arenas of development. *Research Policy*, 41, 996-1010, CHANG, R. D., ZUO, J., ZHAO, Z. Y., SOEBARTO, V., ZILLANTE, G. & GAN, X. L. 2017. Approaches for Transitions Towards Sustainable Development: Status Quo and Challenges. *Sustainable Development*, SHOVE, E. & WALKER, G. 2010. Governing transitions in the sustainability of everyday life. *Research policy*, 39, 471-476..



meta-level pressures and transform socio-technical systems. Paradoxically, however, landscape pressures related to human wellbeing and environmental sustainability have yet to provoke urgent changes needed in the UK's housing system among others. This suggests that regime rigidity discussed in Section 2.1.2 is quite strong and transitions to a sustainable state require conscious steering.

Based on a multi-level understanding of complex systems, TM is predicted to help steer transitions toward sustainability through its facilitation of three transition processes, namely 'deepening', 'broadening' and 'scaling up'. *Deepening* refers to the process of higher order learning, previously defined as "a radical change in interpreting observations (interpretive frames) and in solving problems and advancing objectives. [...] It entails changes in the assumptions, norms and interpretive frames which govern the decision-making process and actions of individuals, communities and organisations, or which underlie a policy discourse. It occurs through reflection and self-evaluation." (Brown and Vergragt, 2008, p. 110). Deepening thus takes place during the visioning and back-casting phases of TM.

Due to the limited number of participants, successful deepening will only produce relatively unstable, so-called 'transition niches', which then coexist with dominant culture, practices and structures. They are characterized as having low influence in the development of the overall regime. Thus, there is also a need for *broadening*, or replication of transition experiments in different contexts – either spatial or sectoral – to achieve the proliferation of deviant niches. At the core of broadening is an evolutionary concept of variation at the micro-level, inspired by theories of speciation and innovation (Levinthal, 1998, Nooteboom, 1999, Rogers et al., 2017). During the broadening phase, heterogeneous actor networks are mobilized and progressively build credibility around alternative configurations before they can be successfully scaled-up (Späth and Rohrer, 2012). Network building is critical for engendering commitment to and investment in niche innovations, developing structural support for their growth, and

disseminating 'lessons learned' to support further experimentation and refine ongoing projects (van den Bosch, 2010).

*Up-Scaling* refers to the final process of niche embedding at the meso-level, resulting in a transition to a more sustainable socio-technical regime (Jolly et al., 2012). Acceleration and stabilization of alternative configurations will ultimately depend on the co-evolution of recursive developments at and between the micro-, meso-, and macro-levels (van der Brugge, 2004). As such, TM experiments should directly involve regime-actors who have the willingness and power to change existing financial, regulatory and material structures (Sengers et al., 2016b).

Deepening, broadening and up-scaling of innovations need not produce sustainable outcomes. The socio-technical shift from carriages to automobiles, for example, have led to significant improvements in mobility, whilst contributing to land-use change, environmental degradation and anthropogenic climate change. These emerging problems are not only difficult to predict, their persistence will inevitably lead to increasing socio-economic-ecologic crisis and the eventual collapse of unsustainable socio-technical systems as they exceed planetary boundaries (Rockström et al., 2009, Steffen et al., 2015). It is hypothesized, however, that with a sufficient understanding of dynamic transition processes and steering mechanisms, actors can consciously influence the course and pace of societal transitions in the direction of sustainability (Rotmans, 2005). On the basis of this theory, scholars have developed Transitions Research, an ambitious, solutions-oriented research agenda to which TM belongs.

## **2.3 SITUATING TRANSITION MANAGEMENT IN THE WIDER LITERATURE**

The Sustainability Transitions Research Network (STRN), an independent, research-driven network of scholars and practitioners, was inaugurated in 2009 with over 1500 current members. These scholars employ a number of analytical frameworks, including the Multi-level Perspective on socio-technical

transitions. Before introducing additional frameworks, I discuss three approaches to governance that have explicitly or implicitly shaped their conceptualization. These include the ‘command and control’, ‘public-private’ and ‘adaptive’ approaches to governance (Section 2.3.1). Thereafter I present Transition Management (Section 2.3.2) as a prescriptive model of *adaptive* governance with a portfolio of steering tools designed to achieve the normative, long-term goal of sustainable development (Loorbach, 2010, Loorbach et al., 2016, Rotmans et al., 2001, Rotmans and Loorbach, 2008, Kemp and Rotmans, 2009).

### 2.3.1 Three related approaches to governance

Frameworks for the analysis and design of transition governance have developed under three divergent (though related) perspectives on governance, namely command and control, public-private and adaptive/reflexive governance (Turnheim et al., 2015). The ‘**command and control**’ perspective employs a more traditional understanding of governance via centralised regulation, emphasizing the role of nation-states, politically defined goals and top-down governance tools to steer transitions toward sustainability.

With significant overlaps, the ‘**public-private governance**’ perspective rather emphasizes the role of firms, public-private partnerships and institutional settings conducive for business-led innovation (e.g., structures for corporate finance, labour markets, patent legislation, etc.). This perspective has developed as a response to the shift from “top-down steering by government” toward “liberalized, market-based, and decentralized” governance structures in modern society (Loorbach, 2010, p. 161). Indeed, with increasing economic privatization, dwindling state budgets and globalized supply chains, firms (particularly multinational corporations) have themselves become relevant governance actors.

Despite the indispensable role of the market and government in steering societal change, several transition scholars have questioned their effectiveness in coordinating trade-offs between conflicting development goals (e.g., pursuing continuous economic growth vs. observing environmental limits to growth) as well as their increasing institutional rigidity (Pierre, 2000, Jessop, 1997, Mayer and Gereffi,

2010). The coordination of trade-offs for long-term development requires less rigid, interactive, and reflexive processes of debate and dialogue, which occur at the level of society. It is in society where people are free to consider adverse side effects of modernization, change their beliefs and attitudes toward dominant regimes and fundamentally reimagine pathways of development. The '**adaptive governance**' approach thus emphasizes the role of society in providing much-needed reflexivity (Newig et al., 2013, Voss et al., 2006). In effect, the adaptive governance approach implies a new governance framework that strikes a balance between state, market and society (Mintzberg, 2015).

It is important to note that the aforementioned governance perspectives are not exclusive. The private-public governance perspective does not deny the need for top-down policy. Rather, it adds to our traditional understanding of governance by showcasing the very real governing power of multinational corporations when operating across national legal jurisdictions, as well as the increasing role of private firms in providing public goods and services. Likewise, the adaptive governance perspective does not deny the formal and informal governing roles of public- and private-sector actors. On the contrary, adaptive governance frameworks utilise the steering capacities of a broad range of societal actors (e.g., interest groups, scientists, producers and consumers and government officials) by facilitating integrated knowledge production, adaptive strategies and experimentation, anticipation, iterative, participatory goal formulation and interactive strategy development (Voss et al., 2006). In other words, the adaptive governance perspective calls into question the ability of actors to govern reflexively when operating from their particular, narrow perspectives.

More specifically, 'integrated knowledge production' refers to the transdisciplinary production of knowledge between experts, scientists and various societal actors (Nowotny et al., 2001). Knowledge that results from methods of scientific inquiry (e.g., systematic modelling and laboratory research) is combined with actors' tacit knowledge gained in real-world experience via discursive interaction. Integrated

knowledge production is an important component of adaptive governance, as it transcends boundaries between disciplines on the one hand and science and society on the other, thereby establishing a fuller set of factors and interactions constituting wicked problems (Norström et al., 2020). ‘Adaptive strategies and experimentation’ refer to the inclusion of experimentation, monitoring and evaluation in all governing activities. Adaptive strategies are needed to systematically address new knowledge and/or trends that emerge over time due to complex system dynamics.

The third component of reflexive governance is, ‘anticipation’, i.e. the identification of potential development trajectories via methods of scenario construction, participatory modelling, or policy exercises. Anticipation is a valuable component of reflexive governance, as it enables actors to consider what undesirable scenarios may transpire and alternative, sustainable pathways of development. Because the guiding concept of ‘sustainability’ produces ambiguous goals and value-laden assessments of risk, ‘participatory goal formulation and assessment’ introduces social conflict into the governance process, which is then mediated through social discourse, deliberation, and political decision-making between actors. Inevitably, trade-offs will be made between development objectives. As such, sustainability targets should not be determined once and for all, but periodically updated through iterative participatory processes to reflect changes in circumstance, values, and public opinion. The final component of reflexive governance, ‘interactive strategy development’, refers to the formulation of a collective development strategy and coordination of actions taken by a range of social actors. Coordination is critical in a world of distributed control, where society is governed in interaction rather than from a single locus of power. (Voss et al., 2006)

Transition Management (TM) was explicitly designed from an adaptive approach to governance with the intention to address system rigidity within the governance sector. “The transitions approach argues that the current top-down governance mode requires change and reorientation in order to allow a

change towards sustainability; a more open yet structured, experimental and frontrunner-oriented process is needed” (Frantzeskaki et al., 2012, p. 24). Strategic-Niche Management (SNM) and Innovation Systems, however, represent public-private and top-down steering approaches respectively. In the following subsection, I briefly introduce these analytical and steering frameworks, among others, before expounding upon TM as the framework which guides this thesis.

### **2.3.2 Theoretical frameworks to analyse and facilitate sustainability transitions**

Transitions Research developed largely from two interdisciplinary fields, namely Innovation Studies (IS) (Fagerberg and Verspagen, 2009) and Science and Technology Studies (STS) (Rosenberg, 1994). Both fields were established during the wave of social science-informed research on technological transformation processes in the 1960s and 1970s and their theoretical underpinnings reject technodeterminism and emphasize the co-determination of social, economic and technological development (Truffer and Coenen, 2012).

According to their systematic review of Transitions literature, Loorbach et al. (2017) identified ‘technological innovation systems’ (IS) as one of four dominant research frameworks guiding Transitions Research. The focus of IS studies are green technologies and the social and economic policies needed to correct for so-called ‘system failures’ (Jacobsson and Bergek, 2011, Woolthuis et al., 2005). Because this body of research largely targets centralised regulation, I would argue it implicitly adopts a ‘command and control’ approach to the governance of sustainability transitions. Because the aim of my research is to provide methodological advancements for *adaptive* co-governance, I was able to quickly eliminate IS as an analytical framework for my research.

The second dominant framework – the socio-technical multilevel model (MLP) – was developed from STS theorisations and thus includes concepts of power, normative behaviour, and shared visions of socio-technical development. With a focus on niche-regime interactions, the MLP’s social theory of change

is based on the idea that social systems are self-adaptive due to the reflexivity of their agents. It is argued that humans have the capacity to (1) reflect on the underlying causes of landscape pressures, and (2) challenge and transform dominant socio-cultural beliefs, values, and practices. This perspective on socio-technical transitions implies the need for governance frameworks that provide opportunities for reflexivity and contestation of existing regimes.

This perspective (the MLP) has informed subsequent analytical frameworks such as Strategic Niche Management (SNM) (Kemp et al., 1998, Hoogma, 2002, Smith and Raven, 2012, Schot and Geels, 2008) – the third dominant research framework identified by Loorbach et al. (2017). First proposed by Kemp et al. (1998, p. 186), SNM is defined as “the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technologies and (2) enhancing the further development and the rate of application of the new technology”. As such, SNM can be understood as a framework that supports niche innovations during the early phases of transition. Similarly, ‘bounded socio-technical experimentation’ (BSTE) and ‘grassroots experimentation’ promote the reflexive management of real-world experiments in the form of pilot and demonstration projects in which new socio-technical configurations can grow; albeit, with a much stronger focus on *social* innovation (Seyfang and Smith, 2007, Brown et al., 2003, Brown and Vergragt, 2008).<sup>8</sup>

In SNM, BSTE and ‘grassroots experimentation’, actors collectively test “precious yet-to-germinate microcosms of sustainable systems and practices” in real-life contexts with the aim of improving sustainable innovations and weakening sources of resistance (Evans et al., 2016b, p. 2). In addition to providing opportunities for the maturation and diffusion of niche innovations, these practice-oriented, analytical frameworks facilitate higher-order learning via the process of real-world experimentation. Taken together,

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<sup>8</sup> BSTE and grassroots experimentation both developed as constructivist critiques to the technology focused SNM.

these management functions qualify SNM, BSTE and ‘grassroots experimentation’ as informal governance frameworks. However, they were not designed explicitly for this purpose and are therefore underdeveloped as governance frameworks.

More recently, however, TM was developed (Hendriks and Grin, 2007, Voss et al., 2006) to provide a prescriptive ‘tool kit’ for governing transitions that “focus[es] (among other things) on new institutional arrangements that can enable new pathways or innovations benefiting sustainability” (Frantzeskaki et al., 2012, p. 31). The tool kit comes with a host of participatory methods for visioning, consensus-building, and decision-making, outlined in *Chapter 3: Methodology*. Much like the other frameworks, TM was developed based on the multi-level perspective on socio-technical transitions. The following section offers a more detailed account of TM.

## **2.4 TRANSITION MANAGEMENT: TOWARDS AN ADAPTIVE APPROACH TO GOVERNANCE**

‘Transitions Management’ (TM) is a prescriptive governance and analytical framework designed to enable change in practices and institutions to help steer society towards sustainability (Loorbach, 2010). TM is prescriptive in that it (1) maintains the normative long-term goal of sustainable development, and (2) provides a portfolio of governance tools (i.e., procedures for visioning, consensus building on these visions, collective goal setting, monitoring, evaluation, and dispute resolution) to improve the reflexivity and thereby adaptability of modern-day governance. As a theoretical, heuristic, and practice-oriented process methodology, TM has been “applied to a diverse range of sustainability questions, policy contexts, and geographical scales (Frantzeskaki et al., 2017, Loorbach, 2014) and has become one of the most prevalent approaches currently used in parts of Europe to scientifically ground and advance in practice the governance of sustainability transitions” (Loorbach et al., 2017, p. 617).



#### 2.4.1 A framework for multi-stakeholder self-organisation and co-governance

‘Management’, as conceptualized in Transition Management, does not refer to the “process of planning and control,” but rather to the facilitation of *recursive* reflexive exercises, learning and self-organisation by a diverse group of stakeholders wishing to disrupt incumbent norms, practices, institutions, and material artefacts responsible for unsustainable development (Loorbach and Shiroyama, 2016, p. 7). Because TM sits outside government (albeit with the participation of select civil servants), decision-making by participating stakeholders is not subject to codified political procedures. Its extrajudicial nature, however, is intentional and considered to be a strength of TM. In legal-administrative regimes and codified political procedures, “closure, hierarchy and power relations [...] emerge when criteria are formulated and decisions are made” (Jhagroe and Loorbach, 2015, p. 70). In other words, contestation and ambivalences are shut down once decisions are taken, and alternative knowledge and perspectives are excluded from decision-making (at least until the next election cycle). This is problematic from the perspective of governing sustainability transitions, as “nourishing diversity rather than sameness, are crucial when it comes to creating a process which eventually fosters transitions” (Wittmayer et al., 2014a, p. 85). By contrast, TM intentionally provides a platform for excluded perspectives to “centre-stage ambivalences and radical contingencies” (Jhagroe and Loorbach, 2015, p. 72). The aim is to disrupt hegemonic institutions (e.g., attitudes, development targets, and material infrastructures) as well as the closures, hierarchies and power relations responsible for their persistence.

In addition to facilitating productive contestation, TM brings together a diverse set of stakeholders with varying vantage points on the socio-technical system they wish to transform, as well as varying influences over that system. In realising transitions locally, there is a recognition that municipalities are unable to address sustainability challenges on their own (Loorbach, 2014, Nevens and Roorda, 2014, Avelino and Wittmayer, 2016, Frantzeskaki et al., 2018a). First, the inherent complexity of these challenges demands the bringing together of actors with various perceptions, interests and capacities that are

operating at different spatial and time scales (Loorbach, 2010, p. 173). Second, landscape trends such as welfare state retrenchment, privatization, austerity and globalization have systematically reduced the ability of the state to manage the many interlinked social, economic and environmental dimensions of sustainability challenges.

#### **2.4.2 Transition Management as a process methodology**

A systematic and extensive literature review of 115 publications revealed that the majority of TM applications have been theoretic or heuristic, with less than a third of publications having reported findings from an operational application of TM (Frantzeskaki et al., 2018b). Whereby theoretic and heuristic applications of TM investigate the governance *of* sustainability transitions (Frantzeskaki and Shiroyama, 2016), operational applications investigate governance *for* sustainability transitions – in particular, TM’s ‘fitness’ as a process methodology. The process can be divided into seven phases, as outlined in the INTERREG IVb funded MUSIC project (Mitigations in Urban Areas, Solutions for Innovative Cities) (Roorda et al., 2012, p. 8):

##### *7 Phases of the TM Process*

- (1) **Setting the scene for Transition Management** [i.e., preparing the “transition arena”]
- (2) **Exploring dynamics in your city** [i.e., systems analysis]
- (3) **Framing the transition challenge** [i.e., problem identification]
- (4) **Envisioning a sustainable city**[-region]
- (5) **Reconnecting long term & short term** [i.e., back-casting/pathway development]
- (6) **Getting into action** [i.e., transition experiment design, selection and implementation]
- (7) **Engaging & anchoring** [i.e., scaling-up innovations]

In the first phase of TM, the ‘transition arena’ is prepared by the so-called “transition team” (Loorbach, 2007, p. 53) – a team of transition researchers and local government officers. The “transition

arena” (Loorbach, 2007, p. 53) is a space for collaborative learning where wicked problems and socio-technical solutions are discussed more openly than in consultative public participation settings (Gorissen et al., 2018). In this phase, the broad issue boundaries (e.g., geographical and sectoral boundaries) are predetermined by the transition team. These are subsequently narrowed by stakeholders in the transition arena in the form of an agreed ‘problem definition’ (see Phase 3).

In the second phase, researchers conduct a systems analysis, which is subsequently presented to frame stakeholders’ discussions on the transition challenge in Phase 3. During visioning exercises, stakeholders are free to imagine alternative socio-technical configurations operating in an ideal, future society. The resulting vision is made explicit in the so-called “transition agenda” (Loorbach, 2007, p. 54) – a TM output that articulates development goals matched to indicators for evaluation. Importantly, transition goals need not focus on environmental sustainability (Evans et al., 2016b). However, based on the Enlightenment belief in rationality and Democratic Liberalism more broadly (Ezrahi, 1990), it is an axiomatic assumption of TM that collective, discursive learning will improve shared visions of sustainable development, so long as deliberations are democratic and framed by scientific evidence of second-order problems conceived of over a multi-generational timeframe.

Once the transition goals are agreed, stakeholders conceive of various development trajectories toward their shared vision by means of qualitative back-casting (Phase 5). Along these envisaged pathways, participants select intermediate development goals or ‘milestones’. Transition experiments are then designed and carried out by societal actors in Phase 6. Transition experiments are meant to initiate transitions toward sustainability along identified pathways. In the final phase, invested stakeholders help mobilize additional actors outside the transition arena, thus growing the transition network as well as the diffusion of socio-technical innovations. Transition experiments are monitored and evaluated by the transition network to inform future ‘development rounds’ resulting in a cyclic process (see Figure 1). At the

end of each development round, transition frontrunners agree on the next set of interim objectives and decide what additional monitoring is needed for future evaluation. Transition experiments are evaluated based on questions such as (Rotmans et al., 2001):

- To what extent were the interim objectives were achieved?
- Of the objectives that were not fully met, what were the main barriers and how can they be addressed?
- Were there any unintended social, environmental or economic effects of experimentation? If so, which factors or relationships were not taken into account in previous design phases, and how can they be incorporated moving forward?
- What external developments (independent of the transition experiment) aided in the achievement of these goals?
- How do different stakeholders experience the initiative thus far?
- Have suggestions been equally considered?
- Is the experiment dominated by certain actors/vested interests?
- Is there sufficient commitment?
- Does the experiment still operate across sectors as intended?
- Should any additional actors be brought in?

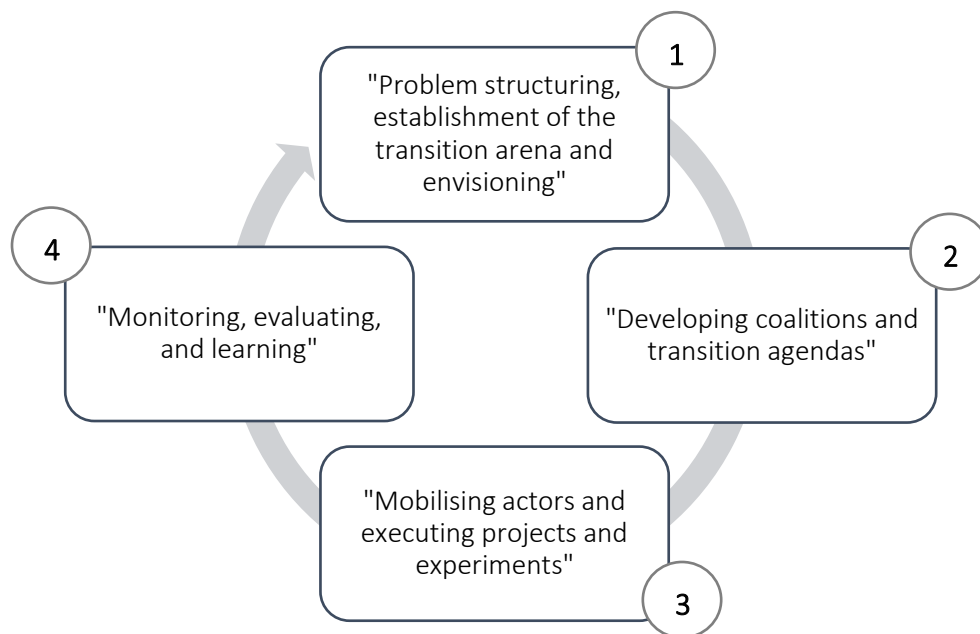


Figure 1: The Transition Management Cycle adapted from Loorbach (2007)

This cyclical process is meant to add much-needed reflexivity to modern governance. In modern society – “modern science, technology development, bureaucratic organization, project management and policy-making” (Voß and Kemp, 2015, p. 5) – complex realities are reduced to and handled as discrete problems. To decide and act rationally, organisations attempt to isolate cause and effect and eliminate uncertainty in their search for supposed solutions. However, “the more problem-solving is disengaged from the full, messy, intermingled natural reality and oriented towards the worlds of specialists, the larger is the share of interdependencies [...] ignored in the development and implementation of supposed solutions” (Voß and Kemp, 2015, p. 5). As a result, unintended consequences (or ‘externalities’) are commonplace and ever evasive. Problem solving through “instrumental rationality” (Voß and Kemp, 2015, p. 6) not only generates a cycle of ‘producing solutions that create new problems’, it lacks the reflexivity to resolve this inherent failing. Organisations thus fall into the cyclical trap of ‘producing solutions that produce new problems’ until they are forced to face often more severe, second-order problems (Jahn and Wehling, 1998, p. 6) of modernist problem solving. “Problem solving becomes paradoxical in that it is oriented towards

constriction and selection to reduce complexity but is force into expansion and amalgamation to contend with the problems it generates.”

To improve the governance of second-order problems, TM is said to facilitate a shift from reactive, linear problem-solving, to an exploratory, systems approach to governance – including a renewed look at how governance institutions not only impact upon objects of steering but, as well, on their own ability to steer. For example, research policies can uncover new learnings that shift the ‘direction of travel’, and subsidies can shift power distributions in the medium term, as previously supported industries develop their own lobbying power. To be clear, TM does not seek to eradicate the practice of instrumental rationality by individual organizations nor deny its value. Rather, it is a prescriptive governance framework proposed to sit alongside existing governance structures to add much-needed reflexivity.

TM adds reflexivity by “widening the filters of relevance,” facilitating knowledge sharing and interaction between specialists, and facilitating participatory and iterative experimentation to learn how complex systems evolve post-intervention. Specific strategies to achieve reflexive governance include: “knowledge integration; anticipation of long-term systemic effects; adaptability of strategies and institutions; iterative participatory goal formulation and interactive strategy development” (Kemp and Loorbach, 2006, p. 103).

### **2.4.3 The ‘localism turn’ in Transition Management**

Although TM is best known for its application in Dutch national policymaking<sup>9</sup> (Loorbach, 2010) the local application of TM has grown as a share of TM experimentation in the past decade (Frantzeskaki et al., 2018b). This is due, in part, to the theoretical assumption that targeting the local manifestations of unsustainability will accelerate socio-technical transitions. Loorbach and Shiroyama (2016, p. 4) argue,

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<sup>9</sup> TM was first taken up by a national government in 2001 in the fourth Dutch National Environmental Policy Plan (NMP4), to help steer the energy transition, sustainable use of biodiversity and natural resources, sustainable agriculture, and sustainable mobility (Loorbach, 2010).

“Cities are the locations where most of the (un)sustainability issues find their origin” as well as locations for societal progress (Rotmans et al., 2000) and hubs for radical sustainability innovation (Bulkeley and Broto, 2013). Indeed, cities are responsible for 75% of resource consumption and 70% of energy-related greenhouse gas emissions (Madlener and Sunak, 2011), and around 60% of the recommendations of the Earth Summit would need to be implemented at local level (Marvin and Guy, 1997).

The ‘local turn’ in scholarship (Evans et al., 2016a, Bulkeley et al., 2011, Loorbach et al., 2016, Raven et al., 2012) followed about a decade after the ‘local turn’ in international political discourse (e.g., ‘Local Agenda 21’ from the 1992 Rio de Janeiro sustainability conference). It was in the early nineties when consensus developed around the role of local authorities as “essential partners” of national and international governments in "implementing sustainable development in cities, towns, villages and rural areas" (Hans, 1994, p. 31). The local turn also translated into the burgeoning urban movements of smart cities, eco-cities, happy cities and low carbon urbanization, among others (De Jong et al., 2015).

In Transitions literature, the notion of geographical context only became prominent about a decade ago (Wittmayer et al., 2014b). Focusing first on the concept of ‘proximity’, (Boschma, 2005) identified five forms of proximity – namely cognitive, organization, social, institutional and geographical proximity – that theoretically aid transition processes. Because “short distances literally bring people together and facilitate information and knowledge exchange” (Coenen et al., 2010, p. 298), geographical proximity is considered to positively reinforce the other forms of proximity. The focus on geographical context was largely triggered by a growing recognition that “where innovation emerge and thrive are not coincidental” (Coenen et al., 2010, p. 295).

By adding spatial sensitivity to transitions analysis, scholars would be better positioned to answer questions such as “Why do transitions occur in one place and not in another? How do transitions unfold across different geographical contexts? What is the importance and role of relations at different spatial

scales for transition processes?” (Hansen and Coenen, 2015, p. 93). To address this theoretical gap, the international network for sustainability Transitions Research explicitly called for an examination of “the spatiality of transitions” and the role of cities and regions in transition processes (STRN, 2010). Since then, scholars have worked to establish a ‘Geography of Transitions’ agenda drawing on insights from multi-level governance and evolutionary economic geography (Truffer and Coenen, 2012, Raven et al., 2012, Truffer et al., 2015, Hansen and Coenen, 2015).

In their treatment of dominant socio-technical regimes, Transitions scholars often *implicitly* assume regime homogeneity within and against which various evolutionary processes<sup>10</sup> operate; when, in fact, considerable regime inconsistencies exist (Späth and Rohracher, 2012). This implicit assumption naïvely implies that sustainability transitions can take place anywhere; while we know this to be untrue.

A transition experiment trialled in cities around the world does not guarantee the anchoring and alignment of sustainable innovations nor the destabilization of incumbent regimes. Local experiments may mature into highly stable alternative configurations in only certain places, establishing local regime inconsistencies that break from the dominant national and/or global configurations with regard to values, cognitive framings or patterns of production and consumption. In other words, institutional alignment may occur locally in unique ‘selection environments’.

For example, in Murau Austria, a group of regional stakeholders imagined and successfully realized a district-wide, renewable wood-fired heating system that replaced the incumbent gas-powered regime, thereby creating an entirely new market, institutions, energy regime actors, professional networks and material infrastructure (Späth and Rohracher, 2012). Among other local factors, Späth and Rohracher

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<sup>10</sup> For TM, ‘evolutionary processes’ (disruptive or otherwise) refer specifically to the ‘broadening’ and ‘up-scaling’ of niche innovations, whilst in the study of Technological Innovation Systems (TIS), they refer to socio-technical ‘alignment’ or ‘coupling’ with incumbent regimes.



(2012) identify physical remoteness from the national gas grid<sup>11</sup>, Marau's huge biomass potential from privately-owned alpine forests and the region's collectively held values of 'autarky' and 'self-reliance' as key determinants of their transition to a district-wide, renewable wood-fired heating system. Coenen et al. (2010) find that Dutch provinces with significant underground thermal resources were much more likely to experiment with Thermal Energy Storage. In the United Kingdom, shallow water in the English North Sea and Liverpool Bay have spurred turbine installation in certain parts of the country by lowering development costs of offshore wind (Cowell et al., 2016).

These examples show how incumbent regimes are *spatially embedded* in diverse, local (regulatory, normative and cognitive (Geels, 2004) institutions and material structures that condition development trajectories and are thereby responsible for regime inconsistencies. "While the notion of socio-technical regime conveys a sense of homogeneity, regimes are in fact far from this and considerable spatial variations exist" (Späth and Rohracher, 2012, p. 466). By highlighting and engaging with regime variation, we can strengthen our understanding as to why niche socio-technical innovations fail to 'broaden' and 'scale-up' in a particular place while succeeding to do so in others (Boschma et al., 2017).

Socio-spatial embedding relates to the conditions of specific places, regions, cities, which may be more or less amenable for the promotion of sustainability transitions, because specific cultures, institutions, political systems, networks or capital stocks have developed in these spaces, which enable the actors embedded in them to promote new technologies, develop new life-styles or to try out new policies in support of sustainability transitions. (Truffer et al., 2015, p. 64)

In other words, contextual conditions create locations of regime vulnerability and resistance, which determine where transition originate and whether and how they might be translated to other places.

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<sup>11</sup> This finding suggests that isolation from national and/or global regimes likely increases the significance of local structures in determining development trajectories.

Because TM facilitates material engagement with the alignment of sustainability innovations, it is expected to have a role in the analysis of socio-spatial embedding. More specifically, case study research of local transition experiments can help identify locally specific landscape factors (e.g., power resources and distributions, actor networks, institutions and material structures) that enable or inhibit the upscale of various socio-technical innovations.

Wittmayer et al. (2014b, p. 481) argue that TM also has a steering role, as “societal challenges, sustainability and sustainability transitions [...] become meaningful only through [action research] practice” (pg. 481). Otherwise, concepts remain empty and abstract to key decision-makers. Moreover, local transition experiments (1) reduce complexity of the alignment process by reducing variation in the selection environment; (2) provide spatial proximity advantages that foster network and trust building around a new socio-technical configuration; and (3) provide tight cognitive, cultural, organizational and professional proximities. TM leverages and even enhances these proximities by providing a ‘transition arena’ in which learning cycles are shortened, a shared vision of ‘progress’ is fostered, and trust under conditions of uncertainty is engendered (Truffer, 2016).

## **2.5 A FRAMEWORK IN NEED OF METHODOLOGICAL ADVANCEMENT**

According to Loorbach et al. (2015, p. 25), TM is “so far not achieving the aspired large-scale systemic changes.” The authors suggest this may be the result of poorly designed and executed facilitation techniques for social learning and capacity building; regime resistance; or even the exclusion of marginalised perspectives. I suggest a fourth potential cause, namely the lack of applied systems thinking. Interestingly, despite the apparent failure of TM to initiate or accelerate sustainability transitions, “the fundamental assumptions underlying transition management” have not been questioned and “new concepts [have] only [been] introduced to a limited extent” (Frantzeskaki et al., 2018b, p. 11). In their systematic review of TM literature, Frantzeskaki et al. (2018b) call for methodological advancements, to

“extend either the phases of TM or enrich it methodologically in a way that can incorporate politics and power dynamics, and to address the political dimension of all outcomes of the transition management process itself (e.g. the vision, pathways, and agenda)” (Frantzeskaki et al., 2018b, p. 10). I attempt to do just that, whilst simultaneously introducing and addressing my own methodological critique of back-casting as a facilitation tool for the selection of local sustainability initiatives.

First, I introduce known criticisms of TM regarding the exclusion of marginalised perspectives, as well as responses of Transitions scholars (Section 2.5.1). Unconvinced by these responses, I propose adapting the TM framework to include the co-creation of a locally produced sustainability evaluation framework. An overview of existing sustainability evaluation frameworks is provided in Section 2.5.2 for illustrative purposes. The second criticism of TM relates to the poor efficacy of transition experiments, which I argue is due, in part, to the lack of applied systems thinking (Section 2.5.3). I propose a second adaptation to the TM framework, namely the replacement of ‘back-casting’ with participatory systems modelling. This recommendation is informed by System Dynamics Modelling methodology reviewed in Section 2.5.4.

### **2.5.1 Transition Management’s democratic deficit**

Early in the TM process, the transition team is charged with the task of identifying and selecting frontrunners to participate in the transition arena (Loorbach et al., 2015). ‘Frontrunners’ refer to “niche-players and [change-inclined] regime-players” (Loorbach et al., 2015, p. 54) who “understand aspects of urban wicked problems, hold innovative ideas or engage in activities in urban development, are committed to their city and sustainability and have the potential to influence change” (Frantzeskaki et al., 2018b, p. 137). For innovative solutions to be ‘scaled-up’, they require resource and credibility. As such, a certain representation of regime-actors, who share a willingness and power to change existing financial, regulatory and material structures, are also invited into the transition arena (Loorbach, 2010, van den Bosch and Rotmans, 2008). As “intermediaries”, these regime actors disseminate proposed innovations; translate

them into various “institutional logics” (Smink et al., 2015, p. 226); identify windows of opportunity (e.g., political momentum and available financial resource (Wittmayer et al., 2016) and carry out other ‘intermediary’ activities to facilitate the deepening, broadening and scaling-up of socio-technical innovations (Loorbach, 2014, Brown et al., 2013, Wittmayer et al., 2016).

Participation, in this sense, is not fully inclusive, but rather ‘selective’. Selective participation has raised concerns regarding its neglect of power and politics in transition processes (Avelino et al., 2016, p. meadowcroft, Smith and Stirling, 2007, Kenis et al., 2016, Hendriks, 2008, Hendriks and Grin, 2007, Smith and Stirling, 2010, Shove and Walker, 2007, Voß et al., 2009, Meadowcroft, 2009)

- “Who is driving the initiatives, with which agenda, and to what end? How do the initiatives relate to incumbent and powerful actors?” (Hölscher et al., 2018, p. 132).
- “Whose framings count (about e.g. systems, problems, goals, sustainability) and what is the relationship with democratic institutions, incumbent regime actors and dominant discourses?” (Hölscher et al., 2018, p. 133).
- Can transition arenas foster truly radical innovations if regime actors are so heavily involved in the process, both as ‘frontrunners’ and members of the transition team?

Selective participation has been criticized for being technocratic and elitist (Smith and Stirling, 2010) and lacking legitimacy as participants are only accountable to themselves (Folke et al., 2005, Hendriks, 2009). Decision-making processes restricted to the input of privileged technocrats often “exclude the knowledge, preferences, and values of the people affected or concerned by the outcome” (Lynam et al., 2007, p. 2). Resource management studies often reveal a misalignment between preferences of experts and the public majority – e.g., Carlsson et al. (2011), Rogers (2013) and Rogers et al. (2013). Rogers et al. (2017, p. 4) write, “reliance on experts to make value judgements may pose risks if these judgements

diverge significantly from those of the public. Ideally, decision making should consider both the technical recommendations of experts to ensure feasibility, and the value judgements of the community to maximise welfare”. Of particular relevance are the values and preferences of those whose wellbeing are most significantly affected by intervention or continuation of status quo.

An additional concern cited in the literature is that the prescriptive selection of frontrunners may actually be “sustaining unequal power relations, supporting those already empowered and resulting in the disempowerment of other actors (Smith and Stirling 2010; Wittmayer et al. 2015; Avelino 2009)” (Frantzeskaki et al., 2018b, p. 133). Indeed, TM has long been criticized for running the risk of “reinforcing incumbent power structures” (Hölscher et al., 2018, p. 150) because it neglects the politics underlying transition processes (Shove and Walker, 2007, Hendriks, 2009, Meadowcroft, 2009). Taking this concern a step further, there is a serious risk that the whole process is hijacked and used to legitimate already dominant perspectives (Loorbach et al., 2015).

In response, some TM scholars have argued that selective participation is a legitimate strategy, drawing on more critical approaches to democratic thought (Laclau and Mouffe, 2014, Rancière, 1999). These approaches depart from “traditional notions of democracy (e.g. representative democracy, pluralist democracy, deliberative democracy) and a priori ‘democratic foundations’ (parliaments, ministers, political parties, stakeholder networks, etc.)” (Jhagroe, 2018, p. 352), arguing that they actually close down space for contestation once decisions are taken and new material and socio-cultural realities are constructed and managed. Take, for example, highways governance regimes that reinforce car-dominant environments and create barriers for socio-technical alternatives or regulatory frameworks in the energy sector that produce barriers for up-scale of renewable energy solutions. It is argued that ‘democratic’ governance regimes “background contestation and conflict” (Jhagroe, 2018, p. 354), ‘policing’ the society and depoliticizing urban challenges (Rancière, 2004). From this perspective, deliberately creating spaces (i.e., transition

arenas) for alternative imaginaries is said to actually provide for democracy. It is argued that such spaces are needed for society “to break out of existing dominant paradigms and routines” (Loorbach et al., 2015, p. 59).

If we are to trade the lack of accountability for the empowerment of marginalized, radically alternative imaginaries (Jasanoff and Kim, 2015), there remains the question of whether and how to open the transition arena to members of the general public who might share these visions but lack the resources (e.g., knowledge, access to finance, and social networks) to realise transitions. Extensive case study research has shown that citizen-led approaches not only produce more socially equitable outcomes, but that the outcomes are also more functional, as they are perceived as more legitimate and acceptable by the public (Arnstein, 1969; Hawkins and Wang, 2012; Innes and Booher, 2003). That said, in the Interreg funded project MUSIC (Mitigation in Urban areas and Solutions for Innovative Cities), TM scholars found that, whilst the significant inclusion of local residents and civil society actors “facilitated a broadening of perspectives and a move away from mainstream thinking, the perceived (financial, legislative) resource limitations also led to scepticism by the participants themselves about their abilities to achieve sufficient leverage for the change they found necessary” (Hölscher et al., 2019, p. 138). By comparison, a transition arena in Rotterdam, which mainly consisted of professionals, was found to lack diversity in societal perspectives, compromising the legitimacy and innovative potential of TM (Wittmayer et al., 2012, Roorda and Wittmayer, 2014).

According to some TM scholars, the solution lies somewhere in the middle. By adapting TM’s participant selection criteria to involve marginalised perspectives from civil society, TM scholars whilst still maintaining a certain representation of regime actors and expert practitioners (Wittmayer et al., 2016, Wittmayer et al., 2014b, Wittmayer et al., 2013, Nevens and Roorda, 2014, Nevens et al., 2013, Frantzeskaki et al., 2014). “Ideally, decision making should consider both the technical recommendations of experts to

ensure feasibility, and the value judgements of the community to maximise welfare” (Rogers et al., 2017, p. 3). The local turn in Transitions studies has supported this development, as it opened the transition arena to inhabitants and members of civil society (Frantzeskaki et al., 2014).

TM is said to empower (non-technocratic) residents through their acquisition of new, interactive governance roles, knowledge and relationships to local policy officers among and other key stakeholders (Hölscher et al., 2019). In practice, however, it is hard to see how the inclusion of these individuals amounts to anything more than tokenism. The same authors recommend capping arena participants at “15 to 20” individuals (Hölscher et al., 2019, p. 179), whilst maintaining a certain representation of powerful actors. ‘Inclusion’ of non-powerful actors is therefore limited to only a handful of individuals.

Persuaded by the arguments presented in critiques of TM, as well as authors’ responses, I believe a bit more imagination is needed to resolve the tension between inclusion and agency. Wishing to maintain the intervention role of powerful actors *and* the genuine inclusion of marginalised perspectives, I propose two adaptations to the TM framework. First, I recommend that the visioning exercises take place outside the transition arena and that invitations target individuals who experience (or are expected to experience) first-hand, the negative consequences of unsustainable development. Though motivated by concerns over equitability, I expect the inclusion of these individuals to improve the ‘efficiency’ of TM experimentation as well. This expectation is based on a recognition that these individuals are (1) more knowledgeable of the perverse outcomes of unsustainable development, and (2) more likely to place greater weight on addressing these outcomes than those who are not directly affected by them. Second, I recommend that an ‘accountability mechanism’ be introduced to hold powerful actors responsible for delivering this vision. This mechanism would be introduced in the transition arena to ensure that stakeholders’ evaluation and selection of transition experiments reflect the priorities of those negatively affected by unsustainable development. For this, I propose the use of a co-constructed evaluation framework. Evaluation frameworks

bring together a wide range of indicators, i.e., operational representations of a system's attributes, to provide information about the functioning of that specific system and to support decision-making and management (Gallopín, 1997). An overview of such framework for urban sustainability is provided in the following subsection (2.5.2).

To investigate the impacts of these adaptations to intended TM outcomes, I set out the following research questions:

- (1) How, and to what extent, did the use of the Evaluation Framework affect stakeholder buy-in to the transition experiments (i.e., multi-stakeholder initiatives)?
- (2) How, and to what extent, did the use of the Evaluation Framework affect the perception of process legitimacy by participating stakeholders?
- (3) Did the use of the 'evaluation framework' sufficiently steer outcomes? If not, why not (e.g. stakeholder co-optation, workshop design, etc.?)
- (4) What technical barriers arose when evaluating interventions against the 'Housing & Wellbeing Evaluation Framework'?

### **2.5.2 Evaluation frameworks for sustainable development**

Despite having developed separately, human wellbeing and sustainable development measurement have been brought together in recent decades under integrated or combined indices and evaluation frameworks. Endeavours to integrate or combine their measurement are commonly based on the anthropocentric, normative agenda to deliver human wellbeing equitably within and across generations. These endeavours require the promotion of environmental quality and the wellbeing of future generations as key indicators in an integrated index, or evaluation framework.

At this point in time, it is clear that what is required is a system that accommodates not only economic and social indicators, but indicators of environmental degradation and resource



conservation. In short, what is required is a comprehensive system of measuring the wide variety of aspects of human-wellbeing, as well as the means of improving it and sustaining it. Unfortunately such a system (as I imagine it, anyhow) would involve the construction of something like a general theory of a good society (something like a utopia) which would be generally acceptable to most people... This is practically impossible because we cannot get agreement on the elements of the utopia or on the proper evaluation of those elements.

(Michalos, 1997, p. 222)

Yet, a political consensus was met in the United Nations 2030 Agenda for Sustainable Development, which developed a framework of 17 sustainable development goals and 169 associated targets. Alternatives to gross domestic product (GDP), which incorporate social and environmental factors, were introduced as early as the late 1980's and 1990's, namely the Index of Sustainable Economic Welfare and Genuine Progress Indicator (Gasper, 2007, Neumayer, 2007). In 2006 the New Economics Foundation published the (un)Happy Planet Index (HPI), which assesses the economic and environmental efficiency of various countries in their production of wellbeing by the equation  $HPI = (\text{life satisfaction} \times \text{life expectancy}) \div \text{ecological footprint}$  (Marks, 2006). These tools provide an alternative to purely economic or social indicators of human development which overlook that which threatens our ability to sustain wellbeing. They integrate or aggregate a diverse set of environmental, economic, social, and governance indicators into single, prescriptive frameworks to help plan for, promote and measure progress towards sustainable development (Hiremath et al., 2013).

Since the Earth Summit in 1992, the number of local-level sustainable development indices, such as the Reference Framework for European Sustainable Cities, Siemen's Green City Index, and the UN-Habitat's 'City Prosperity Index', has grown significantly (Science for Environment Policy, 2018). By

standardising the measurement of local sustainable development, these frameworks provides data for scientific studies on urban sustainable development, improved collaboration and knowledge sharing within and between local governments, and leverage for funding and recognition in higher levels of government and international entities (McCarney, 2014, Pires et al., 2014). Indeed, these benefits motivated over 250 cities across 80 countries to become members of The Global City Indicator Facility to help develop and benefit from a framework of 115 standardized indicators as part of the ISO 37120 accreditation.

However, global standardization also removes variation in context-specific challenges and goals. Indeed, “the [economic, social and] natural resources available, and the robustness of the local ecology [and economy], can differ markedly from place to place” (Economist Intelligence Unit, 2009, p. 19). These varying levels of resource make it difficult, and in some cases inappropriate, to apply common metrics across territories. For example, “Stockholm, with the second-highest overall score [on the European Green City Index], is ranked a surprising 16th place when it comes to water. The problem is not sewage, which it treats and even uses as a source of energy, nor leakages, which are below average. Instead, residents simply use a lot of water, and the city makes little effort to discourage them. While this behaviour might be problematic in hot, dry cities, such as Madrid, or even in London, which receives less rainfall per head than Addis Ababa, it poses less of a concern in Stockholm where fresh water is plentiful and therefore even the high levels of current use are sustainable” (Economist Intelligence Unit, 2009, p. 20). Under the global ISO 37120 ‘Shelter’ indicator, London has a perfect score on two out of three metrics<sup>12</sup>, as they are better suited to targets set in megacities in the Global South. Spatial variation is also important when considering the influence of cultural norms in defining wellbeing. For example, it would be inappropriate to employ a

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<sup>12</sup> (1) percentage of city population living in slums; (2) percentage of households that exist without registered legal titles

common metric for ‘household crowding’ across groups or subgroups with diverse values/views of inter-generational living.

If SD evaluation frameworks become too tailored, on the other hand, they are no longer transferable to a wide range of cities. Additionally, tailored frameworks create a greater bureaucratic burden on under-resourced local governments to monitor and report on a wide range of indicators. One must consider these trade-offs in light of the framework’s purpose. Purpose will determine the scale, approach and choice of indicators of any given framework.

As stated in Chapter 2: Literature Review, the purpose of developing an evaluation framework in TM visioning workshops is to hold frontrunners accountable to the values and priorities of local residents who experience, or are expected to experience, first-hand the negative consequences of unsustainable development. This is accomplished, first, by forcing frontrunners to select proposed interventions on the basis of their anticipated performance against the co-produced evaluation framework. In the transition arena, transition experiments are brainstormed around these interventions, so that frontrunners and the local government can help deliver long-term wellbeing according to the values and priorities of visioning workshop participants. Second, because a handful of frontrunners are invited to attend the visioning workshops to learn about, sympathise with, and potentially advocate the values and priorities of this target population, the *process* (i.e., goal selection and weighting) is just as important as the *product* (i.e., the evaluation framework).

The nature of the evaluation framework, as proposed in this research project, differs from existing built environment frameworks – e.g., BREEAM (Building Research Establishment Assessment Method) Communities, CASBEE-UD (Comprehensive Assessment System for Building Environmental Efficiency for Urban Development), and the Green Star NZ Community Rating Tool – in that the evaluation framework produced at the visioning workshops encompass existing developments in addition to new developments.

Integrating sustainable design into the masterplanning process, the aforementioned frameworks are “designed for the assessment of major developments [...]. As such [they consider] sustainability issues at the earliest possible stage (the masterplanning stage)” (BREEAM, 2013, p. 2). Yet, there is no tool, to the author’s knowledge, that attempts to measure the economic, social and environmental sustainability of the entire local ‘housing system’ – to include both the existing stock, new developments, and their interactions with other socio-technical and natural systems.

### **2.5.3 Rethinking the application of systems thinking in Transition Management**

In addition to concerns over accountability, there is an expressed concern that the current TM framework lacks tools for predicting which experiments will ultimately contribute to sustainability transitions and thus to which experiments valuable resources should be allocated (Loorbach and Wijsman, 2013, Van Eijck and Romijn, 2008). This “presents a significant challenge for [...] TM since, without knowing which sustainability niche to promote, it is unlikely that sustainability transition could be efficiently facilitated” (Chang et al., 2017, p. 367). Therefore, I argue that more should be done in the initial stages of experiment design and selection to improve the likelihood of transition. Specifically, more attention should be paid to the dynamics of pre-existing socio-technical systems to better target intervention.

One of TM’s shortcomings is its inability to estimate the likelihood of success of any given experiment. Indeed, experimentation in TM is theoretically motivated by an understanding of transition as an evolutionary function of variation and selection (Nelson and Winter, 1982, Nelson and Winter, 1977). In other words, the larger the availability of alternative socio-technical configurations (i.e. transition experiments) the greater the likelihood that one will “develop a sufficient fit with the selection environment and challenge and destabilize the entrenched regime” (Späth and Rohrer, 2012, p. 466). With enough time and landscape pressure from unsustainable development, at least one of the experiments will be ‘selected’ for scale-up. However, relying on variation and selection is highly inefficient and the impetus for

selecting sustainable socio-technical innovations may come too late. Meanwhile, transitions experiments risk wasting windows of opportunity and political and fiscal capital, which may in turn deter regime-actors from continued radical experimentation.

What if the majority of transition experiments are destined to fail because they did not properly identify nor tackle key stabilizing processes of existing socio-technical regimes? Indeed, sustainability experiments are often critiqued for focusing too heavily on niche empowerment, whilst neglecting the dynamics of regime destabilisation (Turnheim and Geels, 2013, Turnheim and Geels, 2012). In such cases, the design or even focus of transition experiments would need to be dramatically altered in subsequent iterations of TM. Not only would this require recruiting new actors and finding additional sources of political and capital investment, frontrunners that profited from the original design would likely resist significant changes to existing initiatives. Thus, while motivated in theory, adjusting misaligned and poorly designed transition experiments in practice is costly at best and impossible at worst.

Loorbach et al. (2015, p. 52) write, “The dynamics of the system create feasible and non-feasible means for steering. [...] Process management on its own is not sufficient; insight into how the system works is an essential precondition for effective management.” System dynamics literature argues that the very characteristics of complex systems (feedback, non-linearity, time delays, and path dependence from accumulating stocks) create cognitive challenges that surpass the limitations of ‘bounded rationality’ (Simon, 1957). “As marvellous as the human mind is, the complexity of the real world dwarfs our cognitive capabilities” (Sterman, 2000, p. 26). System Dynamics Modelling (SDM) was thus developed as a computer simulation tool to analyse the dynamic behaviour of complex systems and their (often counterintuitive) development trajectories under various ‘intervention’ scenarios (Forrester, 1997). With the aid of computer simulation, not only do we uncover the dynamics of complex systems, but as well their so-called ‘leverage points’. “Models enable us to conduct sensitivity studies and see which of the system’s elements

can have a decisive bearing on its behaviour” (García, 2006, p. 29). Interestingly, small interventions can have big effects whilst big interventions can have no effect at all given the array of nonlinear interactions and feedback loops. As such, sensitivity analysis conducted in SDM provides “insights in (future) dynamic characteristics of the [systemic] problem and potential causes as embodied in the [model] structure” (Vennix, 1990, p. 58).

Because system leverage points are often counterintuitive (García, 2006), modellers may find it challenging to convince stakeholders of their importance, particularly if an intervention (1) contradicts ideological narratives and/or (2) worsens symptomatic problems in the short-term before resolving underlying problems in the medium-to-long term. By including participants in the modelling process, however, they can gain an understanding of and appreciation for complexity and may be more inclined to shift their ‘problem definition’ relative to their participation under the current TM framework.

“In complex systems, cause and effect are distant in time and space while we tend to look for causes near the events we seek to explain. Our attention is drawn to the symptoms of difficulty rather than the underlying cause” (Sterman, 2000, p. 91). As such, participatory SDM acts as a heuristic tool that helps build understanding of dynamic (counterintuitive) system reactions to human intervention and accept the futility of using linear thinking to resolve complex problems. The shortcoming of this method, however, is that simulation requires decades of quantitative data, which unfortunately do not exist at the local level. Although limited in its ability to reveal the underlying causes of system dynamics, *qualitative* systems modelling provides decision-makers with an alternative to ‘dynamically deficient’ simple mental models of reality.

As part of the TM MUSIC project, Maas et al. (2018) developed the SCENE framework, a methodology to build and analyse a systems model consisting of three capital domains: SoCial, ENvironmental and Economic – the sustainability triangle (Rotmans, 1998). Having applied this

methodology in the cities of Ghent and Aberdeen, qualitative systems models were built in an iterative, participative, and trans-disciplinary way using a combination of desktop research, interviews and expert meetings in each city. The SCENE methodology is similar to SDM in that it seeks to capture the interconnectedness between system domains. It even adopts SDM's method of using stock and flows to represent properties of the complex system under study. The explicit use of other SDM methods, such as the construction of causal loop diagrams, is not reported in Maas et al. (2018).

In both applications, the SCENE model was simplified and presented in the transition arena to assist frontrunners in agreeing a problem definition and transition goals as part of their so-called 'transition vision'. In theory, the introduction of systems thinking is meant to provide insight into how the system works and provide frontrunners with diverse perspectives on the transition challenge (Hölscher et al., 2018, Hölscher et al., 2016). Systems analysis is conducted by Transitions researchers, findings from which are presented to frame participants' 'problem definition'. The presentation is meant to contain information on the system's "main properties, interactions, persistent problems and challenges for the future. In particular, more than being exhaustive, the system analysis should stimulate a systemic way of thinking; and hence tackle the multi-scale challenges of urban sustainability transitions" (Nevens et al., 2013, p. 117).

The systems analysis precedes group discussions in the 'Transition Arena' for three reasons. First, the results provide a common information base from which a diverse group of participants can enter into discussion. Second, they frame participants' definition of the transition challenge from the perspective of environmental, social and economic sustainability. Given its integrative nature, systems analysis enables participants to "look beyond their own expertise and perspectives and to understand the interconnectedness of the system(s)" (Nevens et al., 2013, p. 117). Third, as already stated, the systems analysis facilitates systems thinking. Systems thinking allows stakeholders to distinguish between symptoms and deep-rooted problems and shift the focus from superficial solutions to systemic challenges

and opportunities (Roorda et al., 2012). For example, the systems analyses conducted for the energy systems of Ghent and Aberdeen “revealed interesting connections [...], broadened the problem perception, revealed institutional barriers to sustainable development and served as a catalyst for mutual understanding and learning between the participants” (Maas et al., 2018, p. 159).

Similarly, the application of TM in Ludwigsburg, Germany, “succeeded in opening up the initial energy theme towards social and environmental elements (e.g. culture, mobility, education, housing),” as evidenced by the frontrunners’ transition vision (Hölscher and Wittmayer, 2018, p. 220). Problematically, however, the selection of transition experiments did not directly follow the visioning exercise. Rather, in a separate workshop, participants back-cast transition pathways, an activity that leads to linear narratives of change. So, although systems thinking frames the group’s problem definition, it is not explicitly applied to the investigation of potential solutions. In the Ludwigsburg case study, Hölscher and Wittmayer (2018, p. 219) report that the systems approach “was not translated into the operational level of project implementation [...]. On [the operational] level, project goals were identified from a rather narrow perspective. The question of the energy transition was framed solely from the perspective on energy rather than considering how it connects to, for example, consumer behaviour, mobility and food.”

To address this challenge, I propose that back-casting – the method currently embedded in the TM framework to facilitate the selection and design of transition experiments – be replaced by participatory systems modelling. In theory, this should help improve the application of systems thinking in TM and thereby improve the design and selection of transition experiments. More details on my proposed integration of TM and qualitative systems modelling are presented in Chapter 3: Methodology.

To investigate the impact of this adaptation on the intended outcomes of TM, I set out the following research questions:

- (1) How, and to what extent, did participatory systems modelling facilitate systems learning?



- (2) How, and to what extent, did participatory systems modelling facilitate social learning?
- (3) How, and to what extent, did participatory systems modelling help build consensus around 'system leverage points'?
- (4) How, and to what extent, did participatory systems modelling affect stakeholder buy-in?
- (5) How, and to what extent, did participation engender a sense of 'ownership' over the transition challenge and solution(s)?
- (6) How, and to what extent, did the frontrunner workshop help strengthen or initiate a new 'Transition Network' in Cambridgeshire and Peterborough?
- (7) What technical barriers arose during the co-modelling activities?

## 2.6 CONCLUSION

TM is an analytical framework that adopts a complex systems and MLP approach (Section 2.2.2) to the study of national and subnational governance of past and ongoing socio-technical transitions (Section 2.2.3). Doubling as a prescriptive model of adaptive governance (Section 2.2.4), TM *practitioners* have applied the framework in action research projects, together with national and subnational governments and other relevant stakeholders. My review of TM literature revealed two shortcomings of this framework: First, its primary involvement of technocratic transition frontrunners (niche actors or regime actors sympathetic to the transition agenda) runs the risk of reinforcing incumbent power structures (Section 2.5.1) and the lack of applied systems thinking during the design and selection of transition management (Section 2.5.3). Taken together, these shortcomings threaten the efficacy of TM in theory and practice. Seeking to address these shortcomings and advance the TM framework, I propose two adaptations: First, the formal codification of transition goals set by those who suffer, first-hand, the negative consequences

of unsustainable development, so transition frontrunners can be held accountable to their priorities. Second, I recommend the replacement of back-casting with participatory systems modelling for the design and selection and transition experiments. The instrumentalisation of these adaptations is presented in the methods sections of each findings chapter (Section 4.2 for visioning, Section 5.2 for participatory co-modelling, and Section 6.2 for the frontrunner workshop).. Before presenting the methods associated with each adaptation, I explain how the stages of TM, as a process-based methodology, must also be adapted to accommodate these changes (Section 3.6). Beyond this, Chapter 3: Methodology introduces the philosophy of science that informs my research design, the rationale for conducting qualitative, Participatory Action Research, and reasons for adopting a single case study research design to answer my eleven research questions.

As stated in the Introduction (Section 1.2), my evolutionary research project did not allow a full investigation of these research questions. However, my research design and methodology allowed for an inductive analysis of themes having arisen across each stage of the research project, relating to the gap between TM practice and theory.

## 3 CHAPTER 3: METHODOLOGY

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### 3.1 INTRODUCTION

The methodological contribution of my research is twofold: First, I proposed and aimed to explore procedural methods designed to resolve TM's tension between inclusion and agency; Second, I proposed and explored the replacement of back-casting with participatory, qualitative systems modelling to facilitate the analysis and selection of frontrunner-proposed interventions. Before presenting the changes made to the original Transition Management (TM) framework (Section 3.6), I first discuss philosophies of science (Section 3.2); the rationale for *action* research (Section 3.3); my single case study research design (Section 3.4), and the prioritisation of qualitative data over quantitative data (Section 3.5) in relation to my research objectives. The chapter closes with a list of ethical considerations and actions taken to address them (Section 3.7).

### 3.2 PHILOSOPHY OF SCIENCE

Adopting a critical realist philosophy of science, I approach my research project with the understanding that causal relationships in socio-technical-ecological systems are not reducible to empirical constant conjunctions (Bhaskar, 2014). Because the agents of social systems have the capacity to consciously reflect upon, reimagine and recreate the social institutions mediating human behaviour, the 'laws' which underlie these systems are historically in flux. Because 'laws' in social science demonstrate both persistence and impermanence, they are more appropriately conceptualized as reinforcing internal mechanisms that are capable of being manipulated – even by scientific inquiry. As such, my analysis of the socio-technical-ecological 'Housing & Wellbeing system' is only capable of revealing *temporary*

determinants of the relationship between housing and wellbeing – recognizing, however, the path-dependent nature of societal development.

Moreover, I recognize that my analysis is dependent on human intervention, observation and interpretation and is therefore susceptible to numerous sources of bias affecting original accounts (e.g., caused by slight changes in question wording, interviewer bias, etc.), the interviewer's interpretation of accounts and the researcher's qualitative analysis. The latter biases are caused by knowledge gaps, personal ideology and prejudice, but as well, the very nature of complex, social systems. Mechanisms may exist in social systems that lie dormant and are difficult to identify and impossible to evidence. Alternatively, we may fail to perceive mechanisms that are, indeed, operating but whose effects are counteracted by other mechanisms. As such, I reject the notion that we can ever know, with complete certainty, if scientific analysis has correctly identified the internal mechanisms driving complex systems under study. In light of these challenges to scientific inquiry, I (1) actively sought a *recursive research framework* that seeks to adapt scientific knowledge over time to account for changes in complex, social systems; and (2) which recognizes that knowledge acquired from scientific inquiry is fallible and uncertain, but that consensus around this knowledge can serve to perpetuate or disrupt existing social systems.

Uncertainty is inherent in scientifically produced knowledge; however, this does not suggest that scientific inquiry is an unfruitful endeavour. "A better understanding of the problem offers [a better] solution to the problem" (Wiek et al., 2012, p. 6). If solutions are informed by an inaccurate understanding of the problem, their impacts, if evaluated, will reveal further information about the system of interest, thus improving public knowledge. From a critical realist perspective, both problem definitions and solutions are expected to improve in the process of *ongoing* scientific inquiry, i.e. scientific findings are expected to *approach* reality with ongoing investigation. Recursive inquiry is particularly important in the case of transition analysis where the very nature of complex systems (i.e. the unpredictability of emergent

properties) demands recursive analysis in order to capture changes in socio-technical-ecologic systems over time.

Recursive inquiry is embedded in TM, but I argue that the framework lacks a systematic method by which participants can evaluate their proposed interventions. TM lacks such a method because many of its proponents deny the possibility of correctly identifying system leverage points: “Such transitions [at the global and national scale] can take decades to occur and are highly uncertain in terms of future development, possibilities for change and the level of intervention possible in such dynamic processes. It is thus inherently uncertain how to enhance or stimulate societal transitions given their complexity and the complexity of the societal system (Loorbach, 2010)” (Frantzeskaki et al., 2012, p. 21). Adopting a critical realist philosophy of science, I assume that scientific methods, such as participatory systems modelling, can help us to approach reality – even if that reality is complex. I believe that systematic methods of enquiry embedded in an iterative learning process, can increase the likelihood that our interventions will be successful in unlocking and accelerating transition. This belief is what motivates my recommendation to integrate systems modelling into the TM framework.

My recommendation to open the ‘visioning’ stage of TM is motivated by postmodernist research. Although my research does not adopt a relativist or postmodernist philosophy of science, I join others in arguing that more should be done to improve TM’s methodology in regard to the exclusion of certain values and knowledge in decision-making. This appeal, and attempt to innovate TM methodology, is informed by the understanding that power structures and hidden interests mediate transition processes (in many cases, blocking transitions toward sustainability) because decision-makers “align with societal elites to protect vested interests” (Geels et al., 2016, p. 578). Much of these insights have stemmed from researchers who have adopted a postmodernist ontology and should shape researchers’ thinking around the methodologies they employ, regardless of ontology.

### 3.3 WHY PARTICIPATORY ACTION RESEARCH?

Unlike System Dynamics Modelling (SDM), which interprets “policymakers ‘outside’ the system, pulling ‘levers’ to steer developments,” I interpret policymakers as “part of the system and dependent on other actors [who can] try to ‘modulate’ ongoing dynamics, but not steer at will” (Geels et al., 2016, p. 578). As such, the orientation of my research is more focused towards *societal transformation via collaborative problem-solving processes* than towards *descriptive-analytical production of scientific knowledge* (Popa et al., 2015). As a TM researcher, my work attempts to facilitate the ongoing process of *learning by doing* at the niche level through participatory processes of visioning, experimenting and evaluation. Through this iterative process, system agents undergo collective changes in beliefs, attitudes and behaviour, enabling them to coordinate their actions and co-govern transitions toward sustainability.

TM, as a methodology, falls under the broad category of ‘participatory action research’. According to Bell et al. (2004), there are three main objectives of participatory action research: (1) to achieve practical objectives and to change social reality through group participation; (2) improve the capacity of participants and their organisations to “solve their own problems and keep solving them” (Reason and Rowan, 1981, p. 259) past the end of the research project; and (3) to improve the practice of researchers. To achieve these objectives, three principals are observed.

#### 3.3.1 Participatory action research values local and experiential knowledge and values

Adopting a critical realist ontology, I believe that all human knowledge – including scientific knowledge – is a situated *perception* of reality. Given the biases associated with situated knowledge, traditional methods of scientific research are often “poorly equipped to deal with complex sustainability problems,” (Popa et al., 2015, p. 45). Thus, a transdisciplinary approach is needed to transcend blind spots from any one discipline (Lang et al., 2012). Transdisciplinary research can be understood as a “critical and self-reflexive research approach that [...] produces new knowledge by integrating different scientific and

extra-scientific insights” with the aim of contributing to both societal and scientific progress (Jahn et al., 2012, p. 8). Because knowledge of complex systems will inevitably vary depending on the individual experiences and personal ideology, insights must be gathered across disciplines and from scientific *and* extra-scientific practitioners alike. This is especially true for context-specific sustainability challenges. According to the emerging ‘geography of transitions’ literature (Truffer et al., 2015), socio-technical transition processes are mediated by local, national and regional landscape factors of which community members and local practitioners have situated knowledge. To leverage this knowledge, transdisciplinary research requires a redistribution of ownership and control away from scientific institutions (Heron and Reason, 2008, Kindon et al., 2007).

Although TM calls for a transdisciplinary approach to the *governance* of socio-technical transitions, the systems analysis, which later frames stakeholders’ problem and solution definitions, is conducted by a small team of academic researchers who likely “emphasize certain dynamics while paying somewhat less attention to others, inadvertently diminishing the complexity of the [sustainability] challenge” (Rosenbloom, 2017, p. 37). I argue that TM should be adapted to better leverage diverse sets of scientific and practitioner knowledge to improve our understanding of the problems associated with an unsustainable housing system. As such, I recommend the integration of participatory systems modelling, which is designed to capture a wider breadth of causal factors and relationships of the problem situation under study.

### **3.3.2 Participatory action research recognises the social role of stakeholder involvement**

The second principal of participatory action research is to actively involve participants in data collection and analysis as “co-investigators” (Keahey, 2020, p. 3) in the research project. In ‘descriptive-analytical’ approaches to participatory research, participants simply lend their experiential knowledge to the research project (Popa et al., 2015). By contrast, ‘transformational’ approaches to participatory

research, are more concerned with participants' *social* contributions than their *epistemic* contributions. TM, and other action research frameworks, adopt a 'transformational' approach to participatory research, as they reject the assumed linear relationship between knowledge production and societal progress. Action researchers contribute to societal progress by facilitating technical and social problem-solving processes. By mediating the social dynamics, discourse and power relations that typically interfere in the relationship between knowledge production and societal progress, participatory action research seeks to include stakeholders in the research process to both empower and inform them as change agents.

To this end, Transition Management, with a clear transformational project orientation, provides an attractive framework to overcome the social barriers to change. To inform transformative *action* on issues of unsustainable development, the agency of various system actors is leveraged and directed towards agreed 'transition goals'. When transition goals are not *collectively pursued* from various system actors, they will likely meet resistance and fail to overcome system rigidity/lock-in, as discussed in Chapter 2: Literature Review. Values belonging to a diverse set of societal actors must also be leveraged, as (1) visions coming only from elites risk being rejected by the wider society; (2) they are likely biased and exclude knowledge and value systems of non-elites; and (3) broad ownership of sustainability problems and solutions increases likelihood of success (Sengers et al., 2016a).

In addition to the *practical* demand for stakeholder involvement, there is an *ethical* demand. "At its core, sustainability is a fundamentally ethical concept raising questions regarding the value of nature, responsibilities to future generations and social justice. [...] The values underlying sustainability visions, goals, targets and thresholds need to be elicited [from the wider public], mapped, and discussed in order to support societal deliberation over what values should guide sustainability transitions" (Miller et al., 2014, p. 241). Because these questions concern all of society, sustainability scientists have both a *scientific* and *social* responsibility to include the extra-scientific in the analysis of sustainability transitions. This concern



is reflected in the call for ‘socially robust’ forms of knowledge production in transition research (Gibbons, 1999, Nowotny, 2003, Nowotny et al., 2001).

Because my research is grounded in Complex Systems Theory and the Enlightenment belief in rationality and Democratic Liberalism more broadly (Ezrahi, 1990), I assume that the combination of improved systems learning from SDM and social learning from TM will help build consensus around a aid in the design and selection of socio-technical innovations with greater likelihoods of ‘take-off’. This is based on the axiomatic assumption that more knowledge about system dynamics is needed to improved decision-making and action related to sustainability (Miller, 2013, Palmer, 2012, Wiek et al., 2012, Miller et al., 2014).

### **3.3.3 Participatory action research is experimental and less predictable**

The third principal of participatory action research is that it is experimental. Kemmis et al. (2014) define participatory action research as a collective commitment to address the unintended consequences of social practices by engaging in iterative cycles of planning, acting, observing, and reflecting. In addition to their real-world impacts, such experiments often “produce evidence regarding both the persistent unsustainability of dominant regimes and the possible solutions to given sustainability problems” (Luederitz et al., 2016, p. 1).

That said, the experimental and participatory nature of this methodology does introduce a lot of uncertainty around the direction and outputs of research projects. As such, it is difficult to predict, in advance, what learnings will come about the persistent unsustainability of dominant regimes. For this reason, participants need to buy into the *process* of learning-by-doing as opposed to specific outputs. In this process, researchers gain detailed insights about actors’ experiences, interpretations, and problem-solving in a particular real-world context. Specifically, participatory action research supports the observation and analysis of how ‘experiential learning’ reshapes actors’ beliefs and priorities (Kolb, 1984)—a major area of study for Transitions Research (Geels et al., 2016). Moreover, participatory action research

enables Transitions scholars to intervene in actors' experiences and analyse the effects of these interventions on experiential learning and other actor-relevant dimensions at the individual and group-level. As such, this methodology supports the advancement of researcher practice in facilitating transitions toward sustainability – the ultimate (normative) goal of Transitions Research. Importantly, participatory action research produces recommendations – both for practice and policy – rooted in practice, such as the messy reality of local multi-stakeholder projects.

### **3.4 SINGLE CASE STUDY RESEARCH DESIGN**

This research project relies on a single case study research design. The Dictionary of Sociology defines a single case study as “The detailed examination of a single example of a class of phenomena.” According to (Abercrombie et al., 1984, p. 34) “a case study cannot provide reliable information about the broader class, but it may be useful in the preliminary stages of an investigation since it provides hypotheses, which may be tested systematically with a larger number of cases”. This section explains my rationale for adopting a single case study research design (Section 3.4.1), followed by a description of the case study (Section 3.4.2).

#### **3.4.1 Rationale for ‘single case study’ research design**

Because participatory action research is practice-based and depends on the recruitment and retention of extra-scientific participants, it is limited to single case studies or, in co-ordinated research projects, a small number of case studies carried out by project partners. Given its aforementioned orientation toward *transformative* research (Section 2.3.2), TM prioritises “the co-production of on-the-ground change processes with social actors” (Geels et al., 2016, p. 576) over the production of generalisable knowledge. “Contrary to scientific experiments, the experiments conducted in the context of transitions are not designed to establish facts about a single causal relationship but aim to simulate a complex process of social and technological co-evolution with emergent properties” (Sengers et al., 2016a, p. 17). This is

true of all urban laboratories, which “share the assumption that such experiments are superior in their ‘adherence to life as it is really lived’ (Kohler, 2002, p. 215) and are capable of producing knowledge that will be useful and hence transformative, even if it falls short of the more controlled conditions offered in laboratory activities” (Evans and Karvonen, 2014, p. 417).

Although it would be nice to be able to draw generalisable conclusions for TM about the methodological adaptations I propose in Section 3.6, my research is limited by the fact that I am seeking to advance a practice-based methodology emphasising context specificity. However, within a specific context, I can still investigate the various effects, particularly unintended effects, of my methodological recommendations in one particular context and, from my findings, formulate hypotheses that can be further investigated in future applications of TM. Single case studies are often used to pilot new action research methodologies, as they allow for an in-depth analysis of their effects on a number of social dimensions (e.g., individual experiences of systems learning, trust-building between participants, and the role of power in determining project outcomes) (Flyvbjerg, 2005).

Aside from limited generalisability, the single case study research design is often criticised in Transitions Research for paying “limited attention to wider structural contexts” and adopting a “short-term orientation” to processes that typically take decades to unfold (Geels et al., 2016, p. 580). The second criticism, though fair, would limit research on socio-technical transitions to historical studies. To study the social dimensions of transition processes, however, researchers need access to the narratives of a diverse set of societal actors initiating, steering, accelerating, or even blocking transitions. Such data is hard to come by, making it difficult for Transitions researchers to ‘open the black box’ on transition processes. Participatory action research allows transition scholars to ‘open the black box’ – albeit, only at a very short period of a multi-decade, non-linear transition process. As such, findings must be reported, not only in reference to the specific case study, but also in reference to the ‘transition phase’ in which the research is

being conducted, e.g., “pre-development”, “take-off”, and “acceleration” phases identified by (Rotmans et al., 2001). This limitation also suggests that action researchers should adopt a more reflexive approach to their research, considering, for example, how social developments that were facilitated by the research project (e.g., learning or network building) may contribute to an ongoing transition process and not perceive results as static successes or failures.

The first shortcoming, limited attention to wider structural contexts, could lead one to the same conclusions; however, I would argue that wider structural contexts (e.g., global trade agreements, national policy, technological innovations, and resource limitations) all inform the local context. For example, in realising sustainability transitions, local actors are responding to landscape pressures, constraints and opportunities that have developed from the wider structural context. Indeed, single case studies produce qualitative data rich in detailed accounts of wider structural contexts (e.g., in participants’ narratives and observed behaviours). Although these wider structural contexts are mediated by place-based factors to produce a unique, local manifestation of wider structure contexts, it is in these environments that system agents recreate or challenge wider structural contexts. Only in single case study research can “context-bound knowledge emerge to develop ‘local theory’ that is understandable and actionable” (Bell et al., 2004, p. 2).

### **3.4.2 Case study description**

Although my proposed adaptations to the TM framework can be implemented at various spatial scales (e.g. at the city, regional, national or even international level), the geographical location (Cambridgeshire-Peterborough city-region) and transition topic (housing) were chosen based on a perceived ‘policy window’ and a pre-existing, informal network of regime actors, many of whom are committed to the sustainability agenda and can be considered ‘transition frontrunners’ in their own right. This informal network has been established over nearly two decades thanks to the work of Sustainability

East, a regional social enterprise and driving force behind the East of England's sustainability agenda. In particular, Sustainability East's previous work with local policymakers has established a great deal of trust needed to set-up the so-called 'transition arena' with the newly created Cambridgeshire-Peterborough Combined Authority.

This pre-existing informal network, along with a timely policy window in the Cambridgeshire-Peterborough city-region, provides a compelling case study in which to test adaptations to the participatory action research framework, Transition Management. Policy windows are opportunities situated in time and place when a given 'problem' (an issue of public concern) is catapulted to the top of the policy agenda thanks to the timely alignment with 'politics' (politicization of societal issues) and 'policy' (the provision of alternative solutions) (Kingdon, 1995)<sup>13</sup>. The interaction of these three so-called 'policy streams' is said to produce a political environment in which policy entrepreneurs (e.g. lobbyists, policy experts, scientists, etc.) can most effectively intervene in the decision-making process. This environment, "fertile for the uptake of scientific knowledge into policy" (Rose et al., 2017, p. 2), is said to emerge during crisis events (e.g. high-profile lawsuits, financial and/or environmental crises) and major political events (e.g., upcoming elections, changes in administration, transformation of institutional structures, etc.). The Cambridgeshire-Peterborough city-region faces a number of significant social, economic and environmental sustainability challenges related to its housing system. These crises have been coupled with the *politicization* of housing in relation to the ongoing transformation of governance structures and a devolved budget of £100m for

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<sup>13</sup> Much work has been done on 'policy windows' in environmental research, particularly in looking at the reform of changing governance structures (e.g. ANDERSON, W. & MACLEAN, D. 2015. Public forest policy development in New Brunswick, Canada: multiple streams approach, advocacy coalition framework, and the role of science. *Ecology and Society*, 20.; BUTLER, J., YOUNG, J., MCMYN, I., LEYSHON, B., GRAHAM, I., WALKER, I., BAXTER, J., DODD, J. & WARBURTON, C. 2015. Evaluating adaptive co-management as conservation conflict resolution: learning from seals and salmon. *Journal of environmental management*, 160, 212-225.; KESKITALO, E. C. H., WESTERHOFF, L. & JUHOLA, S. 2012. Agenda-setting on the environment: the development of climate change adaptation as an issue in European states. *Environmental Policy and Governance*, 22, 381-394.; etc.)

housing and infrastructure. The highly uncertain, *political* environment resulting from these tandem developments has thus produced a 'policy window' in which new, *adaptive* forms of governance should be tested for the management of sustainability transitions.

Taking advantage of this policy window, my participatory action research in the Cambridgeshire-Peterborough city-region seeks to (1) provide insights into systemic causes of unsustainable housing development in the Cambridgeshire-Peterborough city-region, (2) facilitate stakeholder-led initiatives in housing across the region; and (3) improve analytical frameworks for the analysis and steering of sustainability transitions.

### **3.5 RATIONALE FOR ADOPTING A QUALITATIVE RESEARCH DESIGN**

Qualitative data collection and analysis took place at three phases of the research project: first, in my preliminary analysis of housing-related sustainability challenges in the region (Section 3.5.1); second, in the co-creation and co-analysis of stakeholders' qualitative systems model (Section 3.5.2); and third in the investigation of applied adaptations to TM methodology (Section 3.5.3). My rationale for adopting a qualitative research design for each piece of work is reported in these subsections.

#### **3.5.1 The use of qualitative data to conduct a preliminary analysis of local housing-related sustainability challenges**

Although city-regions face many of the same sustainability challenges, the local system structure can vary quite substantially. As such, texts such as local policy documents, development strategies, consultancy reports, interest group reports, news articles, etc. were used to contextualise scientific knowledge from urban and regional studies. Quantitative data on key stocks and variables (e.g., average age of housing stock, greenhouse gas emissions, and water consumption) were also collated and helped

build a picture of risks to long-term wellbeing that are either produced by or have implications for the regional housing system.

Recognizing that only limited knowledge can be gained through desktop research, I also conducted semi-structured interviews with at least one representative from each 'stakeholder group' identified in the actor analysis. Interviews were then transcribed and findings from an inductive, thematic analysis of interview data were then triangulated with research findings from the literature review to complete a 'preliminary systems-actor analysis' of the Cambridgeshire-Peterborough 'Housing & Wellbeing System'. The order of data collection (literature review – desktop research – interview) was purposeful, so as to draw my attention to local contextual factors that diverge from previous case studies and highlight the unique place-based factors of the city-region under study. Indeed, information gathered from ongoing interviews brought to light several additional variables and alternative causal relationships not yet covered in the literature review and desktop research. As such, the incorporation of local knowledge into the research process prompted further investigation that might have otherwise been excluded from the system-actor analysis. This reflects a critical element of qualitative research according to Lichtman (2017, p. 14), namely that the scope of one's study (in this case, preliminary systems analysis) is "dynamic" and evolves as data is uncovered through the process of conducting one's research.

### **3.5.2 The use of qualitative data to construct the 'Housing & Wellbeing' systems model**

The co-constructed systems model produced in this research project represents participants' theorisations, or perceptions, of the local 'Housing & Wellbeing system'. Put differently, the model is a representation of local experiential knowledge. Because TM is an iterative process of 'learning-by-doing' and 'doing-by-learning', the model is designed to change as stakeholders' collective understanding of the complex 'housing & wellbeing system' changes.

Although I had originally planned to develop a quantitative system dynamics model, I soon discovered that very little data exists at the local level, what does exist only represents a very short time period, and many variables identified in stakeholder interviews are not quantifiable. As such, I decided fairly early on in my research project that I would construct causal loop diagrammes (CLDs) using qualitative data from stakeholder interviews, as well as findings from the literature, which could then be reviewed and edited in multi-stakeholder workshops. These CLDs could then be used to analyse stakeholder-proposed interventions and generate hypotheses on their intended and unintended consequences (Esensoy and Carter, 2015, Martone et al., 2017).

The main benefit of qualitative systems modelling is that it can represent a broader range of variables and theoretical relationships. In quantitative modelling, if the relationship between A and B is not modelled (e.g., because there is no data for B), the embedded assumption is that no relationship exists between A and B even if practitioners know, from experience, that such a relationship exists. This false assumption can produce highly inaccurate results when scenarios are simulated. Although simulation would have eased the analysis of the systems model, the benefits were considered to outweigh this shortcoming. Much of stakeholders' understanding of the housing system comes from their repeated experiences with the system which they can only represent through qualitative data. Qualitative modelling was able to capture this.

If I had adopted a 'descriptive-analytical' approach to my research, I would consider the inability to validate the qualitative systems model to be a significant shortcoming of my research design. Having adopted a 'transformational' approach, however, I understand the model as a tool to facilitate transdisciplinary discussions about complex sustainability challenges and observe how the co-modelling process informed participants' social contributions – the concern of my research, not their epistemic contributions. For example, I planned to investigate whether co-modelling facilitated consensus-building



around problem and solution definitions or whether it improved the application of systems thinking during the selection of stakeholder-led initiatives.

### 3.5.3 The use of qualitative data to meet my research objectives

Because the aim of my research is to advance TM methodological, there is an implicit hypothesis that the changes I proposed and piloted will improve the TM outcomes in the ways outlined in Chapter 2: Literature Review. I could have tested this hypothesis through the collection and analysis of quantitative data, e.g., testing whether co-modelling had a statistically significant effect on participants' ratings of proposed interventions before and after the co-modelling exercises, and whether the variation in responses shrunk post-modelling as evidence of consensus-building. However, a single case study research design is not capable of testing hypotheses in any case, given the small number of observations and inability to control other factors (e.g., the behaviour of workshop facilitators) that may have influenced observed outcomes.

Having adopted a qualitative research design, I was less interested in testing a null hypothesis and was more interested in *how* my methodological adaptations to the TM framework contributed or failed to contribute to, for example, systems learning. 'How' findings, I would argue, are more valuable for advancing TM's practice-based methodology. Indeed, "most [qualitative research] traditions aim for description, understanding, and interpretation and not examination of cause and effect" (Lichtman, 2017, p. 17).

Moreover, a qualitative research design allowed me to conduct an *inductive* analysis to explore unintended consequences of my proposed adaptations that fall outside the strict bounds of my pre-envisaged research questions. In other words, I could investigate my proposed adaptations in their entirety rather than focusing in on specific elements, bounded by deductive reasoning.

### 3.6 ADAPTATIONS TO THE TRANSITION MANAGEMENT FRAMEWORK TO ACCOMMODATE

#### PARTICIPATORY SYSTEM MODELLING

To integrate participatory systems modelling into TM, I made three changes to the TM framework (see Figure 2). First, in the second phase of TM, retitled “Identifying sustainability challenges in your city,” transition scholars conduct a *preliminary* systems analysis – the results from which frame co-constructed visions of the future. The analysis is considered to be preliminary, as it forms only the basis for participatory modelling and analysis conducted by participating frontrunners (i.e., co-investigators). Phase 5 thus adopts the title “Exploring dynamics in your city” and back-casting is replaced by participatory, qualitative systems modelling – the second change I made to the TM framework. Third, Phase 4 is retitled “Envisioning a sustainable city-region and developing a transition evaluation framework.” In my methodological adaptation of TM, the evaluation framework is a key output of visioning workshops and is later used, in Phase 6, to hold frontrunners accountable to the values and priorities of community members experiencing, first-hand, the unintended consequences of unsustainable development.

#### 7 PHASES OF THE ADAPTED TM PROCESS

- (1) Setting the scene for Transition Management [preparing the transition arena]
- (2) ~~Exploring dynamics~~ **Identifying sustainability challenges** in your city [i.e., *preliminary* systems analysis]
- (3) Framing the transition challenge [i.e., problem identification]
- (4) Envisioning a sustainable city[-region] **and developing a transition evaluation framework**
- (5) ~~Reconnecting long term & short term [i.e., back-casting]~~ **Exploring dynamics in your city [i.e., *participatory* systems modelling and analysis]**
- (6) Getting into action [i.e., transition experiment design, selection and implementation]
- (7) Engaging & anchoring [i.e., actions to support the scale-up of innovations]

Figure 2: Adapting the phases of Transition Management

When determining how best to integrate the two frameworks, I followed closely the System Dynamics Modelling (SDM) process presented in Macmillan et al. (2016). However, I separated out the

visioning workshops, thematic analysis, and evaluation framework development from the rest of the process (see bolded arrows in Figure 3) to indicate that the visioning process runs parallel, but independent from, the transition arena work with frontrunners.

In the end, both the transition evaluation framework and qualitative SD model feed into the multi-stakeholder workshop to inform the evaluation of frontrunner-proposed interventions. These interventions, ranging from policy interventions to voluntary, multi-stakeholder initiatives, are then experimented with in multi-stakeholder initiatives including the city-regional government. The word “policy” in Figure 3 has been crossed out and replaced with the more expansive TM term, “transition experiment”, as proposed interventions may go beyond policy recommendations.

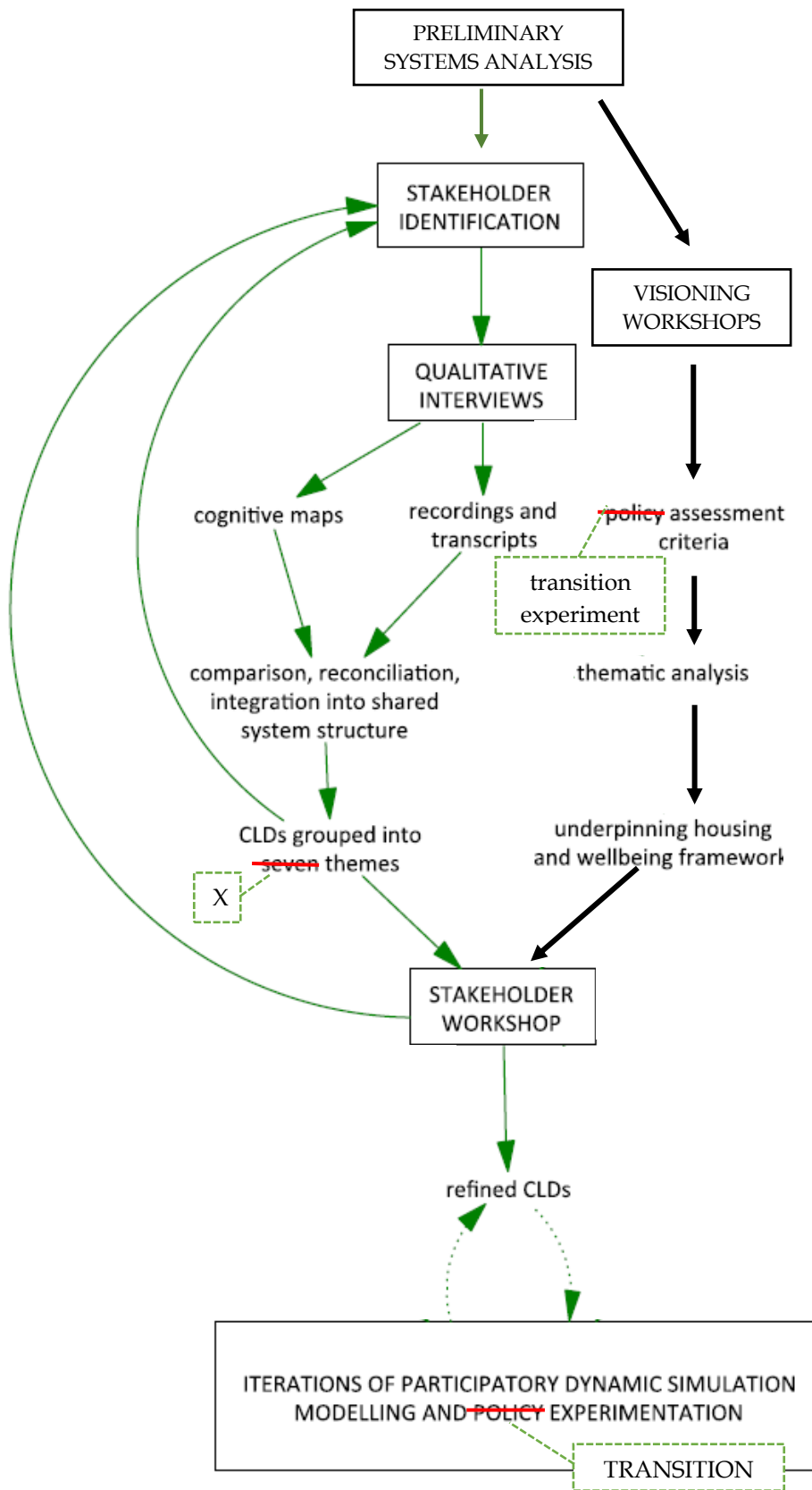


Figure 3: The adapted Transition Management process

### **3.6.1 Setting the scene for Transition Management: preparing the transition arena**

In the ‘preparation’ phase, the so-called ‘transition team’ is established to manage and facilitate the TM process, organise internal and external communications and relate the project to ongoing policy processes. The focus of the transition process is typically chosen by the transition team, composed of a mix of employees of the initiating organisation (e.g., local authority) and experts in the field under study (e.g., transition scholars). For my case study of housing in the Cambridgeshire-Peterborough city-region, the transition team consisted of one representative from the East of England Local Government Association (representing local governments), four academics and two practitioners. It was steered by Professor Aled Jones, Director of the Global Sustainability Institute at Anglia Ruskin University. Under the scope of my PhD, I acted as lead researcher with my secondary supervisors, Dr. Chris Foulds and Dr. Rosie Robison, also serving on the transition team. The remaining two members were drawn from the Board of Sustainability East, the project’s funding organization and regional social enterprise, and from the Board of the Peterborough Environment City Trust (PECT), a leading regional charity set up to protect and enhance the environment. The Transition Team was formed in January, 2016 and received official endorsement by the Cambridgeshire-Peterborough Combined Authority in August, 2017 to host multi-stakeholder workshops in the cities of Cambridge and Peterborough.

### **3.6.2 Identifying sustainability challenges in your city: Preliminary systems analysis**

In the ‘exploration’ phase of TM, the transition team produces a holistic analysis of a chosen change issue, “its main properties, interactions, persistent problems and challenges for the future. [...] More than being exhaustive, the system analysis should stimulate a *systemic* way of thinking” about challenges of local sustainability transitions (Nevens et al., 2013, p. 117). Systems analysis has three main functions in the TM process. First, it includes an actor analysis, which also aids in the selection of transition frontrunners. Second, results from the systems analysis are used to frame participants’ understanding and explicit

definition of the transition challenge (Nevens et al., 2013). Third, the presentation of results provides a common information base for a group of participants with diverse experiences and professional backgrounds to enable mutual understanding of the system under analysis.

Before conducting the systems and actors analysis, I first had to define project boundaries (e.g., geographical and sectoral boundaries). Whilst collective ‘problem identification’ is conducted post-analysis in the case of TM (i.e., after the systems analysis has been presented in the transition arena), it is conducted *a priori* in participatory SDM (see the first step in the participatory SDM process in Figure 4). At closer glance, one could say the same is true for TM, as research ‘themes’ (e.g., CO<sub>2</sub> emissions from energy use and mobility) used to draw system boundaries are implicitly framed by the researchers’ understanding of sustainability problems (e.g., global climate change). This implicit, cognitive step is represented by the ‘problem identification’ think bubble at the top of the ‘TM framework’ in **Error! Reference source not found..** This point is emphasized, as the results of systems analysis naturally depend on what researchers choose to observe, and this choice is necessarily influenced by their subjective problem definition. Albeit, the researcher-defined transition challenge is subject to change throughout the exploration phase and is necessarily influenced by knowledge and perspectives provided in stakeholder interviews.

In many cases of SDM application, the ‘client’ is responsible for defining the problem and assists modellers in demarcating system boundaries. Focus on client ‘needs’ and understanding of systemic challenges is most likely the result of SDM’s original focus on corporate policy problems (Senge and Forrester, 1980, Forrester, 1997, Forrester, 1985), as well as its utilization in governance research that had been framed by a top-down approach to governance (Greenberger et al., 1976, Feng et al., 2013, Vennix, 1990). However, in the past two decades, SDM has been increasingly applied in participatory research in which the problem and boundaries are initially defined by the modeller (see Figure 4) and adjusted based on stakeholder knowledge provided in interviews and in co-modelling workshops (Vennix, 1996, Andersen

and Richardson, 1997, Langsdale et al., 2009, Andersen et al., 2007). Bearing in mind TM's explicit, normative long-term goal of facilitating transitions toward sustainability, I adopt the practice of initial problem framing by the transition team into my proposed, adapted TM framework.

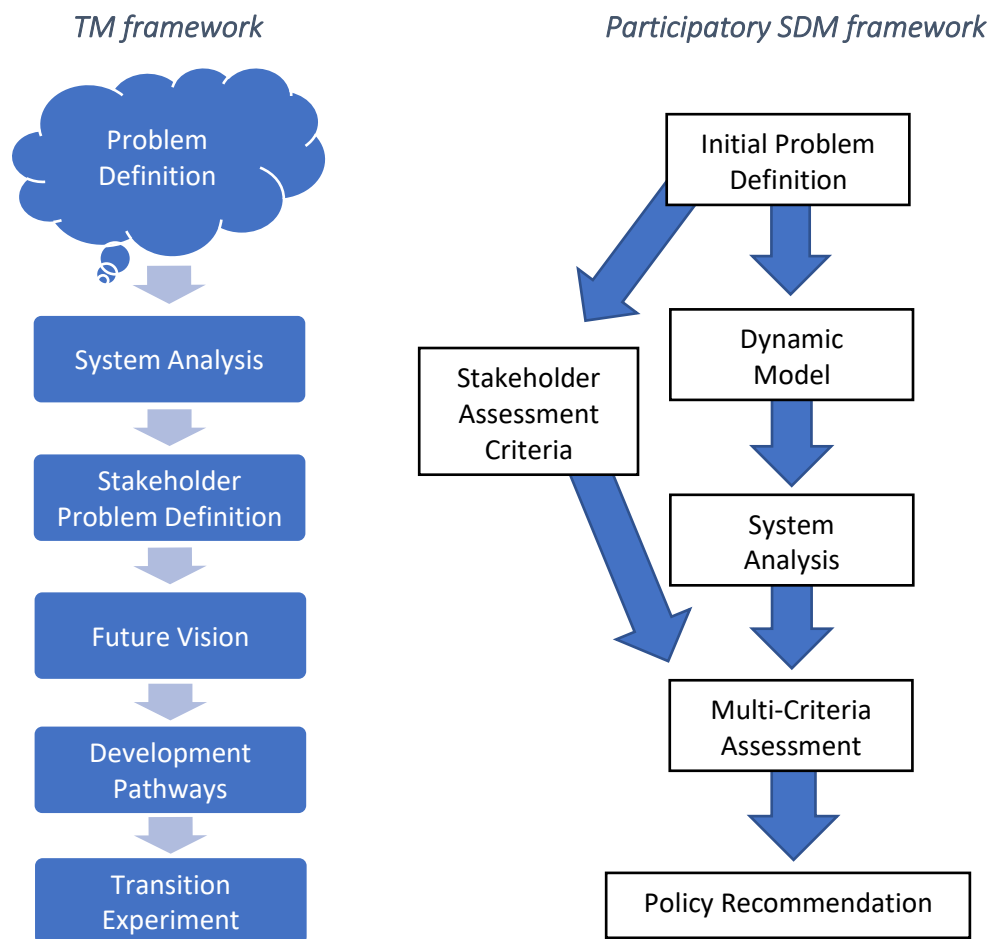


Figure 4: Problem identification in Transition Management vs. Participatory System Dynamics Modelling

In this research project, the problem definition was largely influenced by two factors: (1) the funding organisation's concern over the region's environmental sustainability, and (2) the governance areas included in the devolution agreement between central government and local authorities in Cambridgeshire and Peterborough – namely, adult skills training, housing and transport infrastructure development. Although adult skills training is a critical governance area for realising a fair transition toward sustainability,

the research team was more interested in utilising the window of opportunity associated with devolution to influence decisions around local infrastructure development, as the Combined Authority's spending in this area was expected to produce greater path-dependencies than spending on adult skills training. That said, the effect of spatial planning and housing development on people's access to adult skills was included in the analysis.

To give the project a manageable focus, the initial problem definition was broadly prescribed as "unsustainable housing" which inevitably requires a consideration of spatial planning and transportation infrastructure development. Importantly, my research project adopted the Brundtland definition of 'sustainable development' (Brundtland, 1985) and considered social, economic, and ecological challenges associated with unsustainable housing development. Problems to be identified, initially by the transition team and subsequently by local practitioners, included all housing-related sustainability challenges falling within the territorial jurisdiction of the Cambridgeshire and Peterborough Combined Authority. The methods used to conduct the preliminary actor and systems analysis based on this initial problem identification are presented in Section 5.2.

### **3.6.3 Framing the transition challenge**

The 'transition challenge' was broadly defined by the transition team as "securing or improving long-term, housing-related wellbeing across Cambridgeshire and Peterborough". Specific transition goals were then defined by participants of the visioning workshops based on their subjective understandings of wellbeing, the methods for and results from which are presented in *Chapter 4: Findings from the visioning workshops*. The decision to prescribe a transition challenge goes against standard TM practice. In TM, participants are rather asked to "make explicit a shared perception and structuring of the problems/challenges of the city" (Nevens et al., 2013, p. 113) to develop a collective 'transition narrative' that answers the question "why a transition?" (Frantzeskaki et al., 2012, p. 30). The answer to this question



provides “the foundation for the envisioning and transition experiments in later phases” (Roorda et al., 2012, p. 17). In my proposed TM-SDM framework, however, the main object of participatory modelling is to discover the underlying problem or ‘system leverage points’, based on a collective understanding of the system structure and dynamics – not to identify symptomatic problems resulting therefrom. As such, my projects seek to build consensus around what infrastructure can and should provide in terms of wellbeing, not what (symptomatic) problems should be tackled. The focus is therefore ‘system optimization’ based on a list of collectively aspired goals developed in this phase.

#### **3.6.4 Phase III: Envisioning a sustainable city-region and developing a transition evaluation framework**

In TM, the aim of the envisioning phase is twofold. First, there is the need to create a shared ‘language’ and understanding of the desired future vision and transition goals. “The process of envisioning is as important as the vision itself, since it contributes to [...] a common ‘language’ and therewith the alignment of perspectives” (Roorda et al., 2012, p. 20). Second, as the initial meeting between transition frontrunners, it could very well determine the level of mutual respect, understanding, empathy and trust that develops between frontrunners throughout the adapted TM process. Here, trust refers to “the mutual willingness to collaborate on equal footing, reconcile divergent worldviews, as well as acknowledge different interests (Bernstein et al., 2016, Vandevyvere and Nevens, 2015)” (Roorda et al., 2012, p. 20). Trust is needed to relax biases and rigid cognitive frameworks and open participants to new ways of thinking about, seeing, and valuing the world. Hence, trust is a prerequisite of social learning, i.e., the acquisition of new knowledge, competences, norms and values (van den Bosch, 2010, Van Buuren and Loorbach, 2009).

In my proposed adaptation of TM, the main aim of visioning workshops is to capture the values and priorities of individuals who experience (or are expected to experience) first-hand the negative consequences of unsustainable housing development. These include local residents on the social housing waiting-list, those living in flood zones, farmers, key workers, first-time home buyers, those with limited

mobility and accessibility including the elderly and disabled, as well as those living in high deprivation. I tried to reach these target groups through gatekeepers listed in Table B1 of Appendix B. These groups were identified based on a review of sustainability challenges in the region and are reflected in the Cambridgeshire and Peterborough Combined Authority's Non-statutory Spatial Plan, which lists deprivation and growing inequality; biodiversity loss; climate change; road congestion; and accessibility as 'strategic spatial issues' for the planning/housing sector (CPCA, 2017).

Because participants are selected on this basis, frontrunners participating in the adapted TM process no longer own the vision they are asked to deliver. The risk, of course, is that this adaptation will reduce buy-in from frontrunners who are able and otherwise willing to help change the system. Indeed, an objective of my research is to observe whether and how this potential trade-off actualises. However, I attempt to reduce this risk by inviting a subset of frontrunners from the transition arena to the visioning workshops. The purpose of this decision was twofold: First, their attendance would provide the visioning workshops with a handful of expert practitioners available to answer participants' sector-specific questions; Second, they could later communicate the lived experiences of workshop participants to frontrunners in the transition arena, thus building frontrunners' understanding of and empathy for the perspectives that shaped the transition vision.

Whilst participatory visioning is needed to set goals that are relevant and legitimate to those participating in the visioning workshops, participatory systems modelling by frontrunners is needed to uncover the appropriate interventions to achieve those goals. The visioning work and participatory systems modelling are linked via the 'GCGP Housing & Wellbeing Evaluation Framework' – a technical output of the visioning workshops. The evaluation framework contains participant-defined and participant-weighted goals for the local housing system, used to evaluate frontrunners' proposed initiatives pre- and post-intervention (see Figure 5).

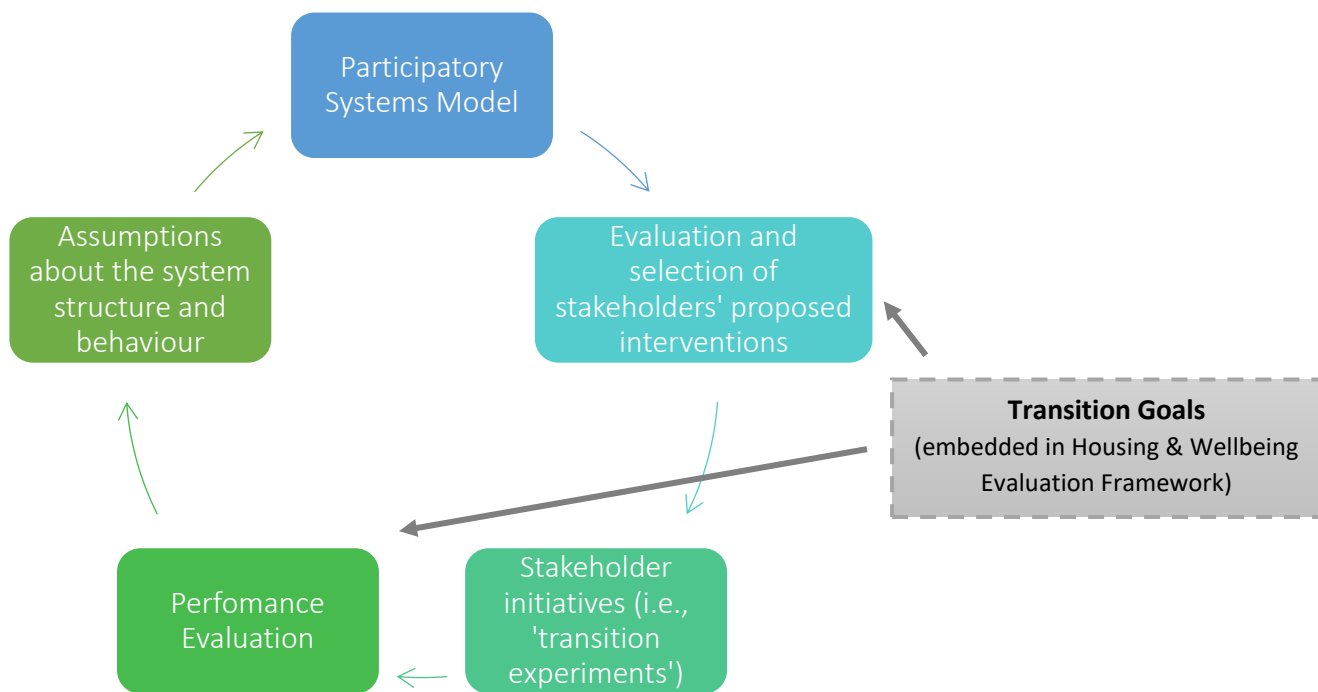


Figure 5: How ‘transition goals’ developed in visioning workshops inform the iterative, stakeholder-led process of ‘learning by doing and doing by learning’

In the transition arena, the evaluation framework is applied in such a way, that only the highest scoring interventions against the GCGP Housing & Wellbeing Evaluation Framework are carried over to the ‘Getting into action’ phase of the adapted TM process. The evaluation framework, applied in this way, improves accountability, one of the requirements of ‘good institutional design’, and safeguards against co-optation by powerful actors (Rodrik, 2008, Sengers et al., 2016a).

### 3.6.5 Exploring dynamics in your city: participatory systems modelling and analysis

*“The world is a complex, interconnected, and finite system with relationships among the ecological, societal, psychological and economic scopes. We tend to act as if this were not so, as if it were divisible, separable, simple and infinite. Our persistent problems directly originate from this lack of perception.”*

*(Garcia, 2006, 42)*

Given its integrative nature, systems analysis enables participants to “look beyond their own expertise and perspectives and to understand the interconnectedness of the system(s)” (Nevens et al., 2013, p. 114). Furthermore, systems analysis is meant to help stakeholders distinguish between “symptoms and deep-rooted problems” and shift the focus from “superficial solutions to systemic challenges and opportunities” (Roorda et al., 2012, p. 12). In TM, the systems analysis is conducted prior to problem identification and visioning. It is not until later that participants create development pathways and design/select transition experiments. According to Roorda et al. (2012, p. 13), TM systems analysis progresses in four steps:

- ❖ **Step 1: Delineate the system boundaries** in space, time and themes (e.g. CO<sub>2</sub> emissions from energy use and mobility in the wider city region, looking at the past 40 years).
- ❖ **Step 2: Structure the system** by defining relevant stocks (e.g. labour force, air quality, housing stock), covering social, environmental and economic domains. Define characteristics and indicators for each of these, and the relationships between them.
- ❖ **Step 3: Collect data required to evaluate the state of the system.** This involves qualitative and quantitative data from studies, policy documents and statistical databases. Personal interviews with potential candidates for the transition arena, experts and stakeholders bring diverse perspectives into the system analysis. This step is performed in conjunction with actor analysis.
- ❖ **Step 4: Analyse the data.** The analysis of the data can be realised by the transition team (also but not always) including external advisors or policy makers. Stakeholder meetings or expert sessions can be applied when analysing and structuring the data.

As a tool for conducting systems analysis, SDM follows a similar process methodology (Aslani et al., 2014):

- ❖ **Step 1: Problem identification** informed by quantitative and qualitative data and expert judgments
- ❖ **Step 2: System conceptualization**, which includes the determination of system boundaries and structure (i.e., subsystems, their relevant stocks, dynamic factors and causal relations, which can be simplified into causal loop diagrams)
- ❖ **Step 3: Collect data required to populate the model**
- ❖ **Step 4: Simulation and model validation**
- ❖ **Step 5: Analysis of system dynamic behaviour** via sensitivity testing

In the MUSIC project, Maas et al. (2018) conducted participative systems modelling and analysis in the second phase of TM. Participative systems modelling facilitates whole systems thinking, “a process for understanding how things as parts of a set influence each other. It is an approach for problem solving by viewing “problems” as parts of an overall system rather than reacting to specific parts (Ackoff et al., 2010)” (Aslani et al., 2014, p. 759). In Phase 5, titled “Reconnecting long term & short term”, back-casting is then used to facilitate the selection of interventions based on linear narratives about societal development and system change. To improve the application of systems thinking in TM, I propose extending systems modelling into Phase 5, retitled “Exploring dynamics in your city”, and I propose removing back-casting from the TM framework. Moreover, I propose moving from *participative* modelling, as proposed in Maas et al. (2018), to *participatory* modelling, meaning frontrunners have greater ownership over the systems model and are even invited to participate in the analysis of their interventions. This further opens the systems analysis to frontrunners, now viewed as co-investigators.

In my proposed adaptation of the TM framework, a diverse set of experts and frontrunners co-construct a qualitative systems model in Phase 2, making sure to include all three domains of the

sustainability triangle: social, environmental and economic (Rotmans, 1998), as recommended in the SCENE model (Maas et al., 2018). Having defined the transition challenge as “securing or improving long-term, housing-related wellbeing across Cambridgeshire and Peterborough” (Section 3.6.3), I further propose that the model contain direct and indirect links between the regional housing system and future wellbeing. I also recommend that the systems model capture non-linear characteristics of the complex system under study via the use of ‘time delays’ and the co-construction of causal loop diagrams (CLDs), as is practiced in SDM. By collating actors’ perceptions and (partial) knowledge of the problem context into interlinked CLDs, frontrunners will be better positioned to identify the myriad of causal relationships that produce dynamic patterns of system behaviour and development.

In Phase 5, I propose frontrunners use their model to analyse the potential unintended consequences proposed interventions. Through fully participatory exercises, outlined in the methods section of *Chapter 5: Findings from the co-modelling process*, frontrunners investigate how the system might react dynamically to interventions creating emergent system behaviour; how their favoured interventions may produce a number of negative, unintended, positive or negative consequences enabling a greater consideration of trade-offs, re-evaluation of intervention and potential need to compensate certain actors; and lastly, how multiple interventions, carried out together, may produce synergistic or counter-productive outcomes.

An additional, particularly interesting, expected outcome of the co-modelling process is increased self-awareness of one’s own contribution to the transition challenge.

“Actors in the problem situation may not be aware that they are participants in a societal problem situation. For example, consumers may have no awareness that they are part of the societal problem situation of “pesticide use and loss of biodiversity”. In our opinion, collaborative research based on systems-thinking methodologies is best suited to address such situations. This is because

collaborative research allows participants' to draw upon their knowledge of the problem situation and because systems thinking methodologies integrate "objective" and "subjective" aspects of societal problem situations (Schwaninger, 2004)." (Müller et al., 2013, p. 4)

Such awareness in the context of transition management is critical. To coordinate their actions and co-govern transitions to sustainability, transition frontrunners must first gain a sense of problem ownership.

### **3.6.6 Getting into action: transition experiment design, selection and implementation**

'Getting into action' consists of four increasingly autonomous steps: transition experiment proposal, design, selection and realization. In my adapted TM framework, interventions are proposed and rated prior to co-modelling and analysis. Thereafter, however, they are asked to re-evaluate interventions based on results from qualitative, systems analysis. The final selection of interventions, however, is chosen based on participants' assessment of interventions' expected performance against each weighted category of the 'Housing & Wellbeing Evaluation Framework'. The design of multi-stakeholder initiatives around interventions scoring highest on the weighted index are then brainstormed in the transition arena. At the end of this process, frontrunners are encouraged to form working groups around each initiative and organize future meetings with the logistical help of the transition team. However, meetings from here forward are rather autonomous and will involve the introduction of new actors.

Frontrunners are also encouraged to invite new stakeholders into their working groups. Bringing new actors into the fold is a sensitive undertaking. First, new entrants must be sufficiently convinced of the insights gained from the systems analysis. Since they did not participate in the co-production of the SD model, new entrants will likely be more critical of the 'intervention points' frontrunners have selected. Second, new entrants must commit to delivering pre-defined transition goals set out by participants of the visioning workshop (or at least in those categories of the evaluation framework where the intervention scored highest). Compared to the three preceding phases, TM experimentation is most subject to personal

agendas and self-interest. This is due to the fact that actual ‘on the field’ engagement requires significant investments in time, money and reputational risk, as ‘experiments’ are highly visible, public initiatives that carry a degree of possible failure. As such, those who engage with the process will reasonably question “what’s in it for me?” If certain precautions are not taken, the transition experiments could be ‘hijacked’ by external interests.

Although the design of transition experiments may significantly change throughout this process, frontrunners should, under no circumstance, change the ‘intervention points’ around which initiatives are developed. As a mitigation measure against co-optation, particularly from new entrants, the transition team publishes these results from the transition arena. As the ‘knowledge and value brokers’, it is important that the city-regional government oversees the assessment of final multi-stakeholder initiative proposals to ensure that they (1) are aligned with the agreed upon ‘intervention points’; (2) are evaluated based upon the criteria developed during the ‘envisioning’ phase; (3) have sufficient financial, social and political commitment; and (4) meet the requirements of ‘good institutional design’, namely embeddedness, carrots and sticks, and accountability (Rodrik, 2008, Sengers et al., 2016a). To this end, I recommend that working groups make explicit (1) the connection between proposed experiments and transition goals set out in the ‘Housing & Wellbeing Evaluation Framework’ and (2) how unintended consequences are being mitigated or compensated. The systems model provides a useful tool to this end, as it can facilitate their thinking and help illustrate their claims. By comparison, the link between transition experiments and transition pathways in the existing TM framework is more ambiguous and therefore more vulnerable to co-optation.

### **3.6.7 Engaging & anchoring: Actions to support the scale-up of innovations**

The transition arena is only a temporary platform. While it can provide a powerful innovation impulse for one-off interventions, future initiatives will be needed to tackle the underlying causes of unsustainable development. “Transitions in the making are not always eventful” (Turnheim et al., 2015, p.



241). They can take decades to unfold, and thus cannot be 'steered' by a single intervention – no matter how novel the socio-technological innovation. As such, ongoing effort is needed to create new impulses for change. Together, these impulses will drive transition toward sustainability in the local housing and transport sectors. For this to happen, insights having informed transition experiments must now find their way onto the agenda of organizations in the position to act upon system 'leverage points'. The success thereof will ultimately rely on the ability of the change agents (the transition team and frontrunners) to spread the transition narrative and make insights from the systems analysis explicit and accessible. The composition of the 'transition team' at this stage, may look very different, consisting of members of the former transition team, former transition frontrunners, local policy makers and potentially even new entrants. Regardless of the composition, the transition team will need to engage in four follow-up activities according to (Roorda et al., 2012), namely (1) engaging, (2) internalising, (3) opening up and (4) igniting.

'Engaging' refers to the *strategic* dissemination of insights from the transition arena to key organizations for the alignment of local initiatives. In practice, this could mean encouraging adjustments to how organizations operate, inviting them to participate in existing transition experiments and advocating the adoption of new initiatives to target a particular aspect of the transition agenda. If successful, the transition agenda thus moves from a small group of frontrunners into the hands of a growing number of actors outside the transition arena. As such, the arena is "broken open and connects to a larger (partly autonomous) dynamic of change, centred around a common and shared narrative" (Nevens et al., 2013, p. 119). In the process of engaging, change agents must be careful to maintain a clear vision of the transition narrative. "Engaging other people who do not (yet) share these perspectives or anchoring the narrative in rigid structures can lead to the loss of the essence of the narrative" (Roorda et al., 2012, p. 35). To prevent this from happening, the authors recommend 'reflection sessions' for both internal and external members of the transition arena, particularly at the early stages of engagement, to ensure a mutual understanding of the transition narrative. In my adapted version of TM, the evaluation framework would serve as the

boundary object (Simpson and Carroll, 2008, p. 46, Simpson et al., 2016) in future reflective sessions. Participants of the visioning workshops could also be invited back to present their qualitative, dystopian and utopian visions and summarise the discussions that led them to personally weight certain categories over others.

‘Internalising’ refers to the anchoring of transition insights into local policy, corporate governance and cultural practices in such a way that they continue to have effect into the future (Roorda et al., 2012, p. 33). The simplest example is to coach transition frontrunners on how to implement insights from the transition arena into their own practice (in both personal and professional spheres). The transition team should also encourage the adoption (by government and industry) of infrastructure-wellbeing development indicators “inspired by the systems analysis to use in ongoing monitoring efforts” (Roorda et al., 2012, p. 34). A ‘learning network’ could also be set up between powerful actors to review and produce insights from ongoing and emerging transition experiments. According to TM theory, iterative monitoring and evaluation is critical to the success of transition experiments as adjustments will necessarily need to be made given the unpredictable development of complex systems. Learning which takes place as a result of monitoring and evaluation may very well provoke further inquiry into the system (e.g. via data collection). Should new insight be revealed, stakeholders are encouraged to revisit their co-produced model and build upon their previous understanding of the system.

‘Opening up’ refers to the proactive creation of space for other emerging initiatives wanting to contribute to the transition agenda. This could include setting up a formal structure that calls for new ideas/project proposals (e.g. a competition or project development agency).

‘Igniting’ is equally about building empathy and inspiring people to think beyond their own stakes, routines and perspectives as it is about getting people to think systemically about complex problems. To this end, the transition team must make an effort to get people excited about working with actors from

other domains on problems which may not have a direct, short-term link to their interests, but which impact upon the system's overall functioning and resilience on which they, their neighbours and future generations, depend.

## **3.7 ETHICAL CONSIDERATIONS**

### **3.7.1 Empowering certain actors over others**

In my project, workshop participants are granted access to senior officers of local authorities in both visioning and frontrunner workshops. My action research project thus interferes in local politics, empowering selected participants over others by facilitating their access to key decision-makers in the region. It is important to acknowledge that my own position in society has granted me the power to decide who is included and excluded from the transition arena, and that I, myself, am using this power, rather than challenging it, to advance interests that I perceive to be altruistic, but which are determined, in large part, by my social advantage. This point relates directly to the post-modernist criticism of TM, that it suffers from a 'democratic deficit' (Section 2.5.1). I agree with this criticism, and through a reflexive understanding of my positioning, I have attempted to address it by targeting a non-technocratic audience for the visioning exercises, so that their priorities, born through lived experience with unsustainable housing development, can be communicated to transition frontrunners to influence their efforts (Section 3.6.4). The extent to which their priorities translate into action was a major point of investigation in my original research design.

### **3.7.2 Conflicts of interest**

Because TM processes are designed to influence the policy and spending decisions of Government, TM processes are subject to influence by conflicts of interest (e.g. private firms operating in the transportation and housing sectors that seek to influence the direction of infrastructure development). It is thus vital to the legitimacy of the TM-SDM process that a profile of participating

stakeholder organizations (e.g., research institutes, firms, government offices and non-profits) be made publicly available.

I also do not interpret information gathered in interviews and multi-stakeholder meetings as facts, but as expressed representations of reality that vary across different stakeholders, each with their own sets of interests, knowledge, perspectives and *stakes* in the research project outcome. What is of interest to the study is how the TM-SDM process impacts upon stakeholders' understanding of the Infrastructure-Wellbeing System and if and how convergence of problem definitions, future visions and actions occur as a result.

### **3.7.3 Privacy and consent**

By reporting the profile of participating organisations, there is a risk that participants may be identified. This risk of identification comes with the risk of political or professional retribution when sharing sensitive information and/or views that may oppose the official stance of their respective organisations. As such, participants may choose to withhold and/or obscure information (Trencher et al., 2015). To protect participants from this risk and to encourage them to speak openly and truthfully, I have anonymised all quotes and contributions appearing in this dissertation and the GCGP Housing & Wellbeing model published on Kumu. Where relevant, I link quotes to the participant's sector or profession, but never to their organisation. Anonymity is also protected through the nature of project outputs such as the Transition Vision, Evaluation Framework, and qualitative systems model – all of which are group outputs, meaning individual contributions cannot be assigned to any one individual. These protections are clearly outlined in the Project Information Sheet provided to each participant and consent forms they signed to participate in the study (see Appendix A).

### 3.7.4 Maintaining expectations

Given the grand aspirations of Transition Management regarding the co-governance of system change for sustainability, it is important that I manage participants' expectations regarding what can and cannot be accomplished through this research project. To manage the expectations of transition frontrunners, I begin the workshop with a slide titled, "Setting expectations" with the following questions and answers:

- Would the partnership's activities be linked to a formal government process? – **no**
- Would the actions of the partnership be voluntary? – **yes**
- Any promise of CPCA funding for initiatives? – **no**

I also sought to set expectations regarding the what can the qualitative systems model can and cannot support with a slide that read:

#### *What the model can do: .*

- *Serve as a 'boundary object' to facilitate debates/discussions around the 'Housing and Wellbeing' system and what interventions are needed.*
- *Help identify potential unintended outcomes of intervention that would be missed by econometric models and models whose parameters are limited to one sector.*

#### *What the model can't do:*

- *estimate outcomes / predict the future*

Of even greater concern is managing the expectations of those participating in the visioning workshops, e.g. households on the social housing waiting list. At the start of these workshops, I defined the purpose of the workshop, "To develop a *shared* vision of housing development in the Greater Cambridge, Greater

Peterborough region that prioritises well-being and is salient and legitimate to your community“, and expected outcomes:

- **Vision document** of housing development with well-being at the centre for current and future generations (to be shared with local policy makers)
- An **Index of Well-being (as it relates to housing)** to orient strategic operational planning of public-private initiatives as well as to monitor and adapt implemented plans
- **Improved understanding of and empathy** for the knowledge, experiences and expressed views of those in your community

I also situated the visioning workshops within the larger project, making clear that their vision would feed into workshops that aim to facilitate action by local government, businesses, and other stakeholders committed to sustainable housing development. Once it became clear that this project was being led by a PhD student, not the local authority, and its success relied on good will and voluntary actions among other criteria, one participant, indeed, chose to leave the workshop. Those who stayed did so under realistic expectations.

### 3.7.5 Emotional distress

Though small, there is a risk that participants become emotionally distressed during semi-structured interviews, particularly during probing questions on the links between infrastructure and the wellbeing of individuals, families and communities:

*“Let’s talk a bit more about the causes of this – why has/does this occur/ed?”*

*“Let’s talk some more about the consequences – what happens because of this?”*

The same can be said for open discussions in workshops. This is especially true for participants working closely with recipients of social care (particularly if the participant is a care provider for a spouse, child or

parent), participants who have experienced homelessness, and low-income participants whose personal wellbeing has been negatively impacted by local infrastructure development (e.g., via the lack of 'affordable' housing, poor quality of the existing housing stock, poor neighbourhood conditions such as high air pollution, crime, lack of social cohesion and/or anti-social behaviour, limited access to the job market, leisure activities and/or public spaces due to poor transport options, etc.).

From the start of each interview/workshop, interviewees/participants are informed verbally of the following:

*"Given the sensitivity of the topic of human wellbeing, questions may be asked or comments made which cause emotional distress. The participant has the right not to answer a particular question or to terminate participation in the [interview/workshop] at any time without giving a reason."*

If the interviewer or group facilitator recognizes signs of distress, they will pause the interview to inquire into the state of the participant's emotional wellbeing with the following question:

*"I recognize this is a sensitive topic that may cause emotional distress. Would you like to continue or terminate the interview?"*

If the participant becomes emotional but insists on continuing the interview, the interviewer should respect his or her desire to have one's story/contribution heard and acknowledge the importance of this to the wellbeing of the participant. However, to prevent psychological injury to the participant, the interview shall be terminated and rescheduled for a future date. Furthermore, a list of public and non-profit organizations that provide support on issues such as mental health, aging well, physical and/or learning disabilities, debt management and domestic violence shall be handed to the participant.

Pausing group discussions to inquire into a participant's wellbeing, however, may cause humiliation and increase distress. As such, signs are handled more discretely, for example, by reminding the group of the sensitivity of the topic they are discussing and asking the group to practice active listening – a

sympathetic form of listening whereby one listens to *understand*, not to *respond*. This interjection can help individuals recognize their own signs of emotional distress. Should a participant choose to exit the plenary or small group discussions, an assigned transition team member will accompany the participant and remind him/her of his/her rights as a participant in the study. If the participant wishes to terminate his or her participation, the resource sheet in Appendix A is provided, should they need to seek additional support.

### 3.8 CONCLUSION

In this chapter, I introduced methods intended to improve the application of systems thinking and accountability in TM. The first of these two adaptations is strongly influenced by the critical realist belief that system leverage points exist, and that we can *approach* their identification through scientific inquiry. I recommend the explicit modelling and analysis of frontrunner-proposed interventions *because* of the inherent uncertainty around complex, societal transitions, not despite this uncertainty. I believe that, through a systematic, recursive governance and research methodology, frontrunners can improve their understanding of the complex housing system and its dynamic behaviour. Critical realism affects, as well, my research design. In experimenting with my proposed adaptations to the TM framework, I recognise that my observations and analysis of qualitative data are biased, and my single case study research design does not allow for the application of statistical methods to observe, for example, the extent to which my proposed adaptations support consensus-building or systems learning. However, as a first, real-world experiment with these adaptations, my investigation is still a valid endeavour because it opens a new area of research for others to build on.

The next three chapters present findings from the three interrelated phases of this experiment: visioning outside the transition arena and the creation of a transition evaluation framework (Chapter 4)



qualitative group modelling (Chapter 5), and the frontrunner workshop where outputs from the first two phases are meant to feed in to inform the design and selection of transition experiments (Chapter 6).

## 4 CHAPTER 4: FINDINGS FROM THE VISIONING WORKSHOPS

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### 4.1 INTRODUCTION

This chapter presents findings from Phase 2, 3 and 4 of the adapted TM framework (see Figure 6). The sustainability challenges identified in Phase 2 by the Transition Team were presented at the visioning workshops to inform participants' vision for a more sustainable housing system. The group's vision (Section 4.3.1) is then converted into an evaluation framework (Section 4.3.2) that is meant to later be used to evaluate and select transition experiments in phase V of the adapted TM framework (see Figure 6).

Invitations to visioning workshops targeted those who suffer, or are expected to suffer, first-hand the consequences of unsustainable housing development. As such, the workshops are considered to take place in an arena external to the 'transition arena' (see Figure 6). However, there was very low turn-out from this target audience, the implications of which are presented in the Section 4.3.3. I conclude this chapter (Section 4.4), by relating these findings back to my original research questions and aims. However, I first present the methods which guided the production of these outputs (Section 4.2).

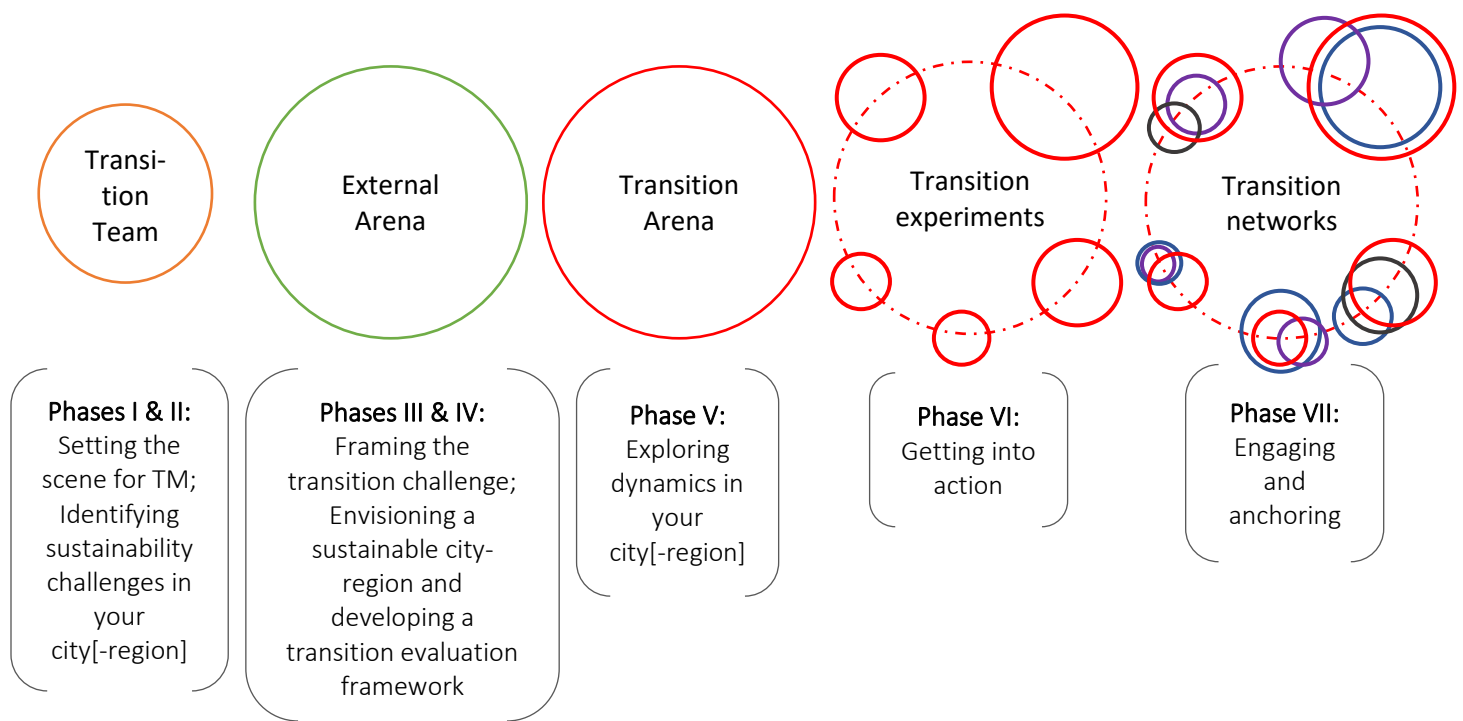


Figure 6: Adaptation from Roorda et al. (2012) model of Transition Management

## 4.2 METHODS

The purpose of the visioning workshops is to build consensus around what housing can and should provide in terms of future wellbeing, based on participants' subjective understandings of what it means to 'live well' and their understandings of threats to future wellbeing. The workshop begins with dystopian and utopian visioning activities in which participants' frustrations, concerns and aspirations (i.e., 'transition goals') are implicitly embedded. In the middle of the workshop, so-called 'Risk Cards' were presented to update participants' understanding of threats to future wellbeing. These cards were produced using findings from the preliminary systems analysis – the methods for which are presented in Section 4.2.1. Methods for group visioning are presented in Section 4.2.2. Once the group visions are developed, participants are asked to make explicit 'transition goals' for the local housing system. Section 4.2.3 outlines the methods used to facilitate the specification and prioritisation of 'transition goals' and the conversion of these priorities into a single evaluation framework.

#### 4.2.1 Establishing an understanding of the ‘transition challenge’

As was explained in Section 3.6.3, the ‘transition challenge’ is pre-defined by the transition team as “securing or improving long-term, housing-related wellbeing across Cambridgeshire and Peterborough”. To detail this challenge, I conducted a preliminary system analysis, which identifies housing-related sustainability challenges (or social, economic and environmental threats to long-term wellbeing) in Cambridgeshire and Peterborough. These threats were then summarised into so-called ‘Risk Cards’ and presented during the visioning workshops to frame participants’ discussions on the basis of scientifically assessed risks. Risk cards are provided in Appendix C)

The preliminary analysis was based on a three-stage, semi-recursive research design, beginning with an independent review of urban sustainable development literature. This review helped to identify key sustainability challenges and their related stakeholder groups from which a dataset of local businesses, non-profits, government agencies and community groups was populated. From this dataset, I recruited a representative from each stakeholder group and conducted 20 local expert/practitioner interviews. Interview data informed both the preliminary analysis and the first draft of the qualitative systems model. More specific methods for actor analysis and selection are presented in Section 5.2.2 in *Chapter 5: Findings from the co-modelling process* alongside a list of interviewees (see Table 4).

As new themes arose during the interview process, the literature review expanded to cover these themes. This iterative process began July, 2017 with five months of literature review and desktop research, overlapping with three months of semi-structured interviews. Together, the literature review and interviews helped to define seven themes that later defined ‘system boundaries’ of the eight subsystem models, namely: (1) Transport; (2) Energy & Climate change; (3) Environment; (4) Housing & landscape design; (5) Community resilience and social cohesion; (6) Inequality; (7) Land economy & Housing market; and, led by the main interview question, (8) Health and Wellbeing.

In the third stage, a document analysis was conducted to gather more place-based information and, in some cases, descriptive data analysis (e.g., changes in housing affordability, deprivation, and greenhouse gas emissions in the six local authorities under study). This document and data analysis, supported by a part-time research assistant, began January 2018 and lasted four months with one month to recruit workshop participants, develop a program and facilitator guide, recruit facilitators, create Risk Cards, and prepare other workshop material. Publications used for the document analysis included national and subnational reports from organizations such as the Environment Agency, Anglian Water, Shelter, Age UK and local councils. Data was first sought from the County Council's Research Team, which makes local data publicly accessible via an online portal (Cambridgeshire Research Group, 2020) and subsequently sought by relevant Government agencies, including the Office for National Statistics.

From this document and data analysis, eleven housing-related social, economic and environmental sustainability risks were identified. Due to time constraints, two of the eleven Risk Cards were not completed in time for the visioning workshops and were therefore excluded, namely *Future Energy Supply* and *Road congestion and public transport*. The nine Risk Cards that were completed were distributed in pairs to workshop breakout groups based on the density of linkages between them (see Table B2 in Appendix B).

It is interesting to note that two themes did not surface until the local expert/practitioner interviews were conducted, namely *Future Trade Barriers & the Local Economy* and the *4<sup>th</sup> Industrial Revolution*. Having surfaced several times in the multi-stakeholder interviews, I included the two themes in my subsequent document review. This is a practical example of how local context/knowledge helped shape the study's parameters.

## 4.2.2 Establishing ‘transition goals’ through visioning

### 4.2.2.1 *Participant Selection for the visioning workshops*

As explained in *Chapter 2: Literature Review* (Section 2.5.1), it is important that the values and priorities of those who suffer, or are expected to suffer, first-hand the negative consequences of unsustainable development inform the programme’s ‘transition goals’. In the case of housing development, these include local residents on the social housing waiting-list, those living in flood zones, farmers, key workers, first-time home buyers and those with limited mobility and accessibility including the elderly and disabled, as well as those living in high deprivation. To reach these individuals, I identified relevant gatekeepers who could advertise workshops to our target audience. A list of gatekeepers and advertising methods are presented in Table B1 of Appendix B.

Moreover, I invited a sample of local practitioners participating in the wider TM process to (1) learn from the hopes and fears of those in our target audience and (2) inform the group discussion with knowledge from their professional experience. Having been assigned two Risk Cards, each group is also assigned two local practitioners with related knowledge (see list of practitioners in Table B2 of Appendix B). Specifically, I invited practitioners with *local* experience in themes arising from the preliminary systems analysis, namely: housing development; architecture; planning for economic growth; climate change; water management; transportation; nature conservation; public health; social services; and community resilience/community infrastructure.

Local practitioners participating in the visioning workshop were invited to help co-produce the evaluation framework. This decision recognises the value of professional and scientific knowledge and the perspectives of practitioners in addition to the knowledge and perspectives of those having experienced, first-hand, the negative consequences of unsustainable development.

#### 4.2.2.2 *Developing a qualitative understanding of participants' transition goals*

To develop a qualitative understanding of participants' desired future housing system, they are invited to envision a utopian housing system in the year 2060. The reference year is set to 2060, as this is considered 'distant enough' into the future to "free participants from the strictures of current norms" (Davies et al., 2012, p. 55). Imagining 40 years into the future, participants are free to think creatively about the future they want, rather than fixating on existing problems and barriers to change. Naturally, this vision is implicitly shaped by participants' understanding of current problems related to human wellbeing (e.g., air pollution, high property prices, lack of jobs and quality skills training for young people from deprived backgrounds, homelessness, lack of affordable services for the elderly etc.). To provide an outlet for participants' frustrations and concerns before moving onto positive, blue-sky thinking, the visioning workshops begin with a 'dystopian' visioning exercise. As qualitative artefacts, dystopian visions reveal participants' problem definition, as they are informed by participants' understanding of existing problems that, if not addressed, will exacerbate. These problem definitions are later updated through the introduction of 'Risk Cards'.

By asking participants to define a 2060 dystopian vision, they are forced to think on a long timescale and, therefore, about trends and 'whole system' problems. The following prompt is used for dystopian visioning:

*Let's start by considering what type of housing we don't want. Let's imagine it is 2060, and we've experienced the worst-case scenario of housing development over the past 40 years.*

- ❖ *What do houses look like?*
- ❖ *What does the environment around them look like?*
- ❖ *How do you travel to/from your home?*

- ❖ *Are people generally happy with their accommodation?*
- ❖ *If not, why not? If not, who not?*
- ❖ *How does housing contribute negatively to wider societal challenges?*

The initial goal in visioning is divergence, i.e., to collect a wide range of ideas of how the housing system ‘of our dreams’ could generate positive outcomes for wellbeing. Divergent tasks are best supported by nominal group techniques (Andersen and Richardson, 1997). Therefore, participants are divided into groups of 4-5. Moreover, divergence requires freedom to explore radical ideas without being dismissed. Discussions should therefore welcome each divergent view and knowledge contribution, embrace creative thinking, and mitigate potential sources of power imbalance. To this end, the transition team employs participatory methods to facilitate open, exploratory discussion.

For example, group members first describe their utopian housing system independently, writing individual characteristics on separate sticky notes. Thereafter, group members take turns contributing one *new* idea each (presumably their best remaining one) to the group’s flipchart. This approach “enables each [participant] to contribute and comment before any [participant] has given its all, no [participant] dominates, no [participant] is left with little to contribute, and ideas end to emergence in order of importance”<sup>14</sup> (Andersen and Richardson, 1997, p. 3). Together, the group’s individual contributions culminate in an eclectic, fully inclusive vision. Whenever conflicting/contradicting points arise in the group’s vision, a simple red dot is drawn on the opposing sticky notes before moving on. Prompts such as the following are used to create a sense of openness and acceptance within the group:

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<sup>14</sup> This potential ‘order of importance’ is noted for later comparison with questionnaires and dominating causal chains identified in systems analysis.



*One of the objectives of the workshop is to learn about each other's hopes and fears. To do this you will need to practice 'active listening', i.e., listening to understand, not to respond.*

***Try to refrain from engaging in disagreement*** – *"The point is not to debate each other's visions, but to understand each other's hopes and fears about the future and current housing system."*

***Challenge yourself:*** *"If someone holds a different view, try – without judgement – to understand why that is."*

Once the dystopian vision is elaborated, each group facilitator invites participants to park their frustrations and concerns and, instead, imagine a utopian housing system:

*"The point of today's workshop is to imagine a radically different housing system, designed to provide positive outcomes for wellbeing. This is meant to be fun and innovative, so there's no need to tie ourselves down to a "realistic" vision. In other words, be as creative as you like! It's just a vision after-all."*

The same nominal group techniques are applied, and participants' sticky-note responses are recorded on a separate sheet of flip-chart paper. Together, participants' contributions made up the group, qualitative vision presented in Section 4.3.1.

#### 4.2.2.3 *Using sustainability challenges to frame visions of a preferred housing system*

After constructing their fully inclusive, utopian vision, each group receives two ‘Risk Cards’ containing information from the preliminary analysis<sup>15</sup>. Having been distributed in pairs (see Table B2 in Appendix B), each Risk Card is assigned to at least one breakout group.

The following prompts were used to help participants consider assigned risks in relation to their group’s utopian vision:

- ❖ *How would these trends impact upon how (and where) we live?*
- ❖ *Can you identify any threats to wellbeing?*
- ❖ *Can anything be done in the housing sector to address these threats (again, thinking about design, location, etc. of housing)? Responses can include actions to mitigate against these trends or adapt to them.*
- ❖ *Let’s reconsider our vision. Remember, we’re still meant to use blue-sky thinking, so anything’s possible!*

Using a different colour sticky note, participants extend their vision (if necessary) to either mitigate or adapt to these risks, such as the green sticky notes in Figure 7.

Later in the workshop, these visions are used to identify, select and weight characteristics of an imagined housing system with the prescriptive goal of ‘maximizing wellbeing’. Risk Cards therefore play a very important ‘framing’ role in the decision-making process.

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<sup>15</sup> The decision to assign each group two risk cards was made to ease cognitive burden. I concluded that it would have been too demanding for participants to read and comprehend all nine risks and then consider their implications – individually and in synergy – for their utopian vision. Time constraints also informed the decision to cap Risk Cards to two per focus group, as the overall workshop was limited to 2.5 hours to improve attendance.

By introducing participants to local risks, I seek to update their 'problem identification'. For those who are already aware of the various risk profiles, 'Risk Cards' still play an important role in bringing this information to the fore. This assumption is based on a large 'cognitive media effects' literature which demonstrates the influence of priming or frame-setting on human decision-making (Scheufele, 2000, Plous, 1993). In the 'urban visioning' literature, an in-depth analysis of community and stakeholder engagement initiatives found that the use of (1) a "preparatory sustainability module" and (2) "extensive situation analysis" as procedural components

in visioning work strongly supported the inclusion of sustainability in urban visions:

*Sustainability visions are more likely to consider also resilience if the visioning methods involve components that are informed by extensive local situation analysis, which sensitizes for case-specific historical contexts as well as problems, trends, and challenges. Consequently, all parties involved get informed so compromises and trade-offs can be negotiated adequately (Moss & Grunkemeyer, 2010; Resilience Alliance, 2010). Overall, these results indicate that careful knowledge preparation on individual and group levels are important methodical components whose interactions need to be explored in greater detail and carefully crafted when aiming for more sustainability substance in visions. John et al. (2015, p. 94)*

In TM, results from the preliminary systems analysis are presented *prior* to visioning. I decided to introduce Risk Cards mid-visioning, however, to allow participants' leading concerns and desires to surface before being framed by the Risk Cards. Sufficient time is allocated to visioning before and after the introduction of



Figure 7: A group's adapted vision post-Risk Cards (photograph taken in workshop)

Risk Cards to allow participants the opportunity to update their concerns and desires based on scientifically assessed evidence.

Once the visioning activity is concluded, participants return to plenary to present their visions – the findings from which are presented in Section 4.3.1. Thereafter, elements of these visions are prioritized via Point Allocation, the methods for which are presented in the following subsection.

#### 4.2.3 Establishing a ‘Housing & Wellbeing’ evaluation framework

As explained in *Chapter 2: Literature Review* (Section 2.6.4), I propose the use of evaluation frameworks in the transition arena to (1) systematically assess proposed interventions at every iteration of TM; and (2) ensure that transition experiments are selected based on the value and priorities of those who have first-hand knowledge of the negative impacts of unsustainable development and who are typically excluded from technocratic decision-making. This subsection outlines the methods used to co-create an evaluation framework based on the values and priorities of those participating in visioning workshop.

##### 4.2.3.1 *Deciding what matters: Facilitating the bottom-up selection and weighting of goals for future housing development*

In creating the ‘Housing & Wellbeing Evaluation Framework’, I adopt the capabilities approach to wellbeing, which emphasizes one’s *ability* to achieve a good quality of life (Nussbaum, 2001). The capabilities approach promotes the measurement of wellbeing-enhancing conditions that create opportunity and improve capability (e.g., a clean environment and access to affordable healthcare). The visioning workshop is therefore designed to facilitate the creation of an inductive, participant-owned list of ‘wellbeing enhancing conditions’ in the housing sector.

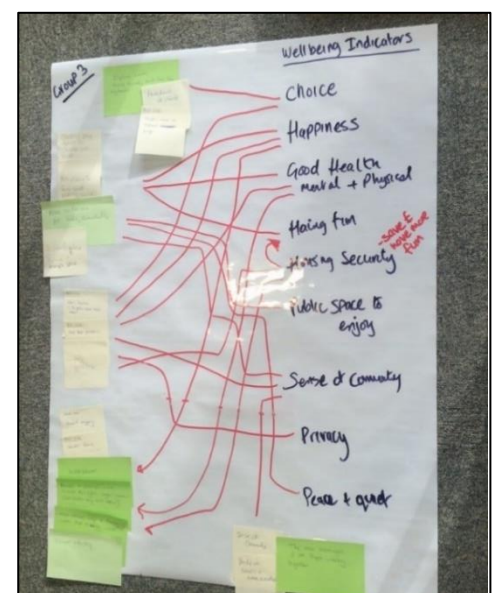


Figure 8: Linking ‘action-outcome associations’ for value-based decision making

The identification, selection and weighting of 'wellbeing enhancing conditions' was accomplished using three activities: linking, agglomeration and point allocation. In the linking activity, participants discuss how their utopian housing system theoretically generates positive outcomes for wellbeing. Wellbeing 'outputs' are listed at the right, with inputs from the housing system listed on the left (see Figure 8 for an example from one of the visioning workshops). This activity is consciously designed to facilitate the 'Valuation' process in value-based decision-making (see Figure 9).

The framework for value-based decision-making in Rangel et al. (2008) breaks decision-making into five processes: 'Representation', 'Valuation', 'Action selection', and 'Outcome Evaluation'. In the first process, actors formulate a representation, or understanding, of the state of the world and personal choice sets (i.e., sets of all possible actions they can take). To complete the second task of valuation, action-outcome associations must be formulated before outcome-value associations. "For complex economic choices (such as choosing among detailed health care plans) we speculate that humans' propositional logic systems have a role in constructing associations that are subsequently evaluated by the [goal-based] system. For example, individuals might use a propositional system to try to forecast the consequences of a particular action, which are then evaluated by the goal-directed system" (Rangel et al., 2008, p. 6). In the workshop, the group linking activity is used to facilitate the concrete formulation of 'action-outcome' associations embedded in each group's utopian vision by linking wellbeing outcomes to features of their utopian housing system. Because linking is designed as a group activity, participants learn from each other's action-outcome associations, thus expanding their own sets.

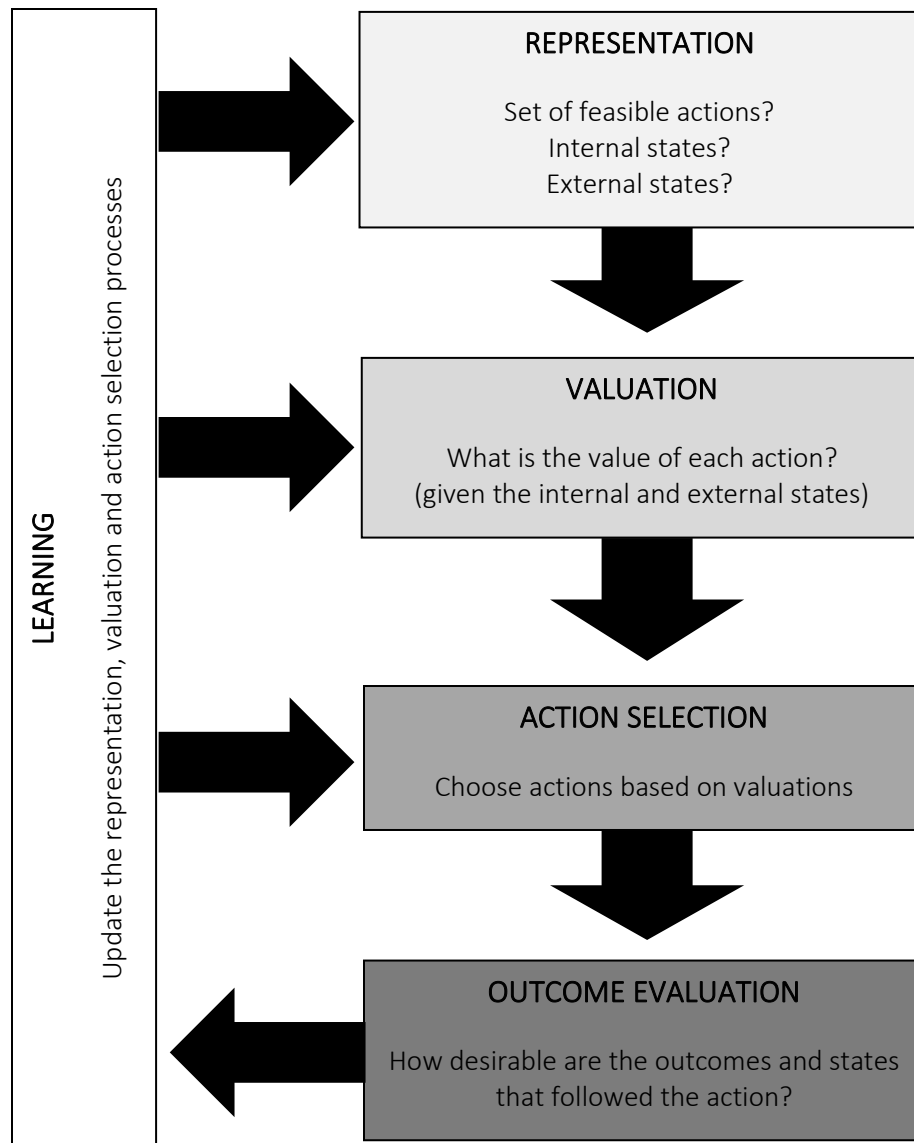


Figure 9: A model of value-based decision-making (adapted from Rangel et al. (2008))

It is important to note that time limitations reduce the number of linkages identified. However, I assume that the most important linkages (based on participants' subjective valuation of various wellbeing outcomes) are listed first. This is because the linking activity starts with the question, *"What positive outcomes does our utopian vision generate for wellbeing?"* After listing outcomes, the group facilitator asks, *"What features of our utopian housing system produced that outcome?"*

After 20 minutes of linking, participants are asked to stop and present their visions in plenary by listing, one-by-one, ‘action-outcome’ associations (or linkages). This helps to expand participants’ associations further. However, having not been exposed to the themes arising in other group discussions, it is unknown to what extent additional associations were understood and adopted into participants’ decision-making process.

During each presentation, the plenary facilitator produces a master list at the front of the room of all features of the utopian housing system and their associated wellbeing outcomes (see Figure 10). Participants are then asked to select, from this list, characteristics they think will have the greatest positive impact on wellbeing, plus any others they feel are missing from the list. In a Point Allocation activity (Hoffman, 1960, Martin, 1957), participants divide 100 points between these variables in order to “maximize wellbeing”. Again, the transition team intervenes in the value-based decision-making process by prescribing a dominant goal: ‘maximizing wellbeing’. This goal forces participants to consider all the various aspects of wellbeing and excludes from their valuation features that may help achieve other goals (such as efficiency) if they fail to generate significant benefits for wellbeing. The purpose of this framing is to intervene in the valuation process in such a way to produce more socially just outcomes – a normative objective of sustainable development.

The agglomeration exercise that takes place during group presentations is an important step, as it produces a large list of action—outcome associations (too large to hold in the forefront of one’s memory) and allows participants to easily visualize and compare the quantity and quality of wellbeing outcomes under each input variable (see *Figure 10*). This again prompts participants to weight input variables based on the normative goal of maximizing wellbeing.

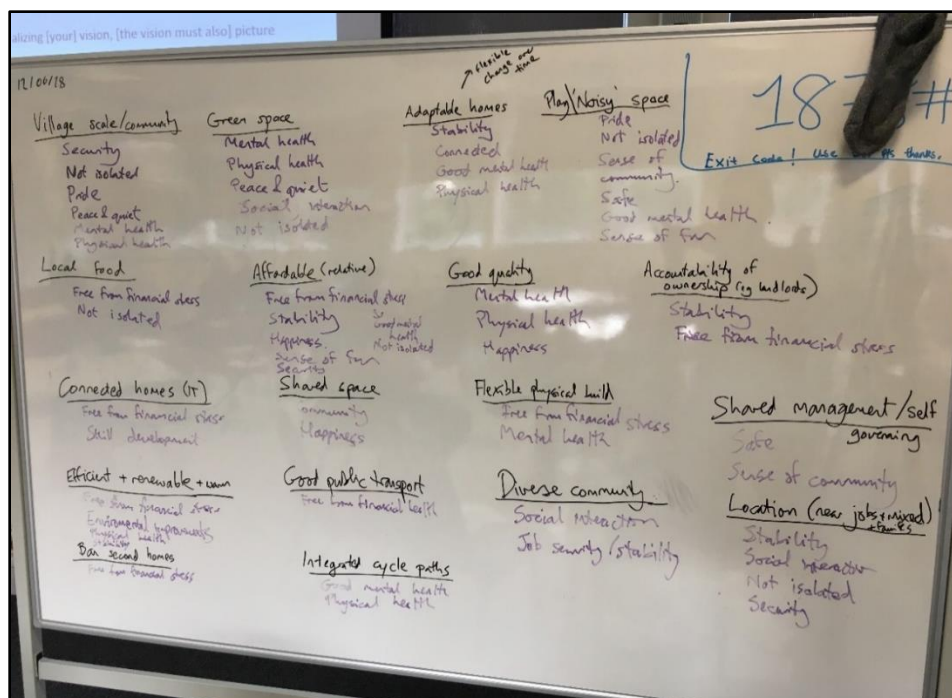


Figure 10: Characteristics of a Utopian Housing System and their Associated Benefits for Wellbeing

Because allocations vary based on participants' action—outcome and outcome—valuation associations, the exercise markedly differs from Transition Management which takes a consensus-based approach to decision-making. In fact, it is likely that not a single participant agrees with the final evaluation framework based on its indicators and weights. However, the framework is a product of the collective input from a diverse set of actors with unique knowledge of and experiences with the local housing system. A similar averaging approach to social decision-making underpins other urban development indices, such as PwC's 'Good Growth for Cities Index'. PwC has used intensive focus groups and large scale statistical surveys – “to establish what the UK public thought were the most important factors in a country's economic performance” and to average respondents' individual scores for the creation of a weighted index (PwC, 2014, PwC, 2017). This approach varies from the top-down approach where respondents weight performance indicators prescribed by experts.



#### 4.2.3.2 *Creating the evaluation framework post-workshop*

Indicators “are often organized following a certain indicator framework for a project. [An indicator framework is] a conceptual structure based on [goal-oriented] arguments in order to facilitate indicator selection, development, and interpretation” (Huang et al., 2015, p. 1179). In our bottom-up design, ‘goals’ are taken directly from participants’ Point Allocation cards, where weighted ‘utopian housing attributes’ are interpreted as ‘goals’ for the local housing system. Some of the participants’ goals are very high-level (e.g., “Eco friendly developments”), whilst others are much narrower (e.g., “energy efficient homes”). As such, an inductive, thematic analysis of participants’ point allocations is conducted to identify ‘themes’ or categories to be weighted. These categories make up the evaluation frameworks’ conceptual structure. Table 2 provides an example of participant goals, coding assigned by the head researcher and categorization which developed inductively.

Quotes with the code ‘strong communities’ (such as the third quote in Table 2) were more often assigned to the theme ‘Community cohesion’ and codes related to landscape design were more often assigned to the theme ‘Well-designed and good quality of build (aesthetic and function)’. However, where participants wrote an ‘input-output’ pair (such as ‘local amenities → strong communities’), the ‘input’ variable was used for the thematic analysis. This is based on the assumption that the participant wants to monitor/achieve the explicitly mentioned action/input. It should be clear from this example that quite a lot of judgement is involved in the thematic analysis. To improve transparency of this process, I present a large sample of participant quotes and their assigned themes in Table B3 of Appendix B, as well as a list of notes taken in reflection of judgements made during the thematic analysis.

Table 2: Coding participant quotes for the inductive creation of themes and categories

Quote	Code	Variable	Subcategory	Category
<i>“Close to work and public transport (preferably walkable or cyclable)”</i>	<ul style="list-style-type: none"><li>• ‘walkability’</li><li>• ‘proximity to public transport’</li><li>• ‘proximity to work’</li><li>• ‘reduced travel’</li></ul>	‘Walkable communities with access to amenities’	‘Modal shift to active and public transport and accessible amenities’	‘Low-impact infrastructure and living’
<i>“People not car dominated environments”</i>	<ul style="list-style-type: none"><li>• ‘walkability’</li><li>• ‘pedestrianisation/ designing out cars’</li><li>• ‘achieving modal shift’</li></ul>			
<i>“Local amenities to reduce travel &amp; strengthen communities”</i>	<ul style="list-style-type: none"><li>• ‘provision of local amenities’</li><li>• ‘strong communities’</li><li>• ‘reduced travel’</li></ul>			
<i>"Good transport system with (a) excellent walking, (b) world class cycling and (c) cars outside the area owned jointly"</i>	<ul style="list-style-type: none"><li>• ‘walking &amp; cycling infrastructure’</li><li>• ‘car-free city centre’</li><li>• ‘shared ownership of cars’</li></ul>	‘Access to good public transport & walking/ cycling infrastructure’		
<i>"Transport to places I want to go - bus/train/cycle"</i>	<ul style="list-style-type: none"><li>• ‘accessibility’</li><li>• ‘walking &amp; cycling infrastructure’</li><li>• ‘access to public transport’</li></ul>			
<i>"Be surrounded by green, wildlife"</i>	<ul style="list-style-type: none"><li>• ‘provision of green space’</li><li>• ‘living in close proximity to green space’</li><li>• ‘conservation of wildlife’</li></ul>	n/a	‘Close access to blue & Green open & wild spaces’	

## 4.3 FINDINGS

### 4.3.1 A vision for housing development to 2060

Despite providing a very useful tool, evaluation frameworks cannot replace qualitative visions detailing the ‘transition agenda’. Indeed, indices provide a simplified indication of progress toward the group’s much richer, qualitative vision. The purpose of this section is to present this vision on which the evaluation framework is based. First, it is important to report that the facilitation methods employed succeeded in creating a relaxed, accepting space in which creative and radical visions could be shared and considered. This positive environment was observed by group facilitators, and even a few participants emailed after both workshops to express their positive experiences.

*“Thank you once again for a thought-provoking evening. It was good to share ideas with others.”*

*(Social housing tenant)*

*“I had a really awesome group – I would suggest that you keep that group together and work with them more – loads of energy and great ideas. [...] I think they could really do with harnessing and setting forth to make things happen.” (surveyor)*

At the Peterborough workshop, one individual on the city’s social housing waiting list shared deeply personal, lived experiences of housing-related poverty. The group facilitator said their stories were educational and helped to build empathy with their experience. This environment, I argue, helped to produce a truly inclusive vision, which is presented first in the form of a word cloud using code frequencies from written text on participant sticky notes (see Figure 11).



Frequency should not be misunderstood as representing weight or importance, but rather consensus between groups. For example, 'Quality Green & Blue Space' and 'Affordable Housing', the two most frequently listed characteristics of groups' utopian housing systems, were present in nine out ten visions; whereas 'more parking' (in small font) was listed in only one group vision. Though table facilitators

asked participants to write down new contributions as they arose, it is likely that some characteristics of participants' utopian vision were discussed but excluded from the written material. To help reduce missing data, additional features listed in the audio recorded group summaries were added to the frequency count.

When analysing sticky-note text, eight themes arose: equity, community resilience, participatory governance, quality design, environmental sustainability, transportation, and fun. More often than not, participants' visions incorporated details beyond the local housing system. Here, we present only those aspects directly relating to housing, community and/or the wider built environment.

Recall that (1) discussions about housing were framed around wellbeing; (2) participatory methods were employed to inspire creative, radical visioning; and (3) the majority of participants are urban dwellers. It may, then, come as less of a surprise that **half of the groups envisioned car-free built environments**. These visions included features such as improved walkability, world-class cycle routes, and automated mass transit. The desire for a car-free environment is motivated, in part, by concerns over climate change, but as well by participants' knowledge of the health co-benefits, with references made to "clean air", "active travel" and "healthy communities." This vision, however, conflicts with one group's desire for "Choice in transport" – also included in the collective vision.

Based on the assumption that regional transport links, such as light rail, encourage settlement in rural areas, **participants also supported improvements in public transportation to tackle 'over-densification' of urban areas** – a concern expressed in several groups' dystopian visions. The radical, self-titled "Ewok village" vision described a utopian future in which numerous small-scale settlements are deeply integrated in nature – sharply contrasting the current model of ever-increasing urbanisation 'next to nature'. In this vision, many of the homes are built in tree canopies, linked by ground and raised walking and cycling infrastructure. The envisioned integration of the built and natural environment is said to inspire

physical activity and adventure. With light rail linking Ewok villages, the group's utopian future is also 'car-free', though employing Sci-Fi-themed, blue-sky thinking.

In relation to equity, **half of the groups called for the 'de-financialisation of the housing sector'**, demanding radical changes in national policy. One group went as far as to envision the complete "nationalization of housing", though this conflicts with another group's vision in which "everyone is able to own a home who wants to". A ban on 'second homes' was also considered. Regardless of the policy lever, the aim was to provide "Housing for living, not for investing in."

**There was also a strong thread of localism sewn through most of the visions.** From home-grown food to skill sharing at local community hubs, community energy schemes, outreach programs for the elderly, and kit homes that people could learn to build together, there was a shared assumption that communities would fare better against environmental and socio-economic pressures if they were more self-reliant. One group envisioned a future where housing is "robust to vulnerability, i.e., tenants can stay in their homes after job loss and be supported by the community." For people to "manage themselves" and "work together", "[indoor and outdoor] spaces to work on issues as a community" were considered essential in nearly every utopian vision.

In addition to building self-sufficiency and resilience, participants expressed three additional motivations for strengthening communities: (1) to improve community spirit, pride in place and happiness; (2) to combat social isolation in an aging population; and (3) to combat racial and other forms of prejudice. There was an expressed concern (observed in both utopian and dystopian visions), however, that a gap is growing between wealthy, cohesive communities and under-resourced, fractured communities. To address this concern, **half of the groups made reference to 'mixed communities' in their utopian visions.** Actions to achieve mixed communities included "requirements for affordable housing in high-value areas."

Closely linked to housing affordability is the theme of rapid economic growth and inward migration. Fears over the negative environmental and socio-economic impacts of this growth encouraged some groups to envision “slow and inclusive growth” across the region. It was said that rapid growth raises house prices, contributing to the acute problem of housing affordability, and permits low-quality development in terms of both aesthetic and function. To this end, groups’ utopian visions included **reforms of local governance structures for “participatory planning” and “democracy in place-making,” ultimately supporting “greater community power over developers.”** The common recurrence of this ambition in groups’ visions suggests that local residents feel that growth is ‘happening to them,’ and the existing system does not provide them with sufficient agency to intervene.

The expressed desire for ‘slow’ and ‘equal’ growth conflicts with one group’s call for “limits to growth,” inspired by concerns over the environmental sustainability of continued growth in **Cambridgeshire and Peterborough**. In their vision, the planning system would “start by identifying what needs protecting” so as to “only accommodate housing need based on what is ecologically/environmentally sustainable.” Another group sharing many of the same concerns rather envisioned an array of technological solutions such as greywater recycling, energy retrofits and even a water reservoir with floating solar panels, battery storage and areas for public swimming. This vision contrasts quite vividly with the “limits to growth” group that, coincidentally, called for more water reservoirs doubling as nature reserves, such as the Abberton Reservoir in Essex that offer environmental education program. Based on my interpretation of the two contrasting sustainability visions, I would argue that they represent differences between anthropocentric and eco-centric worldviews.

Having been shown the list of Risk Cards to be discussed in each group, participants were free to self-select into groups based on their personal interests. It is then unsurprising that those selecting into ‘nature conservation’ focused very little on technological solutions relative to those who selected into

‘Energy & Climate Change’. Interestingly, there may also be an effect of age linked to this self-selection bias, as the group focusing on technological solutions had the youngest median age and the group focusing on ‘limits to growth’ had the oldest median age of any group from the two workshops. Reflecting further on the relationship between participant profiles and self-selection, there was one other group that stood out, namely the group discussing health and social services which, in Cambridge, was composed wholly of social housing tenants. These observations provide evidence that priorities vary by participant profiles, and that the nature of the collective vision necessarily depends on which voices are included and excluded from the visioning workshop. To improve the representation of views in each focus group, and thus improve the reflexivity of each discussion group, I recommend assigned or random seating in future applications of TM.

Lastly, before presenting the evaluation framework, it is worth mentioning a major internal contradiction of the collective vision, namely the desire for more spacious developments, on the one hand, and wanting to benefit from densification, on the other. In addition to calling for more generous space standards (within and between homes), participants listed several housing goals that demand large areas of land (see list of contradicting attributes in Figure 12).

<ul style="list-style-type: none"> <li>• “All homes detached”</li> <li>• “Privacy [e.g., not able to overlook private gardens]”</li> <li>• “No development in flood zones” / “space for flooding”</li> <li>• “[All homes to have] private gardens”</li> </ul>	<ul style="list-style-type: none"> <li>• “More parking”</li> <li>• “Protection of natural environment” and “Ecological enhancement”</li> <li>• “Close proximity to greenspace” and “Access to wildlife”</li> </ul>
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*Figure 12: Contradicting attributes of participants’ utopian visions*

In addition to improved walkability and the ability to live close to work, participants called for shared facilities and great public transport, which are financially unsustainable in areas of low population density. Some groups tried to address this internal contradiction by compensating losses in private spaces



(e.g., private gardens) with community-use buildings and spaces (e.g., community gardens). It was also suggested to incorporate vertical greenspaces, ‘tiny homes’ and ‘high rise apartment buildings up to 5 stories. Other participants strongly opposed ‘high rise’ buildings due to a desire for “locally appropriate architecture” and concerns over safety – with several references made to the fire at Grenfell Tower.

Because the collective vision was wholly inclusive of participant contributions, contradictions inevitably arise when pulling together different views. When embedding these contradictions in the evaluation framework, they take the form of ‘trade-offs’, implying that certain interventions in the housing sector will count both positively and negatively toward the achievement of wellbeing. When reflecting on aging and the urban built environment, a Cambridge architect in a pre-workshop interview said, “You can make the world flat; that’s one extreme option. [...], it may be helping your wellbeing to a point because you’re not engaging in so much risk and danger, but you’re also ceasing to develop. [...] So it’s about maintaining a certain level of challenge [...] and the same is true on the level of society. [...] I then find the word “wellbeing” limited, because it assumes there is such a thing as simply “being well.” The idea that it’s a state you can attain. But it’s not. It’s dynamic. It’s a constant state of becoming.”

In other words, ‘maximizing’ wellbeing is inherently conflictual and, indeed, a never-ending process. No one can sustainably ‘have it all’ without incurring mid- and long-term costs. Similarly, short-term pain and effort must be exerted to build resilience and safeguard long-term wellbeing. The evaluation framework should be used from this perspective, whereby a ‘high score’ today does not necessarily indicate a positive “state of becoming.” Rather, actors should aim to intervene in the housing sector in ways that contribute positively to the long-term pursuit of wellbeing

#### **4.3.2 The Housing & Wellbeing Evaluation Framework**

The analysis resulted in the identification of one very broad category, ‘Low-impact Infrastructure & Living’, which contained six subcategories (see Figure 13 for a breakdown by workshop). Although these

subcategories could be disaggregated further, their disaggregation is limited by participants' point allocations. For example, if a participant assigns points to 'energy efficient homes powered by renewable energy', then the aggregated form is preserved, rather than assuming equal distribution of points to its two components: (1) energy efficient homes, and (2) homes powered by renewable energy.

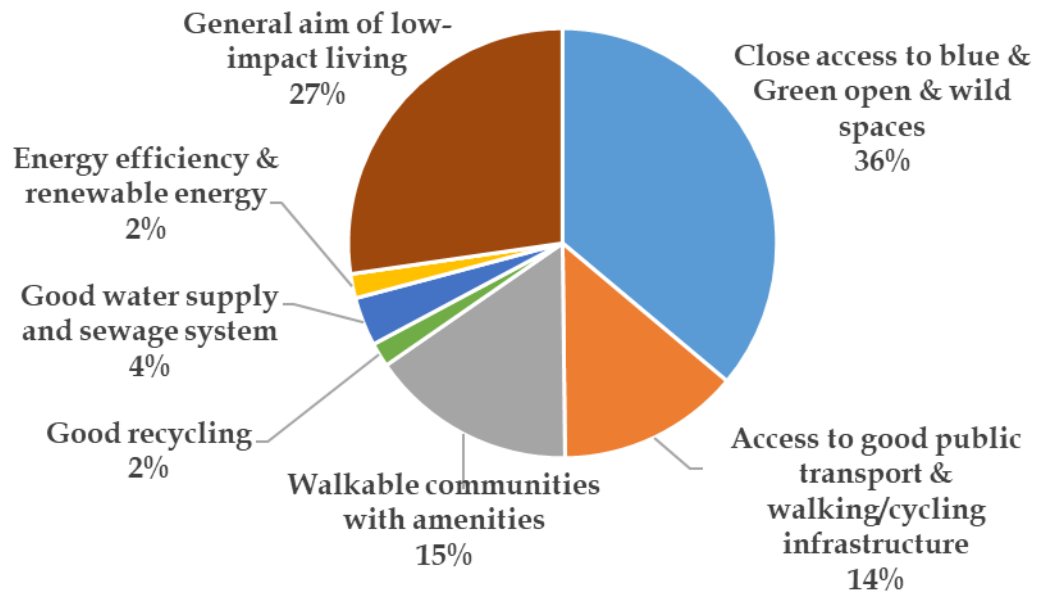
Similarly, it would be inappropriate to assume that the six subcategories sufficiently cover the range of variables conceived of by participants who assigned points to the high-level category 'Low-impact Infrastructure & Living'. As such, I conducted a review of sustainable housing and urban sustainable development evaluation frameworks<sup>16</sup> to identify any further subcategories and related indicators falling under the 'Low-impact infrastructure and lifestyle' theme. Because urban sustainability frameworks include performance measures for multiple urban systems (housing, transportation, energy, water, waste, etc.), only those indicators falling within the 'housing system' were selected. Upon review, two additional subcategories were identified, namely 'responsible land use' and 'use of sustainable construction materials'. Moreover, despite the expressed desire in several groups for a shift away from private cars toward active and public transportation, the goal of "modal shift" was not explicitly listed in the Point Allocation activity. This goal, however, may be captured in the two sub-goals: "Access to good public

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<sup>16</sup> Some of the frameworks reviewed are 'Driving force-Pressure-State-Impact-Response' (DPSIR) frameworks, first developed by the Organization for Economic Co-operation and Development OECD 1993. Core Set of Indicators for Environmental Performance Reviews: A Synthesis Report by the Group on the State of the Environment. Paris.. These are especially useful for the study of social-ecological systems BINDER, C. R., HINKEL, J., BOTS, P. W. & PAHL-WOSTL, C. 2013. Comparison of frameworks for analyzing social-ecological systems. *Ecology and Society*, 18. where the indicators are identified and clustered by: (1) anthropogenic processes (i.e., pressures/driving forces); (2) the changing state of the environment (the system state/impacts of anthropogenic processes); and (3) responses, "relating to societal actions and reactions to changes in system state and driving forces" PROSPERI, P., MORAGUES-FAUS, A., SONNINO, R. & DEVEREUX, C. 2015. Measuring progress towards sustainable food cities: Sustainability and food security indicators. *Report of the ESRC financed Project "Enhancing the Impact of Sustainable Urban Food Strategies"*. Comparatively, the theme-based framework is a more flexible, goal-based framework where indicators are often organized according to the four dimensions of sustainability: Environment, Economy, Society, and Institutions HUANG, L., WU, J. & YAN, L. 2015. Defining and measuring urban sustainability: a review of indicators. *Landscape ecology*, 30, 1175-1193.. This is less often the case for evaluation frameworks more tailored to the housing sector. For example, the BREEAM Communities framework divides indicators between the five themes of: Governance; Social and economic wellbeing; Resources and energy; Land use and ecology; Transport and Movement; and Innovation.

transport & walking/cycling infrastructure” and “Walkable and accessible communities with amenities” – as they combine to support modal shift. As such, the sub-goal ‘modal shift’ is added to ‘low-impact infrastructure and living’.

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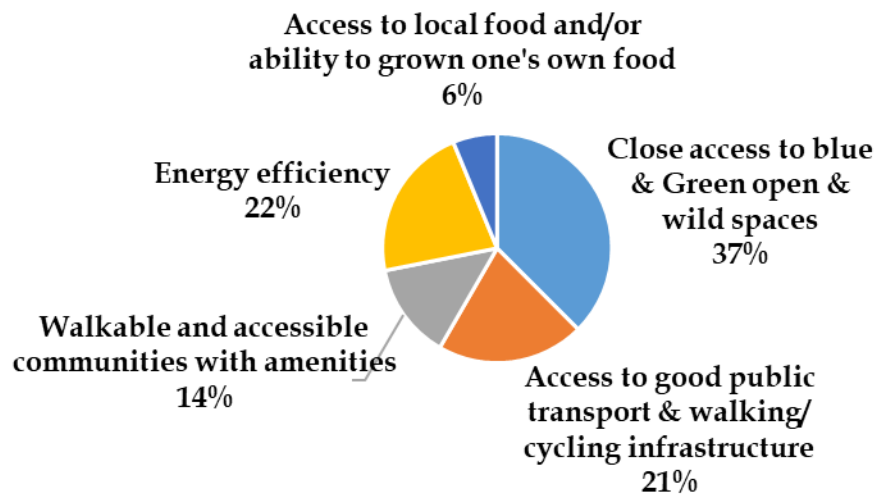


Figure 13: Breakdown of 'Low-impact infrastructure and lifestyle' by subcategory

Though participants occasionally selected narrow goals (e.g. ‘the ability to grow one’s own food’), they more often aggregated input variables into higher-level categories (e.g., ‘environmentally friendly developments’) when completing the Point Allocation (PA) activity. Indeed, only four ‘goals’ were listed on average on participants’ PA cards. Interestingly, however, the maximum number of goals listed increased from six in the pre-workshop weighting activity, to ten in the post-workshop weighting activity. This may provide evidence that co-learning took place. However, it is more likely the result of procedural effects, i.e., working from a list of input-output associations at the end of the workshop vs. working from a blank sheet pre-workshop. Despite the maximum goal/variable count rising to ten, however, the average variable count remained around four. This is rather unusual given that co-learning and procedural effects are both expected to increase the number of goals listed by participants.

**This finding suggests that the chosen participatory method of weighting limits the number of index variables and produced significant measurement bias.** Transition goals that were seen as important for wellbeing, but not major priorities, were largely excluded from participants’ PA cards. As such, they were assumed to have zero value. It is highly unlikely that participants believed only four out of 38 goals were of value for future wellbeing. **The method of PA employed in the visioning workshops effectively deflated the relative value of goals not listed on the point allocation cards.** Alternatively, participants could be asked to allocate at least one point to each variable listed in the group agglomeration, plus any additional variables they felt were missing from the board. This would have forced participants to slow down and consider the relative value of each input variable rather than rush through the final activity at the end of a nearly three-hour workshop. Or, rather, I could have employed ‘Direct Rating’ (DR). In DR, points need not sum to a particular number. Participants first rank all the variables, assign 100 points to the highest ranked variable, then assign relative points to each remaining variable (Bottomley et al., 2000).

Aggregating variables into categories, however, helps reduce the cognitive load of the weighting activity and therefore reduces error (i.e., the average variation between participants' true weights and those assigned after the facilitated process of value-based decision-making). It also allows experts to propose sub-category indicators and weights, which has advantages (potentially producing an index with indicators known to stakeholders) and drawbacks (e.g., not fully democratizing political decision-making in Transition Management).

As always, the choice of method should be based on the aims of the research project. The same applies to the decision to weight and combine indicators from an indicator set into a more complex, *aggregate variable*, i.e., an index (Wu and Wu, 2012). In the absence of explicitly assigned weights, indices assume equal weighting between categories. Indicator sets, on the other hand, do not assign relative values and rather act as a 'checklist' to separately evaluate different aspects of the system. It should be noted that one visioning workshop participant refused to assign weights, writing, "Not possible to allocate priorities!" Although this may be a valid position, our choice to create a weighted index is based on the following research aim: to integrate priorities of our target population into the Transition Management process so that decision-makers are aware of and can address existing pressures of unsustainable development in their proposed public-private initiatives. An index with participant-assigned weights can both represent these priorities to decision-makers whilst also providing a tool to monitor whether transition experiments are delivering on participant-defined transition goals.

Having analysed participant-defined goals, I identified 14 weighted categories or 'goals' for the local housing system with 38 sub-goals. These serve as the conceptual structure of the Housing & Wellbeing Evaluation Framework (see Table 3).

Table 3: Cambridgeshire & Peterborough Housing & Wellbeing Evaluation Framework

<i>Goal</i>	<i>Participant definitions</i>	<i>Weight</i>
<b>1. Low-impact infrastructure and lifestyle</b>	1. Energy efficiency & renewable energy 2. Walkable and accessible communities with amenities 3. Access to good public transport & walking/cycling infrastructure 4. Modal shift to active and public transport* 5. "Good recycling" 6. "Good water supply & sewage system" 7. "Access to local food or space to grow food" 8. Sustainable construction materials* 9. Responsible land use*	36 points
<b>2. Affordability</b>	10. "Affordable According to what you can pay" (i.e., not 80% of market value) 11. "No homelessness"	15 points
<b>3. Well-designed &amp; good quality of build (aesthetic and function)</b>	12. "Generous space standards" 13. "Good sunlighting" 14. "Adaptable to accommodate changes in household size and/or disability" 15. "High quality, locally appropriate architecture" that's not identikit 16. "Enduring"; "built-to-last"; "resilient to climate change (overheating and flooding)" 17. "Living fabric" / easy to maintain 18. "Beauty in build and setting"	12 points
<b>4. Community-centred landscape design and community infrastructure (i.e., shared spaces and other amenities)</b>	19. "Community-focused design" that encourages social interaction between neighbours / "People-dominated landscapes" 20. Close proximity to play space and recreational grounds -- "play space" / "Places for youth to hangout in the evening" / "Neighbourhoods children would choose to live in" 21. "Shared indoor and outdoor spaces" / "shared facilities" / "Co-working spaces" / "Community hubs" where skills sharing takes place 22. "Communal growing spaces"	9 points
<b>5. Safe &amp; secure neighbourhoods</b>	23. "Safe neighbourhoods" (low/no crime) 24. "Protected from traffic" / "Safe spaces for children to roam free" 25. Safe homes (related to fire, tripping, etc. hazards)	8 points
<b>6. Mixed communities</b>	26. "Mixed communities" in age, tenure, household income, culture and ethnicity	5 points
<b>7. Community Cohesion</b>	27. "Respect in community" / "Friendly neighbours" / Engaged and supportive community	4 points

<b>8. <i>sufficient space in neighbourhoods</i></b>	28. "Enough space within area (i.e., not too dense)" / "Not too close to neighbours; having space to move around" / "village-style neighbourhoods"	4 points
<b>9. <i>Better housing sector governance</i></b>	29. "Democratic design of new developments" & "Shared management" 30. "Tenure security" / Better enforcement of renters' rights 31. "Investors and developers held accountable"	2 points
<b>10. <i>More sheltered accommodation &amp; care homes</i></b>	32. Increase in sheltered accommodation relative to demand – to reduce burden on unpaid carers and provide those who are aging with accessible accommodation	1 point
<b>11. <i>Sufficient roads &amp; parking space</i></b>	33. Implies there is too much traffic and insufficient parking space	1 point
<b>12. <i>Maintained housing stock &amp; neat/tidy estates</i></b>	34. Well maintained housing stock 35. Tidy and clean estates - to include proper clean-up post-build or post-maintenance work	1 point
<b>13. <i>Community Support</i></b>	36. Services to support communities, such as paid staff at local community centres	1 point
<b>14. <i>Privacy &amp; Spaces to be alone, lose oneself and find peace and tranquillity</i></b>	37. E.g., from overlook into garden 38. "Spaces to be alone," lose oneself, and find peace and tranquillity	1 point

\* = added by the head researcher

What is most striking about the results is the weight participants assigned to 'Low-impact infrastructure and living' (36%) compared to the second highest priority, 'Affordability' (15%). This was not the result of a few eco-minded participants who allocated all their points to 'low-impact' variables and cared little about social welfare. On the contrary, only 4 in 10 participants allocated points to 'Affordability' (3 in 10 in Cambridge and 6 in 10 in Peterborough), whereas nearly all participants, 9 in 10, allocated points to *at least* one 'Low-impact' sub-goal. Despite major differences in weighting between the two workshops (see Figure 14), the high prioritization of 'Low-impact' variables was true for both workshops.



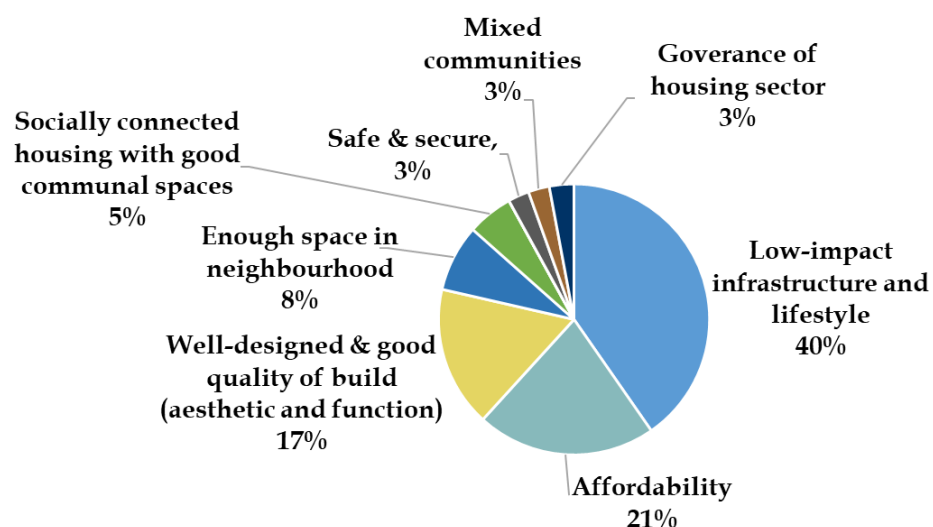
Following ‘Low-impact infrastructure and living’, Peterborough’s top-ranked goals in descending order were ‘Affordability’ and ‘Quality design & build’; whereas the top-ranked goals of Cambridge participants were ‘Safety & security’ and ‘Community-centred design and community infrastructure’. Based on results from the Point Allocation activity, Cambridge participants prioritized community cohesion and mixed communities far more than Peterborough participants, whereas ‘Sufficient space in neighbourhoods’ was far more prioritized in the Peterborough workshop. These differences, however, were not reflected in time spent discussing these issues during the breakout session. Indeed, similar levels of concern were expressed, particularly regarding the importance of community and concern over excessive densification.

It should be emphasised that Point Allocation results reflect differences in lived experience/profiles of a small number of diverse participants, not differences between the cities of Peterborough and Cambridge. As with all focus-group workshops, results should not be interpreted as representative of the wider population. For example, housing affordability, ranked second at the Peterborough workshop with a weighting of 21% and fourth in the Cambridge workshop with a weighting of only 9%, despite the fact that housing affordability is a much greater problem in Cambridge than in Peterborough. ‘Affordable housing’ likely received a higher weight at the Peterborough workshop, as there were seven individuals on the city’s social housing waiting list in attendance and none at the Cambridge workshop. Similarly, the crime rate is much higher in Peterborough than in Cambridge, yet it was ranked second at the Cambridge workshop (14%) and ranked last at the Peterborough workshop (3%). There may be geographical explanations for this outcome (e.g., residents living in areas with a history of crime may be less concerned than residents living in areas with low but rising crime rates). However, the difference between workshops is more likely the result of individual bias inherent in small-N studies. For example, the table of social housing tenants at the Cambridge workshop discussed, in length, the relationship between maintained, neat and tidy estates and residents’ sense of security – if not actual criminal activity. These participants are all active members of

their social housing estates with two representing social housing tenants on local or housing association advisory boards where issues such as estate maintenance and crime are heavily discussed. Therefore, the overall weighting of this category in the Housing & Wellbeing evaluation framework is likely the direct result of including these specific voices in the visioning process.

Although I cannot draw conclusions regarding the *differences* between the two cities, I can conclude that in both cities, **residents with very diverse backgrounds are similarly concerned about the environmental impacts of unsustainable housing development and perceive actions to reduce these impacts as highly important for future wellbeing.** One explanation could be the long list of co-benefits (e.g., the social and health benefits associated with better insulated homes, people-dominated landscapes and active transport). Another explanation could be a wider (eco-centric) understanding of ‘wellbeing’ held by some participants, as the facilitators refrained from using the term ‘human wellbeing’.

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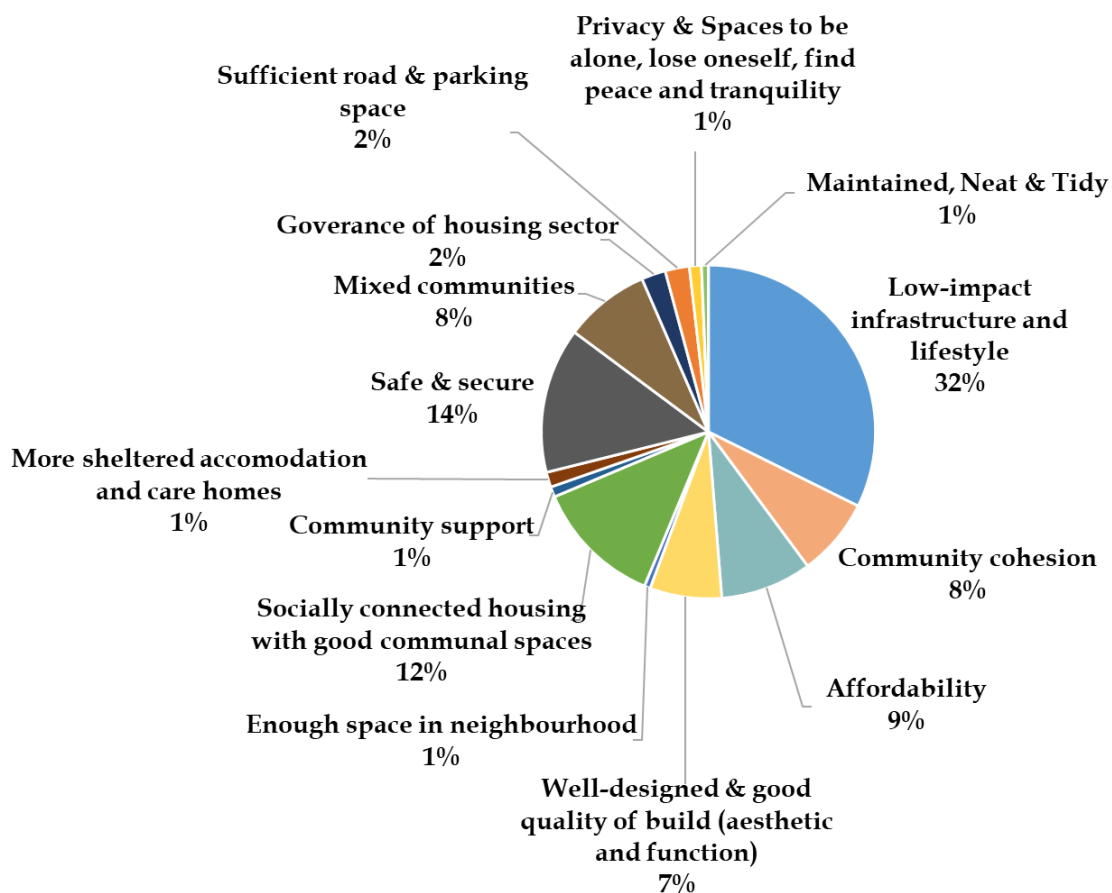


Figure 14: Comparison of Cambridge and Peterborough categories and weights

#### 4.3.3 Implications of low turn-out for the transition goals

Recognizing that life experience affects people's priorities and perceptions of risks, we expect a divergence of views around a utopian housing system and do not aim for consensus. Rather, all goals written on participants' Point Allocation cards are accepted into the evaluation framework, and participants' weights are averaged. Note that the final averaged weights may not be agreeable to any one participant. Rather, the framework should be understood as a product of the collective input from a diverse set of actors with unique knowledge of and experiences with the local housing system. However, the balance of attendance between target groups matters. For example, if nearly all participants were private renters, we should expect greater emphasis on renters' rights and less emphasis on concerns unique to homeowners. The remainder of this section discusses how over- or under-representation may have influenced the collective vision.

Due to a high 'no-show' rate, the Peterborough workshop contained only 15 participants (5 groups of 3), with only seven local residents from our target audience – all of whom were on the social housing waiting list, meaning the other target audiences were not represented at the Peterborough workshop (see Table B1 in Appendix B for list of target audiences). This was despite a high registration rate and knowledge that participants would receive a £20 gift voucher.

According to feedback, the gift voucher did play an important role in encouraging some participants from the social housing waiting list to attend. However, with only 30% of registrants having attended the workshop, gift vouchers were clearly an insufficient incentive on their own. In retrospect, recruiting local volunteers already embedded in the community and with regular contact to our target audience would have yielded better results. Rather than sending electronic invitations through large listservs with a financial incentive, these volunteers could have discussed the non-financial benefits of participation in-person and

reiterated these to registrants in the weeks leading up to the workshop. However, this would necessitate additional time and effort to set up and coordinate.

Unlike the Peterborough workshop, the Cambridge workshop had a good turnout. However, due to poor outreach, the number of registrants was originally very low. Before the days of the General Data Protection Regulation (GDPR), Peterborough City Council was able to send invitations to a sample of 470 households registered on their social housing waiting list. Despite advertising the event through several gatekeepers, all non-practitioner attendees to the Peterborough workshop were recruited through this single outreach effort. Cambridge City Council, on the other hand, had an internal policy against sharing third party invitations with households on its social housing waiting list. Rather, the workshop was advertised on Home-Link.org, a website used by home seekers on the social housing waiting list, and by the Cambridge & District Citizen's Advice Bureau via its website and notices posted in its kitchen and reception area. Although the city's largest housing association, BPHA, did not respond to our request to forward electronic invitations to its tenants, Cambridge Housing Society did and also encouraged other local housing associations to do the same, having recognized the value in providing their tenants with a platform to express their concerns and desires for future housing development.

Despite significant efforts made through these advertising channels, registration rates remained low. As such, I decided to open the Cambridge workshop to the public, meaning participation was no longer restricted to our target audience. This was due, in part, to the fact that the workshop fell on a Friday evening. Although Fridays are unfavourable, local community centres could not offer another date during such a popular timeslot for after-school activities (16:15 – 19:00). In the end, the trade-off was made as the venue (community centre in an area of high deprivation) and timeslot (between school pick-up and dinner) were considered to address greater barriers to attendance from our target audience than the calendar date.

To advertise the event to the public on short notice, an electronic flyer was posted on social media, tagging various local groups with interest in sustainable housing development. Cambridge City Council also shared the event on its website and social media channels. Electronic invitations were sent via listservs through Cambridge University's Department of Engineering, Department of Architecture and Department of Land Economy, as well as Anglia Ruskin University's Department of Engineering & the Built Environment.

Having opened the workshop to the public, we did not assign seating, as with the Peterborough workshop, to ensure that our target audiences were evenly represented in each breakout group. Interestingly, all of the social housing tenants formed a single group at the Cambridge workshop. As such, the aim of exposing expert practitioners to stories of their lived experiences, perspectives and values was not achieved at the Cambridge workshop.

Having surveyed participants prior to the Cambridge workshop, we interestingly found that only two target audiences were missing from the workshop, namely those with poor access to key services such as a doctor's surgery; and those living in a flood zone or who have experienced property damage from flooding – though, the latter is unsurprising as Cambridge has very few properties falling in flood zones relative to Peterborough. Otherwise, every other target group was represented by at least one participant (see Table 5). It could be, however, that only a small number of individuals ticked multiple boxes, meaning the Cambridge vision would still be biased towards the values and priorities of local practitioners and non-target, local residents.

*Table 4: Questionnaire to check which target groups were missing from the workshop*

Survey Question	Cambridge (25)
I am a social housing tenant.	7
I am an interested home buyer, but I can't afford local prices.	4

I am <35 years old and live with my parents.	2
I own a home, but it is overcrowded, and I cannot afford to up-size.	1
I'm a commuter, because I can't afford to live in the city where I work.	3
My home is often colder than I'd like to save on energy bills during the winter.	1
I own in a home in a flood zone.	0
I have experienced damage to my home from flooding.	0
I own farmland.	1
I am retired and live alone.	3
I find it difficult to access key services such as a doctor's surgery because of where I live and/or because of my physical condition.	0
I find it difficult to access the leisure market such as shops, the cinema, museums, etc. because of where I live and/or because of my physical condition.	3
I find it difficult to access public, outdoor green space because of where I live and/or because of my physical condition.	1
I'm a teacher, nurse or social worker.	2

Difficulty in access to local amenities and services was expressed by some participants, though it is unclear from survey questions whether this is due to physical ability or location of housing. That being said, 'adaptable housing for people with disabilities' features in the collective vision, as well as 'access to local amenities' based on spatial proximity and/or affordable transportation. It is also unknown how many unpaid carers were in attendance. However, information on the Health & Social Services Risk Card prompted discussions about social isolation, limited mobility and other issues related to aging and disability.

Key workers (e.g., nurses, teachers and social workers) and young, first-time homebuyers struggling to get on the housing ladder were under-represented in both workshops. However, the survey revealed that several participants in both workshops would like to own a home but cannot afford local prices; three participants in the Cambridge workshop commute for reasons of affordability; and two young, adult participants still live with their parents because they cannot afford rent in their local area. Regardless, housing affordability was a priority for the majority of participants, likely given its high visibility in the region, and was not found to receive higher weighting amongst social housing tenants.

Because commuters were under-represented, their concerns (e.g., transportation) may be under-weighted in the evaluation framework. This is particularly true, as the workshops were held in the region's two cities (Cambridge and Peterborough) and not in villages or market towns. The urban bias of the evaluation framework should be emphasized. If stakeholders wish to design an initiative employed in both rural and urban settings in Cambridgeshire and/or Peterborough, it would be advised that a second evaluation framework be produced from visioning workshops with rural residents. For TM practitioners operating in urban-rural areas, I recommend that workshops be hosted in an equal number of urban and rural locations to address this bias in the evaluation framework.

## **4.4 CONCLUSION**

The co-creation of the 'Housing & Wellbeing' evaluation framework followed a participatory, bottom-up process of developing a utopian vision, followed by a list of transition goals to secure or improve long-term wellbeing, and finally weightings of these goals based on participants' values and priorities. The resulting evaluation framework contains 14 weighted 'transition goals' and 38 sub-goals by which to evaluate proposed interventions for the design and selection of transition experiments. In an iterative TM process, the actual performance of transition experiments could also be evaluated against the framework.



The point-allocation activity revealed three interesting findings. First, when asked which features of their desired (imagined) housing systems were most critical for securing or improving future wellbeing, participants placed significantly more value on 'Low-impact infrastructure and living' (36%) than on 'Housing Affordability' (15%). Second, this prioritisation was shared by the vast majority of participants, regardless of socio-economic backgrounds. These findings suggest that residents with very diverse backgrounds are similarly concerned about the environmental impacts of unsustainable housing development and perceive actions to reduce these impacts as highly important for future wellbeing. Third, I found that the chosen method of point-allocation limited the number of index variables and deflated the relative value of goals that were perceived as important but of lesser priority. This method, if applied in an iterative governance process, would create chaotic system behaviour, as the evaluation framework, biased towards the greatest priorities at  $\text{Time}_x$ , might neglect goals whose weights were deflated by measurement bias, creating perverse outcomes and a shift in priorities at  $\text{Time}_{x+1}$ . It is thus recommended that another method, such as 'Direct Rating' (DR), be used to weight transition goals.

The workshop findings also confirm what we already know, namely that the results of small-N studies are heavily influenced by individual characteristics of those participating. The implication for TM, embedded in the critique of TM's democratic deficit, is that visioning exercises and discursive debate amongst small groups of 'transition frontrunners' inevitably produce transition goals skewed towards the values and priorities of participants – the majority of whom are technocrats who do not represent the general public, and are less likely to have experienced, first-hand, the negative consequences of unsustainable development. The critique is not resolved by inviting a small number of token 'civil society representatives' into the transition arena. Nor was it resolved in my action research project, as I failed to successfully recruit those with lived experience of the negative consequences of unsustainable housing development. Given the recruitment challenges I faced, I would recommend that the transition team

contain at least one individual with expertise in recruiting ‘hard-to-reach’ groups and that plenty of time is allocated to this recruitment.

From the visioning activities, I found that the facilitation methods employed succeeded in creating a relaxed, accepting space in which creative and radical ideas could be shared and considered. As a result, participants envisioned radically different futures, with half of the groups expressing a desire for car-free built environments, ‘mixed communities’ and the ‘de-financialisation of the housing sector’. The majority of groups also called for “participatory planning” and “democracy in place-making,” ultimately supporting “greater community power over developers.” At the Cambridge workshop, in particular, there was an expressed desire for ‘slow’ and ‘equal’ growth which conflicted with one group’s desire for decision-makers to recognise social and environmental “limits to growth.”

This was not the only contradiction present in the fully inclusive vision. One major contradiction existed between the desire for space, on the one hand (e.g., for detached homes, private gardens, sufficient space between homes to allow for privacy, more parking spaces, and no high-rises) and densification on the other (for improved public transport, improved protection and enhancement of the natural environment, improved walkability, and improved access to key services, amenities, leisure market and community infrastructure). Some creative solutions were found, e.g., high-rise buildings limited to five stories, community-use spaces (e.g., gardens) to compensate for losses in individual space, vertical greenspaces and the construction of ‘tiny homes’ – albeit these are only superficial solutions that address symptoms in the short- to mid-term if the region’s population growth is to continue. When embedding these contradictions in the evaluation framework, they take the form of ‘trade-offs’, implying that certain interventions in the housing sector will count both positively and negatively toward the achievement of wellbeing. This reflects the fact that ‘maximizing’ wellbeing is inherently conflictual, as ‘more parking spaces’, for example, can impact both positively and negatively on wellbeing. These trade-offs are captured

by the framework, as interventions can score positive against certain criteria and negatively against others. That said, criteria are weighted based on their perceived impacts on future wellbeing which were explicitly discussed in the 'linking' workshop activity.

It was understood that actions which positively impact short-term wellbeing may incur mid- and long-term costs. Similarly, short-term pain and effort must often be exerted to build resilience and safeguard long-term wellbeing. Because the evaluation framework was weighted from the perspective of *future* wellbeing, interventions that produce short-term gains but do not support a positive “state of becoming” score poorly relative to actions that secure or enhance long-term wellbeing. This valuation may be met with resistance by participants at the subsequent multi-stakeholder workshop, as they may require short-term gains to participate multi-stakeholder partnerships. This potential conflict is investigated at multi-stakeholder workshops – the findings from which are presented in Chapter 6: Findings from the frontrunner workshop.

## 5 CHAPTER 5: FINDINGS FROM THE CO-MODELLING PROCESS

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### 5.1 INTRODUCTION

The aim of this chapter is to illustrate how a collective theory, in the form of a qualitative systems model, can be co-created based on findings from a literature review and stakeholder interviews. This chapter begins with an overview of methods used to define system boundaries (Section 5.2.1), to conduct actor analysis and select participants (Section 5.2.2), and to develop and refine the group, qualitative systems model (section 5.2.3). The findings section (Section 5.3) provides an overview of the Greater Cambridge, Greater Peterborough (GCGP) Housing & Wellbeing systems model (Section 5.3.2), here forth referred to as the “GCGP model”, as well as a detailed presentation of one of its eight subsystem models, “Housing & the Environment” (Section 5.3.3). Because the model is too large to present in full in this thesis, key findings from remaining subsystems are provided in Appendix D. A full, detailed understanding of the systems model can be obtained through a review of the open-access, digital Kumu model<sup>17</sup>. Directions for navigating the online model are provided in Section 5.3.1. The chapter closes with a summary of findings from the co-modelling process (Section 5.4).

### 5.2 METHODS

#### 5.2.1 Drawing system boundaries

‘System conceptualization’ begins by identifying key sectors pertaining to the transition challenge and their relevant stocks, flows, intervening variables and causal relations (Sterman, 2000). For the

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<https://kumu.io/Istabler10/housing-wellbeing-model> and <https://kumu.io/Istabler10/housing-wellbeing-model-CLDs-only>

identification of relevant sectors and their key components, I conducted a ‘snowball’ search of peer-reviewed system dynamics modelling (SDM) literature on the topic of urban and/or regional housing development and its impacts on wellbeing or sustainability. System dynamics literature was chosen to build my understanding of the problem situation as well as system parameters defined in past research.

Of particular influence was the University College London (UCL) Energy Institute’s Housing, Energy and Wellbeing (HEW) systems model (Macmillan et al., 2016), which formed the base of the GCGP model. However, the GCGP model goes beyond this energy-housing-wellbeing nexus and investigates how the region’s housing system affects and is affected by the region’s transport system, local ecology, global habitat loss, and more, with implications for future wellbeing. The model’s parameters thus exceed those of the HEW model.

The snowball review of SDM literature was supplemented with a non-systematic review of publications exploring the links between housing and wellbeing using the keyword search:

TS=(“housing” OR “infrastructure” OR “spatial planning” OR “built environment” OR “regeneration”) AND (“wellbeing” OR “health” OR “sustainability” OR “social cohesion” OR “community” OR “safety” OR “deprivation”)

Studies tended to focus on specific aspects of individual wellbeing (e.g., physical and mental health) or, less often, community wellbeing (e.g., community resilience). Taken together, the literature revealed a large number of relationships between housing and short-, medium- and long-term wellbeing. Having conducted an inductive, thematic analysis (Charmaz, 2011), relationships were grouped into themes, many of which re-emerged in subsequent stakeholder interviews.

Interviewees (i.e., transition ‘frontrunners’) contributed significantly to my evolving interpretation of the problem situation and system boundaries. Much like the analysis of publications, an inductive, thematic analysis of interview data was conducted. I could have conducted a deductive analysis, e.g., by

applying themes from the aforementioned literature analysis. However, I decided to conduct a separate inductive analysis to enhance the co-production of knowledge, i.e., to ensure that themes important to stakeholders were used to define system boundaries. Interviews with frontrunners revealed themes not yet identified in the system dynamics literature I had reviewed. This is likely due to the exclusion of non-quantifiable variables or variables with missing data in quantitative SDM.

Stakeholder interviews thus prompted a subsequent review of non-SDM literature in the fields of sustainability, urban studies, and public health to further investigate theoretical relationships identified by local stakeholders. During this iterative literature review and interview process, my premature understanding of thematic boundaries was deconstructed and reconfigured.

### **5.2.2 Actor analysis and participant selection**

Stakeholder groups were identified in an iterative actor analysis carried out during the literature review, desktop research and early interviews using the selection methodology developed by Müller et al. (2013) (see Figure 15). “No single person has a sufficiently broad perspective on the important actors” (Müller et al., 2013, p. 5). As such, the initial list produced from the researcher’s system-actor analysis and recommendations from experienced practitioners must be refined as the researcher’s understanding of the problem situation evolves. Early interviews providing additional information on the problem situation therefore contribute to the iterative process of stakeholder identification, until a saturated understanding of the problem situation and its related stakeholders is reached.

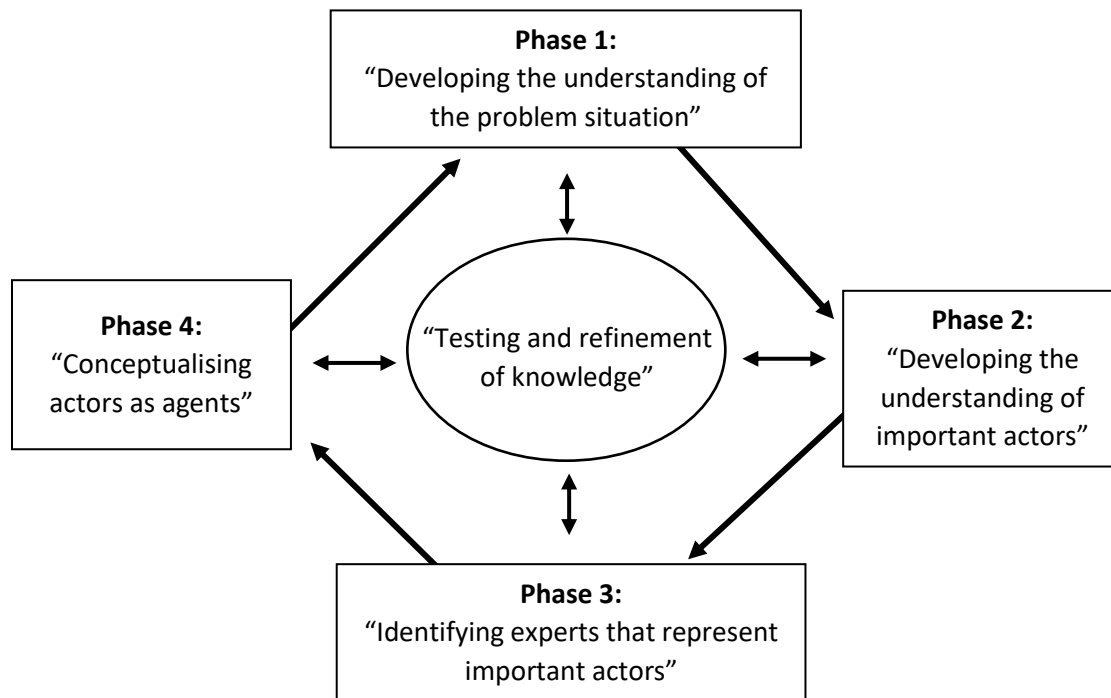


Figure 15: Participant selection methodology (adapted from Müller et al. (2013))

Table D1 in the Appendix D displays the final list of stakeholder groups by sector or theme having arisen in the inductive analysis of interview data, grey and academic literature. This list was then populated with names of local stakeholders, i.e., individual organisations, businesses, knowledge institutes, etc. At least one representative from each stakeholder group was interviewed (see Table 5 for the list of interviewees).

Although only 20 individuals were interviewed, the list of actor roles in Table 5 exceeds 20, as some interviewees held dual roles. When recruiting interviewees, I had to consider, as well, TM’s participant selection criteria (Loorbach, 2007, 2010; Frantzeskaki, Loorbach and Meadowcroft, 2012), as interviewees were also invited to attend the frontrunner workshop. The purposive sampling frame contained the following criteria: ‘Representativeness’; ‘Inclusivity’; ‘Niche Engagement’; ‘Sources of agency’; and ‘Openness to the transition process’. Definitions of these criteria are provided in Table D2 of Appendix D.

Table 5: Interviewees having participated in co-modelling

STAKEHOLDER GROUP	ORGANISATION	POSITION
HOUSING & THE ENVIRONMENT	Local authority	Head of Environment Strategy
HOUSING & THE ENVIRONMENT	Local environment charity	CEO
HOUSING INEQUALITIES / HOUSING & COMMUNITY	Housing association	Board member
HOUSING & TRANSPORT	Greater Cambridge Partnership	Board member
HOUSING & THE ENVIRONMENT	Landscape design firm	Board Director
HOUSING, ENERGY & CLIMATE CHANGE	Cambridgeshire and Peterborough Combined Authority	Head of Sustainability
HOUSING, ENERGY & CLIMATE CHANGE	Cambridgeshire County Council	Project Director
HOUSING & TRANSPORT	National active travel charity	Head of Partnerships
HOUSING DESIGN / HOUSING & COMMUNITY	Communications firm (supports housing developers on community engagement)	Managing Director
HOUSING, ENERGY & CLIMATE CHANGE / HOUSING DESIGN	Architectural research consultancy	Director
HOUSING & THE ENVIRONMENT	Environment Agency	Manager
HOUSING, ENERGY & CLIMATE CHANGE / HOUSING DESIGN	Greater Cambridge Planning Services	Senior officer
HOUSING MARKET & LAND ECONOMY	Commercial developer	CEO
HOUSING DESIGN & SPATIAL PLANNING / HOUSING & WELLBEING	Centre for Urban Conflicts Research, University of Cambridge	PhD Student in Architecture (focus on 'aging and the city')
HOUSING MARKET & LAND ECONOMY	Department of Land Economy, University of Cambridge	Research programme director
HOUSING & COMMUNITY	Cambridgeshire Police	Senior Intelligence Analyst
HOUSING & COMMUNITY / HOUSING MARKET & LAND ECONOMY	Charitable, rural local development agency	Rural Housing Enabler & Neighbourhood Planning Officer
HOUSING & WELLBEING	Centre for Diet and Activity Research, University of Cambridge	public health researcher
HOUSING & WELLBEING	NA	social housing tenant
HOUSING, ENERGY & CLIMATE CHANGE	Rural renewable energy consultancy	Founder and director
HOUSING MARKET & LAND ECONOMY	Housing developer	Executive Director
HOUSING, ENERGY & CLIMATE CHANGE	BEIS	Local energy policy advisor
HOUSING & THE ENVIRONMENT	Local nature partnership	Chair
HOUSING MARKET & LAND ECONOMY	Regional Local Enterprise Partnership	Board member



In TM, participant selection criteria are applied, first of all, to ensure stakeholder diversity – both in influence over and understanding of the complex system in which participants wish to intervene. Selection criteria are also applied to improve the group’s overall level of experience with niche innovations, decision-making power, and openness to the transition process. Cognisant of the difficulty in soliciting trust in and commitment to a rather time-intensive, stakeholder-led process with unpredictable outcomes, my initial contact with potential participants was largely opportunistic. Having worked locally in the field of sustainable development and policy for a large part of their careers, the four Sustainability East board members on the Transition Team provided a rich social network from which twelve participants were recruited. Thereafter, eight additional participants were chosen at random from each of the remaining stakeholder groups. All participants, regardless of the selection process, were held to the same sampling criteria.

Having already recruited participants from the Transition Team’s social network, we were able to advertise the time-intensive workshops as contributing to a legitimate stakeholder engagement process endorsed by the Combined Authority, thus increasing the likelihood of invitation acceptance by randomly selected stakeholders. In some instances, where I was unable to assess whether representatives fit the selection criteria, gatekeepers (e.g., firm management) were asked to select representatives based on the aforementioned criteria.

### 5.2.3 Development and refinement of the group systems model

Co-modelling via one-on-one interviews was achieved using ‘cognitive mapping’, a prescriptive note-taking technique performed in the interview process (Eden, 1992). Resulting cognitive maps are then analysed using grounded theory methodology to inform the construction of causal loop diagrams (CLDs),

and thereby system conceptualization. This research design is taken from Macmillan et al. (2016), albeit with a critical realist ontological perspective on the construction of CLDs.<sup>18</sup>

In addition to its relatively simple conversion into CLDs, cognitive mapping is often used in participatory system dynamics modelling to improve (1) the quality of data collected during interviews, (2) stakeholders' own understanding of the system and (3) their trust in and co-ownership of the SDM model (Senge and Forrester, 1980). First, cognitive maps are shared with the interviewee, so that they can be validated or corrected, thus reducing misinterpretation from the mapper. Second, the interviewee's own understanding of the system improves "through the necessity of questioning how the chains of argument fit together" (Ackermann et al., 1992, p. 2). In other words, cognitive mapping forces the interviewee to elaborate, distinguish, explore and work upon his or her understanding of relevant factors, causal relationships, feedback loops and value-laden definitions of systemic challenges, risks and 'positive development'. Third, if participants have more trust in the model and its findings, they are more likely to contribute to multi-stakeholder initiatives informed by these findings.

By informing interviewees in advance that their cognitive maps will be treated in confidence and that all the data will be kept anonymous, they are encouraged to raise important issues without the risk of political and/or professional ramifications. This helps to elicit information that participants may not want to discuss in group settings (e.g., information about informal decision-making practices in one's organisation).

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<sup>18</sup> MACMILLAN, A., DAVIES, M., SHRUBSOLE, C., LUXFORD, N., MAY, N., CHIU, L. F., TRUTNEVYTE, E., BOBROVA, Y. & CHALABI, Z. 2016. Integrated decision-making about housing, energy and wellbeing: a qualitative system dynamics model. *Environmental Health*, 15, S37. view the construction of CLDs as akin to the development of a constructivist grounded theory, i.e., that data is not 'discovered' but rather constructed by the researcher in interaction with participants. Adopting a critical realist ontology, I assume that data can be discovered, but recognize mediators in our perception of objective facts (e.g., life experiences of interviewees, their cognitive biases, the researcher's personal interpretation of interview data, interviewer bias, questionnaire bias, etc.).

Following a verbal introduction to the project and signing of the written consent form, one-on-one interviews began with a single opening question (Macmillan et al., 2016, p. 26),

*“What do you think are the links between hous[ing] and the wellbeing of individuals, families and communities in the UK?”*

The following probing questions were used to further explore each identified link,

- a. *Let’s talk a bit more about the causes of this – why has/does this occur/ed?*
- b. *Let’s talk a bit more about the relationship you’ve identified. Do you believe [x] effects [y] directly or indirectly through some mediating factor? For example, segregated bicycle lanes are said to increase the number of people who travel by bicycle, not directly but indirectly, through raising people’s perceived sense of safety.*
- c. *Let’s talk some more about the consequences – what happens because of this?*

To differentiate between localities, the following questions are asked,

- a. *“What is the relative state of housing and wellbeing in your district of residence compared to others in the Cambridgeshire-Peterborough city-region?”*
- b. *What do you think is driving this difference?*

To gain a historical perspective, the following question is asked,

*How has the relationship between housing and wellbeing changed in your area over the past three decades?”*

These probing questions support formal, inductive inquiry and theory inference. “One of the main objectives of grounded theory resides in linking [...] concepts to generate meaningful theories. Since

“linking” is at the heart of system dynamics, grounded theory speaks to the same goal of drawing relationships among factors in a targeted system” (Luna-Reyes and Andersen, 2003, p. 284).

At the end of each interview, the cognitive map was reviewed with the interviewee. This has two benefits: First, it supports stakeholder-researcher relationships, “as the map becomes a shared document rather than a set of notes belonging to the mapper” (Ackermann et al., 1992, p. 4). Second, the review helps participants later identify their contributions to the group model during the frontrunner workshop which may improve their trust in the overall co-modelling process.

The 90-minute audio recordings were then transcribed. Together with the hand-drawn cognitive maps, I was able to create a digitised version of each map in Vensim, a simulation software used to run system dynamics models. After analysing semantic and latent themes in both sources of data – the maps and transcribed text – the structure and content of the digital model changed significantly from the hand-drawn map (Braun and Clarke, 2006). In every case, more variables were added. These variables, and their related links, were likely missed during the interview due to the highly demanding nature of ‘cognitive mapping’. During cognitive mapping, interviewers have to transform narratives into causal trees and feedback loops whilst practicing active listening. Inevitably some of the interviewee’s contributions are missed but are then added back in during the digital modelling and review process.

Whilst constructing a digital model for each interview, I manually entered about 50% of the transcribed text. This text was entered in the form of anonymised quotes and all identifying information was removed. Because the model is a simplification of the interviewee’s mental model, it is sometimes difficult for a third party to understand the theoretical relationship shown before them. I try to reduce this barrier by translating sector-specific terminology in variable names. However, a user may still require more clarification. The purpose of embedding quotes is to provide this clarification and context with, for example, stories from interviewee’s experience with the region’s housing system.

I originally planned to have participants review their mental models once they were restructured into digital CLDs. My intention was to reduce modeller bias whilst keeping stakeholders engaged in the process. After three months of transcribing interviews and digitising cognitive maps, however, I had only completed digitising a random selection of ten interviews. On average, it took four hours to transcribe each 90-minute interview, and another ten hours to build and modify each interviewee's causal map and embed select quotes. Because the method of analysis was so time intensive, I decided to abandon the digitisation of individual cognitive maps and, instead, began merging the ten completed maps with the HEW model (Macmillan et al., 2016).

When given the opportunity to pause and reassess my work, I decided to switch software and build the group model in Kumu, an open-source modelling software that enables sharing of digital models online. Unfortunately, all of the models had to be transferred manually, as Kumu developers had not yet created a way to upload Vensim models. This delayed my work by several weeks.

To integrate interview data and the HEW model, I first conducted an inductive, thematic analysis to identify common themes. Although the HEW model formed the base of the GCGP model, its seven themes were not outright adopted. Rather, some of these themes were combined or expanded upon to create the GCGP themes, or subsystems, with typically broader parameters. The remaining transcribed interviews were then analysed through the lens of the existing group model. Aligned and conflicting theories were sought, but so too were theorisations on subthemes not yet modelled. The implication of this method is that the order in which interviews were analysed and the order in which concepts were integrated into the model influenced, to some extent, its composition. The process was, however, iterative, meaning previously modelled theorisations underwent significant changes as additional interview data was integrated.

“The development of system [...] models is an iterative process” (Luna-Reyes and Andersen, 2003, p. 271). The process of moving from individual causal maps (from the HEW model and GCGP interviews) to an aggregate representation of knowledge (i.e. the merged, group model) can be “tentative and experimental” (Eden, 1992, p. 272). First, interviewees may use different terminology to define identical concepts or use identical terminology to define different concepts. The role of the modeller is to interpret the *meaning* of each concept when merging individual causal maps into one group model. Second, causal maps may contain multiple variations of the same causal chain with an unequal number of elements or causal chains whose theorisations are conflicting. The material must be “sifted and compared. Cross-verification and contradictions are sought. Similarities begin to emerge between the new information and previous systems which are already understood” (Forrester, 1975, p. 161). Where multiple versions of the same causal chains are expressed, the theory was reduced and modelled its simplest form using non-sector-specific terminology. Where theories conflicted, a red exclamation mark was inserted to signal disagreement. The model developed in this way until the final interview was analysed.

Throughout the entire, iterative process, significantly more time was dedicated to changing existing casual chains and feedback loops in Kumu than to their original creation. Had I analysed interviews in a different order, I would have likely chosen different terminology and may have emphasised different concepts, based on which terms and concepts were introduced first. However, the exhaustive, iterative process ensured that all theorisations identified in stakeholder interviews significantly shaped the final model.

In its entirety, this analysis (transcribing interviews; coding documents; rereading transcriptions to be sure of patterns and meanings; modelling proposed relationships using computer software; challenging and reconfiguring causal chains and feedback loops based on data analysed in subsequent interviews; etc.) required over 850 hours of intensive labour over the period of six months. Carrying out and preparing

interviews (e.g. risk assessment, ethics review; participant recruitment; and creation of interview materials such as consent forms and interview protocols) required an additional 225-250 hours. Indeed, the time intensity of qualitative methods is a known limitation of qualitative systems modelling (Luna-Reyes and Andersen, 2003); albeit, time estimations are rarely reported. Practical implications of this time-demanding process for Transition Management are reflected upon in Chapter 7: Discussion.

## 5.3 FINDINGS

Following an overview of the full ‘GCGP Housing & Wellbeing model’ (Section 5.3.2), one of the model’s eight subsystem models, “Housing & the Environment”, is presented in detail (Section 5.3.3). Key findings from the remaining subsystems are provided in Appendix D. Before diving into the model, I introduce key symbols commonly used in the creation of CLDs and provide instructions for navigating the online Kumu model (Section 5.3.1) – both of which should support the interpretation of causal maps.

### 5.3.1 How to interpret causal maps

The causal maps represent elements (material stocks, social norms, actions, and other variables) and their interactions that are likely to explain observed trends in Cambridgeshire and Peterborough’s Housing & Wellbeing “system”. Stocks, which appear occasionally in this model as boxes, represent elements that accumulate or deplete over time. See, for example, “<greenhouse gas emissions from housing stock>” in Figure 16, where the flow, “emissions rate”, signifies the rate at which the stock accumulates. The stock also has an outward flow, namely carbon storage whose rate is determined by the state of nature (modelled here as “<global environmental degradation>”) and the amount of carbon stored in building materials. The latter depends on the “use of wood products to build and insulate homes” as well as the rate of house building (i.e. “<housing development>”) and (re-)insulation of existing homes (i.e. “<supply of energy efficiency retrofits>”).

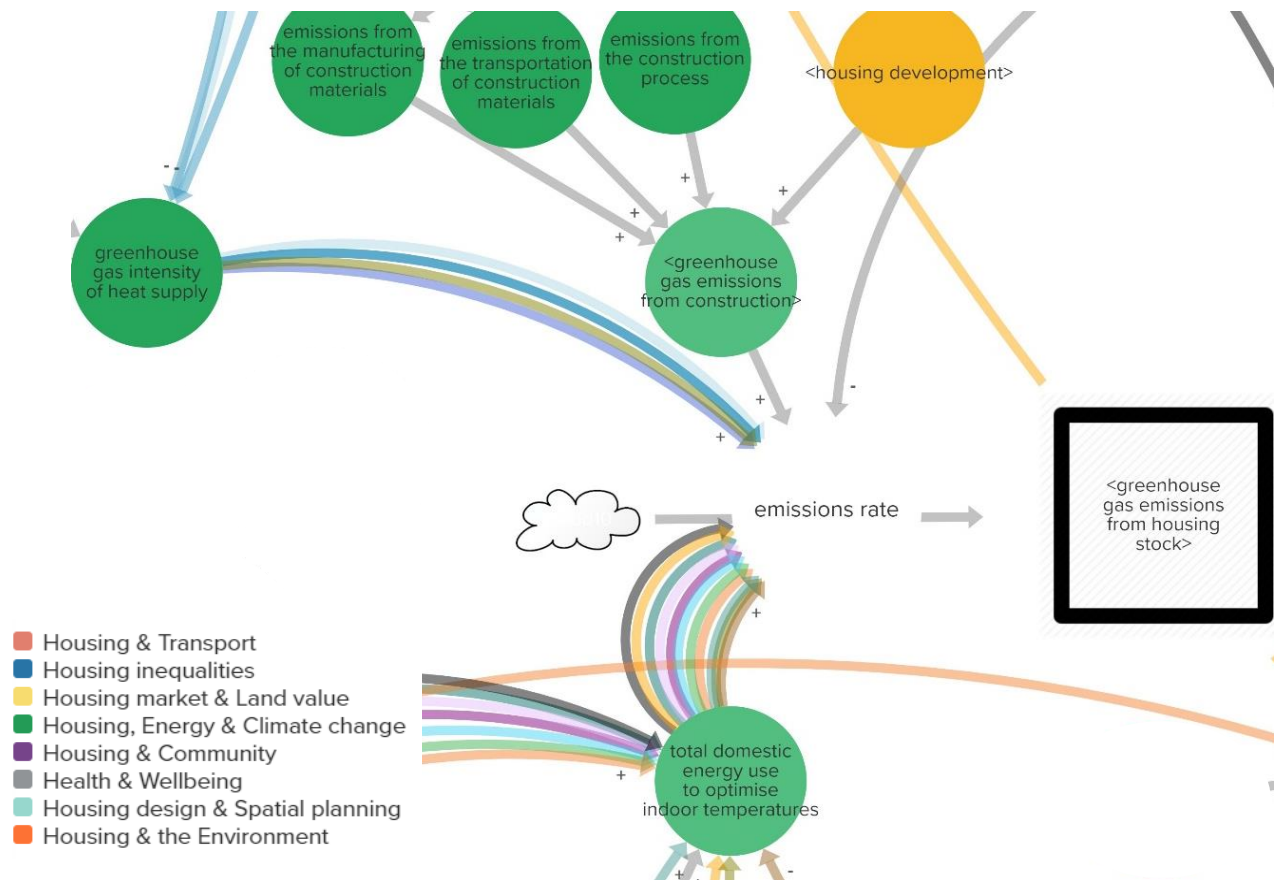


Figure 16: Introducing 'stocks' and 'flows'

All non-stock variables, or 'elements', are presented as circles and are colour-coded based on the subsystem from which they originate. For example, "<housing development>" in Figure 16 is coloured differently to all the green elements belonging to the 'Housing, Energy and Climate change' subsystem, as it originates from the 'Housing Market and Land Economy' subsystem. Elements that are non-coloured with a bold circle, such as "use of wood products to build and insulate homes" in Figure 17, are interventions. This intervention is meant to be actioned by developers, but one could imagine related interventions to be carried out by other actors, such as local authorities or the Combined Authority, through changes to the Local Plan or conditions attached to housing infrastructure funding.



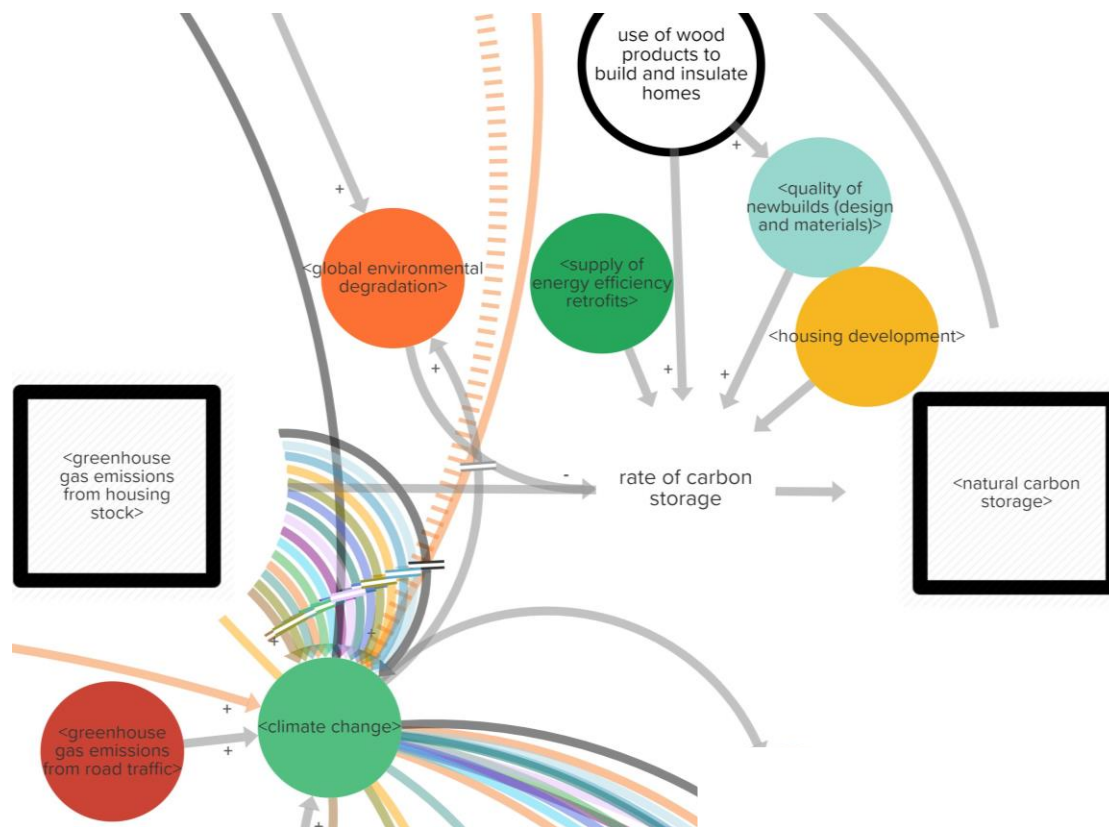


Figure 17: Introducing 'stocks' and 'flows' (continued)

Note that some elements are carroted, e.g., "<housing development>" and "<greenhouse gas emissions from construction>". This means they appear in multiple subsystem models and can be searched for using the search bar on Kumu (see Figure 18).

The elements are connected by causal links (arrows). Straight arrows represent links in linear causal chains, whereas *curved* arrows, taken together, form reinforcing or balancing feedback loops – cycles of cause and effect that determine how a complex system behaves over time. Reinforcing feedback loops reinforce patterns of system behaviour causing exponential growth or decay over time. The effects of reinforcing loops are often dampened, and sometimes overpowered, by the presence of balancing loops that limit trends over time.

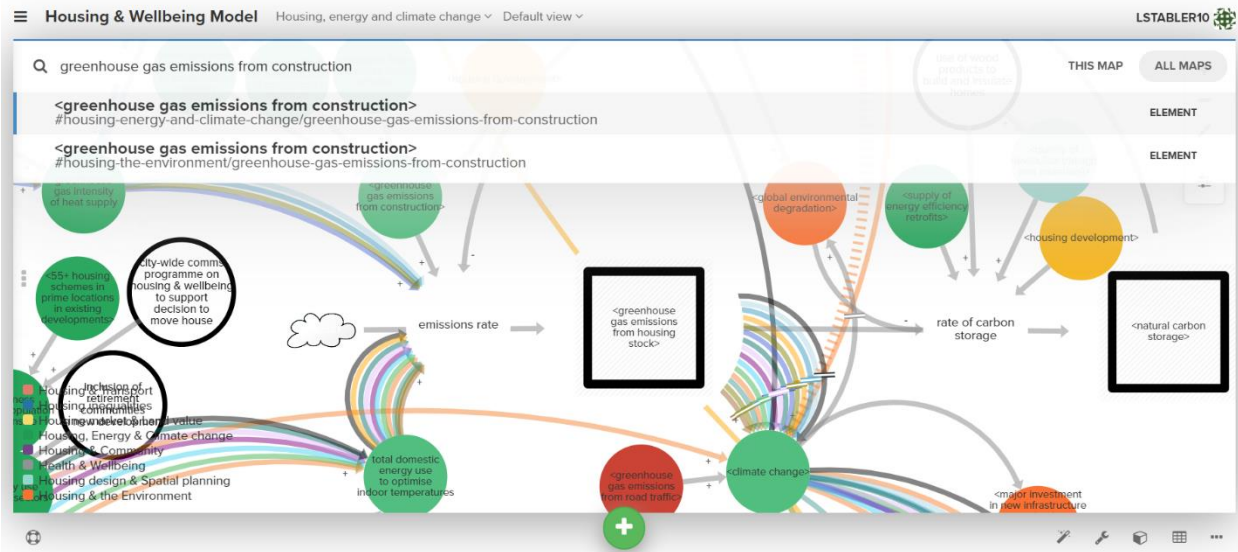


Figure 18: Searching elements across “all maps”, or subsystem models, on Kumu

Figure 19 shows examples of three reinforcing loops and one balancing loop. Note that the titles of the feedback loops are numbered to signify the order in which they are meant to be read and begin with an ‘R’ if the feedback is reinforcing and ‘B’ if it is balancing. The balancing loop, “B1 CC reduces energy demand in winter months”, is taken from the HEW model and represents the balancing effect of lower heat demand during winter months in a warming climate. As “<climate change>” increases, so too does “ambient outdoor winter temperatures” – lowering energy consumption from indoor heating. The arrow connecting these two elements has a +ve sign because a change in “<climate change>” leads to a change in “ambient outdoor winter temperatures” in the same direction. Whereas, a change in “ambient outdoor winter temperatures” leads to a change in “energy required to optimise household winter temperatures” in the opposite direction (hence the -ve sign next to the arrow connecting these two elements).

Conversely, climate change results in an increase in “ambient outdoor summer temperatures”, leading to more energy consumed to power air conditioning units (R1 CC increases energy demand in summer months). Both the first and second reinforcing loops were also taken from the HEW model. In the second reinforcing loop, climate change related, extreme weather events (such as heat waves and storm

surges) increase the occurrence of “<significant infrastructure failures>”. Particularly for commuters, this results in more <time spent at home>, increasing further “total domestic energy use to optimise indoor temperatures” and contributing an accumulation of greenhouse gas emissions (see the +ve connection to the “emissions rate” flow into the emissions stock).

The third reinforcing loop, “R3 Climate change increases the need for energy-intensive pumping of water from reservoirs or water-rich regions” cannot be found in the HEW model, as the narrower system boundaries applied in the UCL project did not allow for the exploration of causal links between climate change, the water environment (orange elements), and energy. Having interviewed a representative of Anglian Water and having read grey literature on climate change impacts in the East of England, a reinforcing loop between climate change, drought, energy demand to transport water over longer distances, and its related emissions was identified and added to the model. This is an example of a feedback loop existing between subsystem models that actors in multiple sectors (e.g., energy, planning, water and nature conservation) should be made aware of.

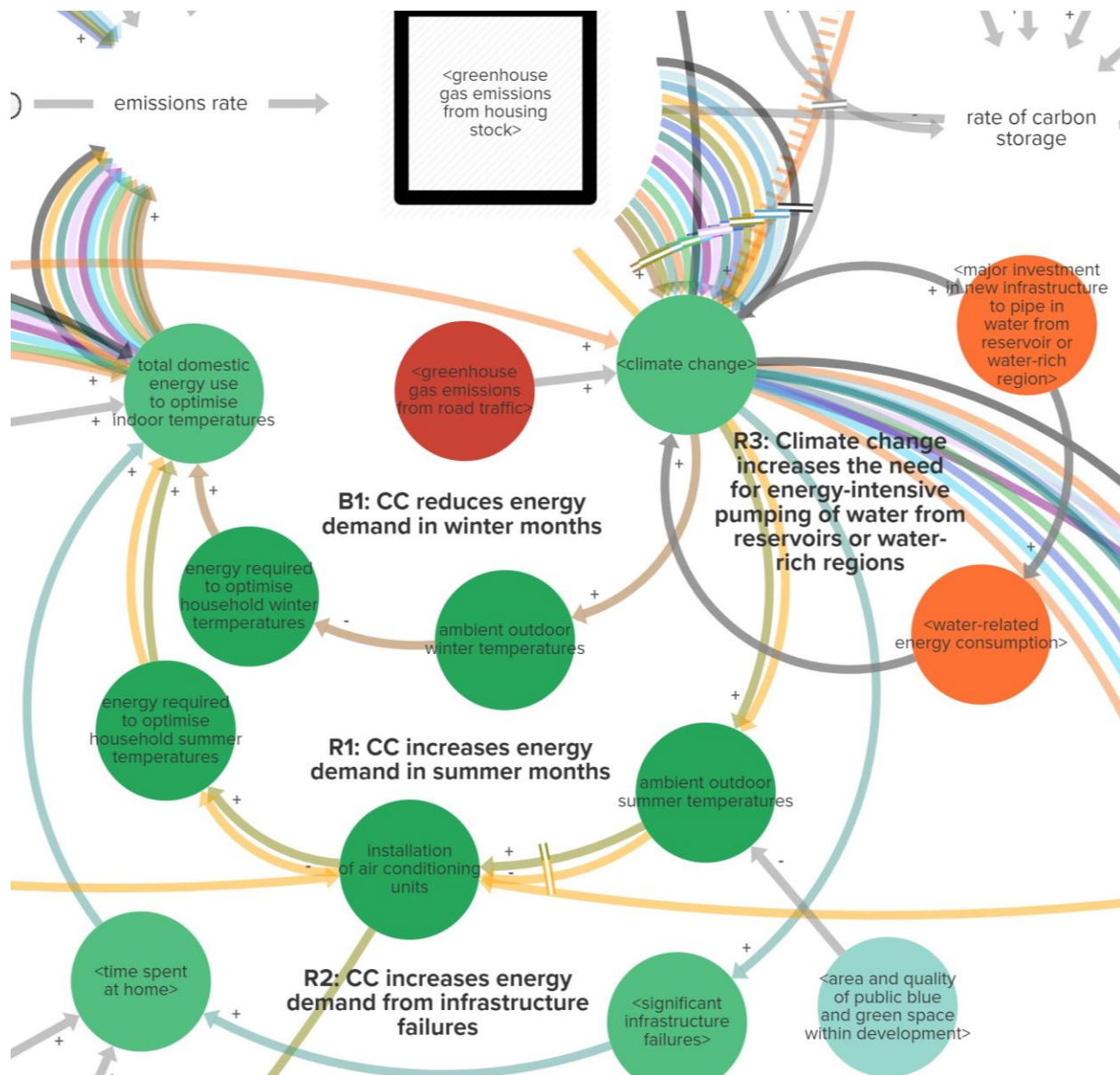


Figure 19: Examples of reinforcing and balancing loops from the 'Housing, Energy & Climate change' subsystem model

Delays in causal links, such as the one between accumulating emissions and climate change, are shown as double lines through the arrows (see arrows connecting "<greenhouse gas emissions from housing stock>" to "<climate change>"). These delays can influence trends over time. For example, "significant infrastructure failures" may not occur immediately. By the time society has experienced these impacts and have chosen to respond, for example by retrofitting homes to make them more energy

efficient (see balancing loops B4 through B6 in the online model), it will have ‘overshot’ its emissions of greenhouse gasses.

One last feature of the model is that the electronic version has interview quotes embedded in the ‘description’ of some elements. To access quotes, simply click on elements. If the description box does not appear as a panel on the left-hand side of the screen, as in the top image of Figure 20, click on the three dots on the far left-hand side of the screen (see dots circled in red in the bottom image of Figure 20). The two quotes embedded in the description of “<area and quality of public blue and green space within development>” refer to the causal links between blue/greenspace and (i) air quality; (ii) carbon sequestration; (iii) nature conservation/restoration; and (iv) mental health. The literature review revealed a fifth, -ve relationship with “ambient outdoor temperatures” as modelled in Figure 19. Unlike interview quotes, citations were not systematically embedded in the model – a shortcoming resulting from time limitations.

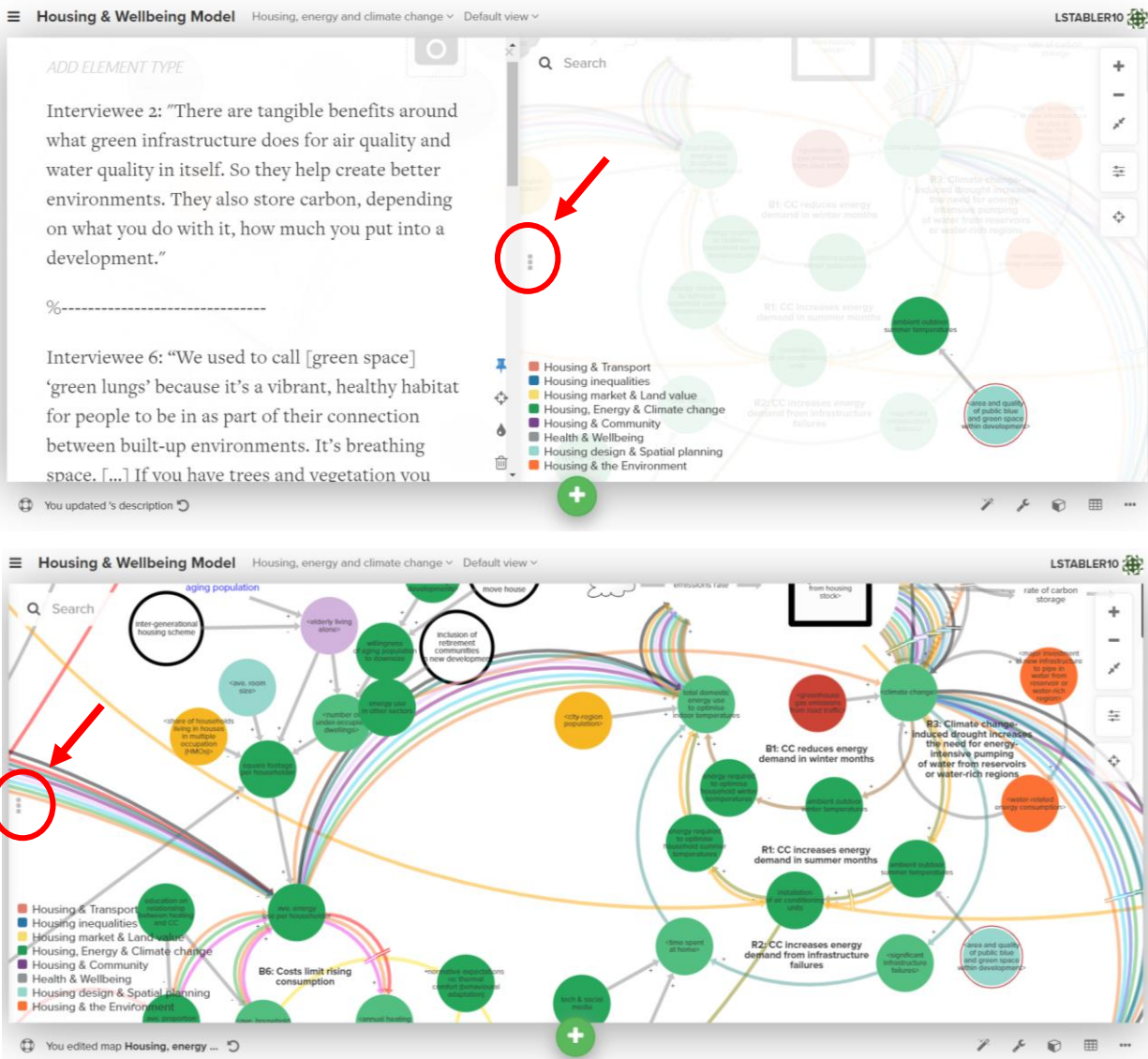


Figure 20: Accessing quote embedded in the online Kumu model

### 5.3.2 Model overview

The 'GCGP Housing and Wellbeing Systems Model' is divided into eight, interconnected subsystem models, or themes having emerged from an inductive analysis of SDM literature and interview data (see Figure 21). The dense web of interconnections suggests that an intervention taken in one subsystem is likely to impact outcomes in others. Whilst most subsystems were found to be connected via causal chains running in both directions, occasionally causal chains were found to only run in one direction (e.g., from



‘Housing design’ to ‘Housing inequalities’). The relative thickness of this arrow indicates the relatively large number of causal links connecting the two subsystems. By comparison, the arrow running from ‘Housing & the Environment’ to ‘Housing Inequalities’ is relatively thin, as only one causal chain was identified (see Figure 21).

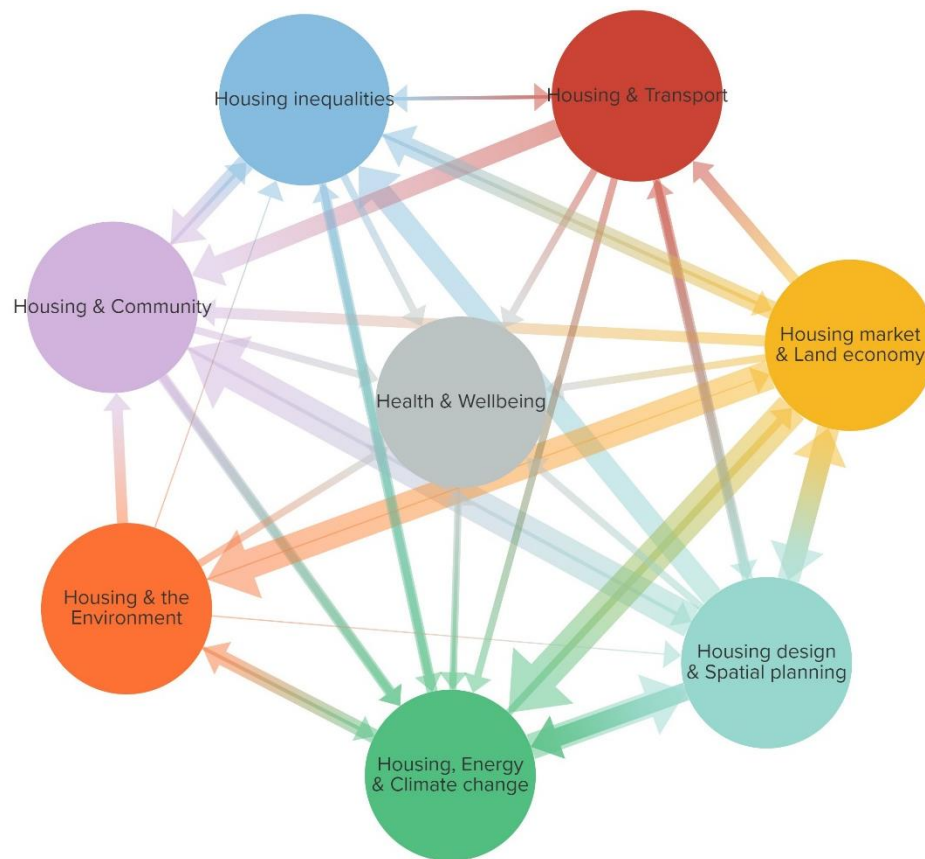


Figure 21: Overview of subsystem models and their close connections

When interpreting Figure 21, the width of each connection should be understood as representing the *frequency*, or number, of connections identified by interviewees and the literature reviewed. For example, the arrow running from ‘Housing & the Environment’ to ‘Housing Inequalities’ is very thin, as there was only one causal chain identified by interviewees in this direction.

The thickness of arrows in Figure 21 should not be misinterpreted as representing the *significance* of causal relationships. The small number of thin arrows stemming from the ‘Housing & the Environment’

subsystem does not suggest that its impact on other subsystems is minimal. Societal systems (e.g., housing and transport) would collapse without nature – as all human systems are embedded within the natural world and thereby constrained by environmental limits (Cato, 2009, Meadows et al., 1972). The dependency of communities, energy, etc. on nature is not fully represented in the model. This is, in part, due to the system boundaries set at the early stages of the research project, as well as the system boundaries informing SD models analysed as part of the literature review. As well, the modelling exercise is limited by the knowledge and expertise of interviewees. Figure 21 should thus be interpreted as representing the density of interlinkages identified within this particular co-modelling exercise, which might be interesting to compare with other projects seeking to model the relationships between housing and long-term wellbeing. Figure 21 also excludes feedbacks identified between subsystems. These are presented in the summaries of each qualitative, subsystem model including “Housing & the Environment” in Section 5.3.3 and the remaining subsystem models in Appendix D.

Together, these qualitative models are composed of 964 elements, or variables; 3277 connections; and 121 feedback loops. Individual subsystem models range in size from five feedback loops to thirty feedback loops (see Table 6 for a full list of model dimensions). The number of subsystem interlinkages is significant. Around 1/3 of all elements link into another subsystem model, meaning developments in the subsystem from which they originate may affect developments in interlinked subsystems. Because the HEW model formed the base of the GCGP model, its parameters are similar. The HEW model was developed by a team of researchers at the University College London’s Energy Institute (Eker et al., 2018) and used as the base model for this project. However, the scope of the GCGP Housing & Wellbeing project extended beyond ‘housing and energy’ to include relationships between the housing system and accessibility, road congestion, social isolation, heritage conservation, nature conservation, and social inequality stemming



from unequal access to good schools, job market, training, and essential services. The parameters of the GCGP model are thus broader than those used to create the HEW model.

In the GCGP Housing & Wellbeing model, the ‘Housing Inequalities’ and ‘Housing market and Land economy’ models are relatively large (17 and 23 feedback loops respectively) as they combine multiple subsystem models from the HEW model (plus additions from stakeholder interviews). By comparison, variables and relationships modelled in the ‘Housing & the Environment’ subsystem were only informed by stakeholder interviews (5 feedback loops). The larger ‘Housing & Transport’ subsystem model was informed by stakeholder interviews and the ‘Road expansion, Traffic congestion and Air pollution model’ in Armah et al. (2010). The ‘Housing, Energy and Climate Change’ subsystem model is significantly larger than the others. Upon reflection, I believe this developed due to my own curiosity and expert knowledge in this area – resulting in more interview prompts around energy and climate change as well as finer specification made during modelling.

The final subsystem model, ‘Housing & Wellbeing’, varies significantly from the other seven in that the number of linear connections feeding into the subsystem far exceeds the number of connections forming feedback loops. This is due to the opening interview question, which leads interviewees to *end* causal chains at wellbeing. This is why the ‘Health & Wellbeing’ subsystem is placed at the centre of Figure 21). Because the “Housing & Wellbeing” subsystem is large and mostly composed of linear causal chains, its presentation is excluded from the thesis. However, it can be viewed on the online Kumu model<sup>19</sup>.

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<sup>19</sup> <https://kumu.io/Istabler10/housing-wellbeing-model> and <https://kumu.io/Istabler10/housing-wellbeing-model-CLDs-only>

Table 6: Dimensions of the GCGP Housing & Wellbeing systems model

HEW maps	GCGP subsystems	# Feedback loops	# Elements	# Connections
	1. Housing & the Environment	5	107	191
1. Community connection and quality of neighbourhoods	2. Housing & Community	12	161	312
2. Energy efficiency and climate change	3. Housing, Energy & Climate change	30	184	472
3. Housing affordability 4. Household crowding 5. Fuel poverty and indoor temperature	4. Housing inequalities	17	204	521
6. Land ownership, value and development patterns 3. Housing affordability	5. Housing market & Land economy	23	293	575
6. Land ownership, value and development patterns	6. Housing design	11	188	615
	7. Housing & transport	14	100	223
7. Ventilation and indoor air pollution	8. Housing & Wellbeing	9	215	368

When describing the relationships between housing and wellbeing, interviewees mostly focused on individual and community wellbeing and only seldomly considered family wellbeing. Two interviewees rejected a human-centric definition of wellbeing and sought to consider the impact of housing in the UK on the wellbeing of all life.

*"I fundamentally believe that green infrastructure is important because nature is important per se.*

*You don't have to put a value on nature in terms of its importance to human beings. We share the*

*planet with nature, and therefore we should respect it in that way. [...] It has a value in itself."* –

Interviewee 2

In each interview, stakeholder representatives tended to focus on structural influences, e.g., policies, market dynamics, cultural norms and material factors that either have a direct impact on wellbeing (e.g., by creating environments that are directly beneficial or harmful to health and wellbeing) or that have an indirect impact by influencing human behaviour in ways that are conducive or detrimental to wellbeing. In other words, less attention was paid to individual choices than to structural determinants of these choices.

Moreover, the distribution of wellbeing across different groups in society (including across income, ethnicity, and generation) was a major focus of nearly every interview. This represents a commonly held concern over social inequality amongst interviewees but, as well, the common perception of housing in the UK as a system that *produces* inequality through a number of reinforcing feedbacks featured in the ‘Housing inequalities’ subsystem model. Several participants thus concluded that interventions should be evaluated based on their ability to produce *equitable* outcomes for future wellbeing:

*"Everyone has to balance their own interests against those of other people. If we're going to have strong communities, it can't be about my wellbeing and not yours, because then one could be at the expense of another."* – Interviewee 3

*"If your own wellbeing is at the expense of somebody else's wellbeing, then I'd question whether that can be valid; i.e., if your wellbeing was based on the number of slaves you had, I'm not entirely sure if we've got the balance right there."* – Interviewee 2

‘Housing inequalities’, along with six other subsystem models, are presented in the following subsections. The models can be seen as a collective theory about the way the region’s Housing & Wellbeing “system” works at the aggregate level. Although this aggregate level may prevent the exploration of many specific policies, subsystem models can be further specified by stakeholders working in each sector. The purpose

of this model, however, is to facilitate systems learning and high-level decision-making, amongst a diverse group of stakeholders participating in Transition Management.

To achieve this goal, a shared understanding of the most important feedback structures is needed. As such, the multi-stakeholder workshop did not introduce the full model, as is available on Kumu. Some of the linear causal chains, within and across subsystem modes, were excluded, and the presentation of subsystem models rather focused on the feedback loops. This decision was taken to “support learning and understanding about [...] complex feedback structures”, and “emphasise that it is these structures that are likely to determine trends over time” (Macmillan et al., 2014, p. 9). The presentation of causal maps in this thesis (Section 5.3.3 and Appendix D) follows the strategy. The text accompanying each causal loop diagram describes the feedbacks and presents supporting quotes from stakeholder interviews.

### **5.3.3 The ‘Housing and the Environment’ subsystem**

The ‘Housing & the Environment’ subsystem model contains one balancing and five reinforcing feedback loops operating between housing, climate change, and natural environments in the GCGP region and beyond – all of which are presented in this subsection. Although many individual relationships embedded in this model came from the UCL Housing, Energy and Wellbeing project – the vast majority are unique and additional to the HEW model.

The CLDs presented in this subsystem detail the impacts of housing development on nature and the co-evolution of nature and climate (Section 5.3.3.4). Although nature is self-organising and resilient (Section 5.3.3.1), external pressures, such as extreme weather events, pollution and land development, can trigger downward spirals that threaten biodiversity (Section 5.3.3.2). In turn, the degradation of nature threatens human wellbeing, as we rely on ecosystem services (e.g., for the provision of water). These pressures can be partially alleviated through technological innovations (e.g., greywater recycling) and through socio-cultural innovations (e.g. water-saving practices) but are outweighed by inward migration

and global warming from locked-in emissions (Section 5.3.3.5). When responding to these pressures with energy-intensive, technological solutions, society reinforces environmental degradation in the mid- to long-term by emitting greenhouse gas emissions (Section 5.3.3.4).

#### **5.3.3.1 R1 nature creates its own abundance**

The first feedback loop, identified by GCGP interviewees, resulted from conversations about nature's ability to create abundance and "biodiversity" over time – with the awareness that this abundance and diversity has been dramatically reduced locally over a short timescale, mainly due to land use change for agriculture, industry, housing and transportation infrastructure. The two dashes on the link to "biodiversity" in the centre of Figure 22 represents the longest time delay in the GCGP Housing & Wellbeing model, dependent on the conservation of natural habitat. The reinforcing feedback loop between "biodiversity" and "quality of the natural environment" is based on resilience theory, or an understanding that ecosystems thrive when there is a greater diversity of plant and animal species and associations, as they are more resilient to system pressures (e.g., plant diseases and invasive species).

High quality natural environments also do a better job of storing water and filtrating pollutants, helping to maintain a healthy natural environment (see two remaining feedback loops). In other words, quality natural environments are self-sustaining. This reinforcing loop can also drive the decline and potential collapse of natural environments if there are too many pressures (e.g., pollutants or land use change). Some of these pressures are shown in Figure 22, such as pressures on water and air quality from biomass burning", "municipal and industrial waste burning", and a rising "<[...] population>" (e.g., "water consumption", "sewage", "diffuse pollutants", air pollution from increased traffic, and loss of habitat from the "<development of greenfield land>").

*"Protecting and enhancing our water environment is absolutely crucial, and we know that the growth we have seen so far and how we have developed in this region has had a real impact on the*

*natural environment. [...] We need to leave more water in the environment rather than abstracting it for the need of growth.” (Interviewee 8)*

*“The increase in sewage and the increase in runoff from urban areas and all those things has to be regulated by the natural environment and our river systems. [...] It’s that receding water course that sits downstream of the sewage treatment works... Has it got capacity in it to actually treat and absorb [increasing] input?” (Interviewee 8)*

Figure 22 also shows the mitigating effects of “<environmentally sustainable site selection>”, “<quality landscape design>”, the “<provision of SUDs>”, “<land allocated for allotments>”, and “habitat management, maintenance and restoration”.

*“If you have trees and vegetation you have habitat, if you have habitat you have invertebrates, insects, [...], really, a thriving ecosystem.” (Interviewee 6)*

*“[Quality landscape design means] aesthetic quality, functionality for people and nature, e.g., supports biodiversity via choice of vegetation, permeability, etc., stores and filters water naturally, natural drainage to prevent flooding, and drought resistant.” (Interviewee 5)*

*“There are tangible benefits around what green infrastructure does for air quality and water quality. They help create better environments. They also store carbon, depending on what you do with it, how much you put into a development.” (Interviewee 2)*

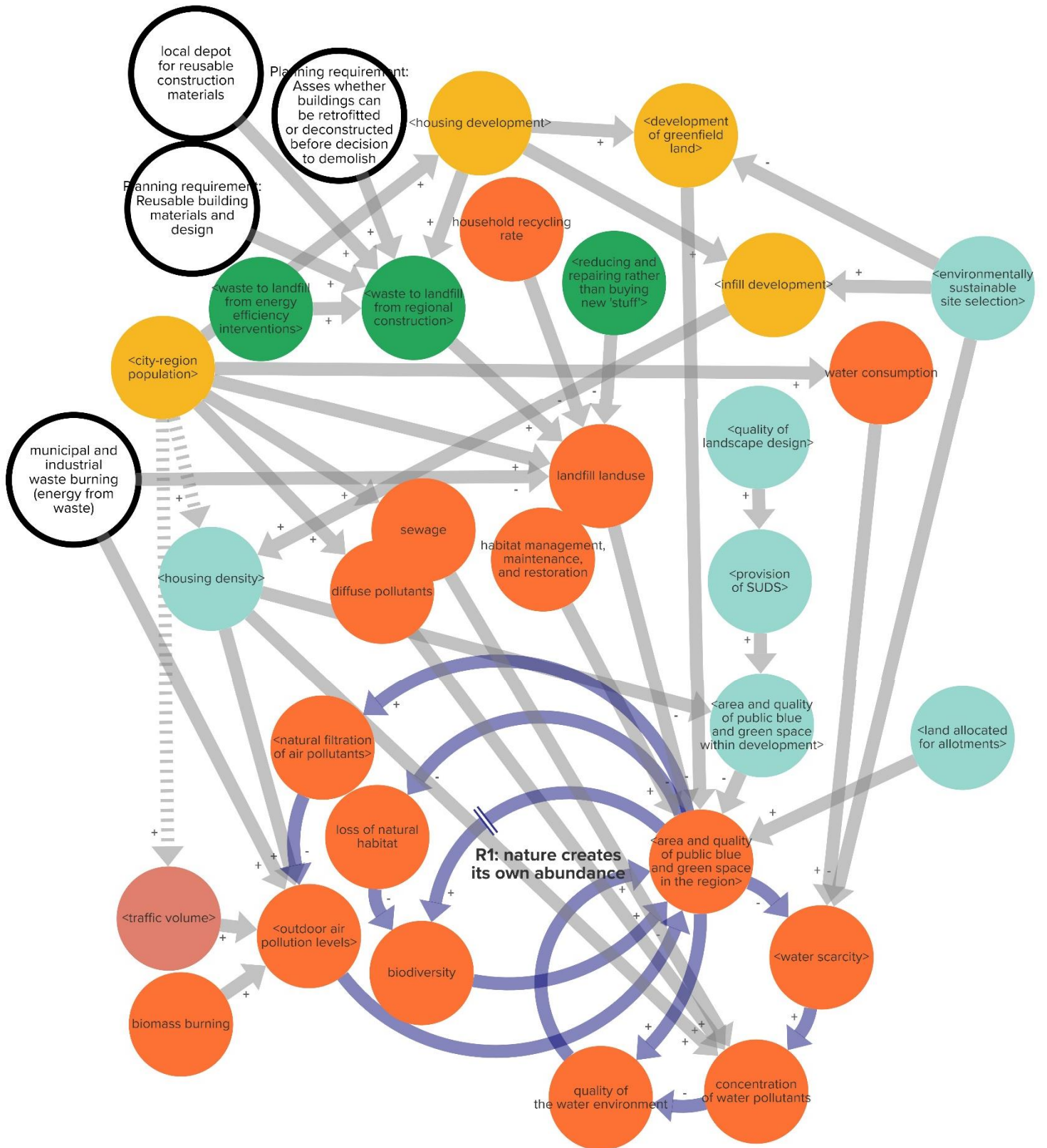


Figure 22: R1 nature creates its own abundance

In this subsystem model, densification (“<housing density>”) is shown to have a negative effect on the environment through pressures on greenspace in urban areas and a higher concentration of pollutants; however, causal links running through other subsystem models (e.g., transport) show positive impacts of densification, such as the prevention of urban sprawl and modal shift from private car use to public transportation and active travel. Densification also helps reduce pressures for greenfield development, helping preserve natural habitats that might have been established on, e.g., disused farmland, and supports the economic feasibility of renewable heat systems.

*"[The provision of quality green space and leisure sites] comes down to density as well. [...] Over time, the amount of space between houses [...] has significantly been reduced." (Interviewee 5)*

*"The big push to raise housing density in the early 2000's seems to have gone away now [...], and I think that is good in some respects and not so good in other aspects. I think it was really good on sustainability and environmental terms. For instance, travelling distances came down in some settlements" (Interviewee 13)*

Land pressures from the waste is also considered in the model. Higher “household recycling rate[s]” and “<reducing and repairing, rather than buying new ‘stuff’>” would, in theory, reduce “landfill landuse”. However, there is still the issue of industrial waste. Three interventions, that could theoretically support a transition to a circular construction economy, are proposed to lower waste from construction – namely, a “planning requirement [to] assess whether buildings can be retrofitted or deconstructed before [demolition]”; a “planning requirement [to use] reusable building materials and design [in all newbuilds]”; and for local government to establish a “local depot for reusable construction materials”.

Echoing findings from the preliminary systems analysis, some interviewees vocalised their concern about the lack of natural abundance in the region and recognised the toll that inward migration and housing development continues to have on the local natural environment.



### ***5.3.3.2 R2 flood risk and environmental degradation are positively reinforcing***

The second CLD in the 'Housing & the Environment' subsystem model considers the reinforcing loop between environmental degradation and flooding. During rainfall events, nature manages the movement and storage of water. High quality (and quantities) of blue and green spaces reduce flood water quantity, thus reducing flood risk (see the inner reinforcing feedback loop in Figure 23). Without natural or artificial water management system (e.g. SUDs), sewers can overflow during flood events and contaminate the environment with "[...] pollutants" such as nitrogen, sulphur, bacteria, microplastics and even pharmaceutical substances. These pollutants reduce the environment's functioning and future performance in rainfall events.

This inner feedback loop is directly related to the outer feedback loop in Figure 23. As flood risk increases, those in flood zones "take actions to relocate [...]", creating "<pressure to develop on urban green space>" or "<[...] greenfield land>". This land use change reduces the permeability of developments and the wider region, thereby increasing the risk of future flooding. A similar feedback loop, not shown in this findings section, is "R5 self-reinforcing climate change via the relocation of housing in flood zones", which models the reinforcing relationship between climate change, flooding, the displacement of communities, and environmental degradation from housing development.



Figure 23: R2 flood risk and environmental degradation are positively reinforcing

Figure 23 also shows a number of factors effecting “<environmentally sustainable site selection>” for housing development. One factor, considered to *negatively* impact sustainable site selection, was “political commitment to the ‘growth agenda’”:

Interviewer: *"Why do you suspect local authorities aren't taking much notice of which environments are more vulnerable [and thus poorly suited for growth]?"*

*"Well, [...] clearly [they] want to be seen as growth areas. If someone comes along as says you can't develop there, you can't grow your district your region because the environment won't allow it, they're not going to go away and say, 'Thanks, we gave it our best shot, but we won't bother growing, we won't bother developing'. They will say we need to find ways of making it happen. And that's a challenge. That's when, as a region, because we don't have natural resources which (a) satisfy the demand we have already and (b) [can handle] growth in the future, that's when we need to start thinking about bringing water resources in, so from other parts of the country, it's when we start thinking about significant infrastructure to handle that."* (Interviewee 8)

Although the growth imperative was cited in several interviews, only one interviewee recommended that something should be done to alter it:

*"I truly believe we need to move on from capitalism and find a new paradigm to live in which has got greater harmony. It has to be an environment-led economic model as the model at the moment doesn't really account for the environment and its resources and I think it'll be a strong part of any future economic model."* (Interviewee 12)

The second factor said to negatively impact sustainable site selection was the abolishment of regional development agencies in 2010 and the associated "loss of evidence base [...]" underpinning a spatial strategy being developed by the East of England's regional government.

*"I think we've moved from a position, even from recent past, of having a regional tier of government (development agencies) who actually worked on regional spatial strategies and started to bring all this evidence together, and started to map out across the whole of the east England [...] where some*

*of these issues were. [...] But then we lost [the regional government] and [...] all this work that would have been done to build that evidence base [...] went overnight."* (Interviewee 8)

On the other hand, three factors were cited as potentially having a *positive* effect on sustainable site selection, namely, "Anglian Water[']s partnership with UEA", local authorities' "consultation with water agencies and [the] Environment Agency at early stages of planning" and the "Combined Authority[']s forthcoming] non-statutory spatial plan". One interviewee explained how the water company's partnership with UEA could help improve site selection:

*"Anglian Water are working in a partnership with UEA. [...] They are starting to map where the challenges and opportunities potentially lie. They are starting to build some GIS layers of challenges and opportunities [that] it is starting to add some of the detail [around the natural capital benefits to local inhabitants] that people take for granted. [...] I think [these GIS layers] would be very useful to developers and local authorities to say, 'Actually, that may not be the best place to develop' and 'these are all the added benefits we can get from the environment [if we develop at another location]'. "* (Interviewee 8)

Interviewees were uncertain of the potential impact of the Combined Authority's Non-Statutory Spatial Plan (see question mark in Figure 23). The spatial plan focuses specifically on new towns and was created to support delivery of economic and infrastructure growth agreed to in the region's devolution deal with central government.

*"The spatial plan will focus on additionality - what one might describe as 'threshold sites', which are sites that might be bigger or might be stalled."* (Interviewee 1)

*"The new mayor of the [Cambridgeshire and Peterborough] Combined Authority, and others, have put together a plan for a garden town... there are 10,000 houses and part of the reason for that is*

*they recognize that the congestion and the pressure of house prices is so much greater around South Cambridgeshire."* (Interviewee 11)

The plan is guided by the principals of “inclusive growth” and “net environmental gain” – the latter of which includes “addressing strategic water issues (flood risk and supply), green infrastructure, open spaces and biodiversity, pollution, clean energy and climate resilience in line with the climate risks outlined in the UK’s Climate Change Risk Assessment” (CPCA, 2017, p. 13). However, no trade-offs between the plan’s strategic priorities (e.g., economic growth, housing affordability, accessibility, and environmental net gain) are considered in the plan, and no limits or ‘hard lines’ are drawn to ensure that growth is sustainable. Moreover, the plan is non-statutory, so it is unclear what its impact it may have on the region’s Local Plans.

*"[Much like the Quality Charter,] the aim of the non-statutory spatial plan isn't to impose it, but to guide development. You try to get each of the six Local Authorities to [...] apply [it] to all major development sites."* (Interviewee 1)

The implications of growth-oriented spatial planning (i.e., the implications of prioritising development where it can most significantly improve affordability and accessibility) are not shown in Figure 23, but rather in the “Housing Market and Land Economy” subsystem model. Growth-oriented spatial planning increases inward migration, water demand, water scarcity, and the concentration of pollutants. Increased water demand, pollutant concentrations, and the development of greenfield land all contribute to a degraded natural environment, thereby increasing flood risk.

#### **5.3.3.3 R3 society responds to climate change with energy-intensive interventions**

R3 of the “Housing & Environment” subsystem model is simply a more detailed version of R3 of the “Housing, Energy & Climate change” subsystem model, which describes the reinforcing relationship between climate change and water scarcity.

Much like the reinforcing feedback between flooding and environmental degradation (R2), environmental degradation increases the risk of drought and vice versa. (see negative links feeding back between “frequency and severity of drought” and “<area and quality of blue and green space in the region>” in Figure 24). When the environment degrades, the “Environment Agency reduces water company’s abstraction permits”.

*"The Water Directive actually drives [the Environment Agency] to reduce the amount of water companies can actually take. They'll have a licence which permits them to take a certain amount of water per day. If that is having an impact, [the agency] will reduce that quantity down to what [they] think could be a sustainable level. But then that has a big impact on security of supply [...]. So that is when [water companies] may need to think about other sources."* (Interviewee 8)

This leaves companies with no other choice than to make “<major investment[s] in new infrastructure to pipe in water from reservoir[s] or water-rich region[s]>”. Such interventions require a substantial amount of energy, embodied and operational, whose contribution to climate change depends on the carbon-intensity of energy used to extract minerals, manufacture building materials, develop new infrastructures, and operate them... as well as the land use changes associated with this societal response.

Not shown in Figure 24, is the reinforcing relationship between flooding and drought (via environmental degradation). A downward spiral is prevented by nature’s ability to repair itself (R1). Land development and climate change, however, can push this self-sustaining system past its tipping point – ramping up the severity and frequency of drought and flooding events and related environmental damage.

*"[The East of England is] the driest region by some distance. Climate change will make that pressure more significant going forward. The fact that we are a very flat region as well makes us more susceptible to extreme weather and flooding. We got the polar opposites really of not having enough water to go around for supply, to, often having too much water to cope with and having*



*houses would be flooded, a lot of people would have to move, a lot of people moving in from elsewhere.” (Interviewee 11)*

Much like constructing reservoirs and moving water, “desalination” and “<housing development>” are energy-intensive interventions. Again, to the extent that this energy emits greenhouse gasses, the societal response to coastal flooding reinforces future climate change.

#### **5.3.3.4 R4 self-reinforcing climate change (via environmental degradation)**

Because the natural environment is a carbon sink, and its degradation from climate-change induced “<water scarcity>”, “saline intrusion”, and “<[...] contamination>” is self-reinforcing. This happens at both the local level (“<area and quality of blue and green space in region>”) and global level (“<global environmental degradation>”). Environmental stewardship, such as the “[Peterborough Environment and City Trust’s] initiative, ‘Forest for Peterborough’”, can help mitigate some of this degradation and restore natural carbon sinks. However, due to the historic over-development of UK land and global supply chains, the region’s residents degrade natural carbon sinks more through their consumption of imported goods (e.g. construction materials) than through domestic actions, such as the conversion of farmland to new towns. This is why “<reducing and repairing rather than buying new ‘stuff’>” is included as a key element in this CLD (see Figure 25).

Towards the bottom of the CLD, the element “<pressures from climate change and environmental degradation on human wellbeing>” is modelled, which feeds into the “Health & Wellbeing” subsystem model. Some pressures include “water scarcity”, “<interruptions to clean water supply>”, the increased “cost to clean drinking water” “[...] food supply [shortages]”, and the increased “cost of flood damage”. There are also unknown pressures related to rapidly diminishing biodiversity (Hayhow et al., 2019). These pressures were considered to impact the wellbeing of individuals, households and business:



*"The provision of some of these services is [also] to business. Businesses also rely on an uninterrupted supply of water to generate jobs, to be able to provide income for families [...]. Access to clean water is not only relevant for individual personal health but as well for the health of the local economy" (Interviewee 8)*

In summarising the links between housing, nature, and wellbeing, one interviewee said:

*"If our wellbeing is at the expense of nature and the environment, (1) I think that is probably morally wrong, and (2) I think that probably comes back to bite you anyway. Because we are embedded within this larger [natural] system, our wellbeing is dependent on the wellbeing of nature."*  
(Interviewee 8)



#### 5.3.3.5 B1 consumers respond to climate change by consuming less water

As the climate natural environment co-evolve (R4), experts anticipate significant “<water scarcity>” in the East of England with acute shortages expected for the city of Cambridge (see Figure 26). Not only will this trend degrade the “quality of the water environment”, it will also lead to a higher “wastewater [to] abstracted water ratio” via the “reduction in water abstraction licenses”. Both outcomes – a degraded water environment and a high wastewater to abstracted water ratio – increase the “cost to clean drinking water” and require “<major investment in new infrastructure to pipe in water from reservoir[s] or water-rich region[s]>”.

*"Water companies have to make significant investments, which is what they are planning for now for the next 5-year cycle into improving those discharges and putting better technology in order to reduce the pollutant loads going into the water environment." (Interviewee 8)*

In theory, this should result in an increase in “<annual water bill[s]>”, which could incentivise behaviours, such as “retrofit[ting] rainwater harvesting system[s]”, that reduce “water consumption” in the region. However, “Ofwat pricing regulation” pins the price of water to wages, not to rising operational and investment costs associated with the supply of clean drinking

*"The water industry has delivered an awful a lot of massive environmental improvement over the last 20 to 25 years since it has been privatised. [...] Customers have seen their bills go up a bit over that time. More recently they have been kept flat because of the economic climate that we live in. We are in a situation where wages don't go up, and utility bills should shoot up and that's why it's difficult." (Interviewee 8)*

Because this balancing loop is currently inactive, water companies are relying on other interventions, such as “[...] water metres” to “detect [...] leaks” and “algae [water treatment and energy production]”. Water companies are also investing in “education campaign[s] [...] to encourage water-efficient behaviour” – the

assumption being that a better “understanding of the value of water” can reduce household water consumption to levels similar to those found in countries such as Germany (Eurostat, 2019).

*"Some people will understand the message, especially if you invest a lot of time in actually explaining the whole story to them [...], but I think we're [only] scratching the surface. [...] I think a lot of people have lost that understanding of exactly where our water comes from. If we don't tackle some of these problems, then our water will be being piped in from all over the place. We are looking at long term solutions to some of the water resource issues in this region... about tanking in water from Scandinavia in massive ships. And that to me is incredible... that that could be seen as a viable option. It beggars belief, and I'm not sure that people have any understanding that that is the future that we are very close to. " (Interviewee 8)*

If these campaigns are successful, and/or Government reforms regulation around water pricing, the subsequent reductions in water consumption relieve some of the pressures on the water environment and water companies, and can even reduce “water-related energy consumption [and emissions]” that further reinforce water scarcity via “<climate change>”.

However, the balancing effect of significant, but small, reductions in water consumption can easily be outweighed by a rising “<city-region population>”. This is why the “<water efficiency of newbuilds (incl. rainwater harvesting)>” is so critical, as well as “< “inclusive growth” across [the] region>” to take some of the stress off Cambridge city’s water environment.

*"Of all the areas in this region, Cambridge itself has the biggest pressure on the natural resources and the availability of water. [...] We know that the sort of current way of operating and current [underground water] extraction rate [in Cambridge] are having an impact on the environment. So therefore, we need Cambridge to leave more water in the environment and not extract as much. [...] We are just about at the peak [water abstraction] now." (Interviewee 8)*



interview data required an additional 850 hours. The process of integrating individual causal maps into the group mode was a highly tedious process requiring hundreds of revisions each time an interview's data was integrated. The online Kumu application was a useful aid in creating and editing the group model and should have been used from the outset to ensure that the final group model was publicly accessible.

Having made the decision to set broad model parameters, I had to devote ca. 200 hours to the model's literature review. This literature review was additional to my review of TM literature from which my research questions were drawn. Because the parameters were broad, stakeholders can explore the many ways in which the housing system impacts upon wellbeing *through* its interaction with related sectors. The output was a very large, qualitative systems model with 964 variables, 3277 connections, and 121 feedback loops.

With 284 subsystem interlinkages, many of which form feedback loops *between* subsystems, the co-constructed model illustrates the level of complexity involved in intervening in the housing system to improve or secure future wellbeing. This model could be used to investigate the unintended consequences of stakeholder-proposed interventions on future wellbeing, as outlined in Chapter 6, Section 2, and to help produce a list of trade-offs for further consideration. Furthermore, with few adaptations, the model is transferable to other rural-urban English subregions, and with moderate adaptations, to strictly urban areas. The model is open-access and can be viewed by anyone with an electronic device and internet connection. Those wishing to adapt a copied version of the model can also do so free of charge, making it a material contribution to the study of urban sustainability and qualitative systems modelling.

Whilst interviewees appreciated the mind mapping exercise, frontrunners having attended the co-modelling workshop found it difficult to review and further contribute to such a large model. The difficulties associated with reviewing and working with such a large model, discussed further in Section 6.6.1, highlight

the benefit of drawing more limited model parameters, such as those employed in the UCL Housing, Energy and Wellbeing project.

Limiting model parameters would have reduced the analysis time. For example, expanding parameters to include “Housing & Transport” and “Housing & the Environment” added 185 variables and 20 CLDs to the group model. Though, even within the themes of the HEW model, my literature review and interview data yielded larger causal maps. For example, HEW’s “Community connection and Quality of neighbourhoods” causal map contained 46 variables, and my very similar “Housing & Community” causal map contained 143 variables. This increase is to be expected when new interview data (from 20 GCGP stakeholder interviews) is added to an existing model (from 30 HEW interviews). Similarly, HEW’s “Energy efficiency and Climate change” causal map contained 156 variables and 15 feedback loops; whereas, my “Housing, Energy & Climate change” map contained 266 variables and 34 feedback loops. This more significant jump is owed, in part, to a new dimension having emerged from my literature review of renewable heat transitions. This all goes to show that the model parameters, number of stakeholders interviewed, and breadth of literature covered in the literature review all determine the resulting model size.

It is important to note, however, that even smaller models, such as the HEW model, require a significant investment of time to develop – time that is typically only available to academics. As such, a purposive governance framework, of which systems co-modelling is a component, would require the continued funding and involvement of academics.

The next chapter explores how the GCGP model, constructed over a two-year period, was utilised in a multi-stakeholder workshop to facilitate systems learning. Group analysis of the model was also meant to replace back-casting and facilitate the design and selection of transition experiments. However,

this second purpose of the group model was not realised, as the multi-stakeholder workshop was significantly curtailed for reasons explained in Section 6.2.5.



## 6 CHAPTER 6: FINDINGS FROM THE FRONTRUNNER WORKSHOP

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### 6.1 INTRODUCTION

This chapter's objective is to provide insights from an extra-scientific community regarding the prospects of (1) mobilising local stakeholders around an *iterative*, co-governance process in the form of multi-stakeholder partnerships prevailing beyond a single initiative, and (2) integrating participatory systems modelling and analysis into multi-stakeholder partnerships to facilitate a systems approach to the design, selection, and monitoring of local initiatives.

New empirical evidence from the frontrunner workshop, in which local stakeholders participated in a systems model-led deliberative workshop, suggests (1) that stakeholders would find value in co-modelling at the design-stage of local initiatives, but that the process will lose value if it is *too* participatory; and (2) that the prospects for iterative co-governance are poor at the subnational level in the UK. To present these findings, and others, we summarise participants' reflections on the value of and barriers to multi-stakeholder partnerships in Cambridgeshire and Peterborough (Section 6.3); followed by their expectations regarding the value of and barriers to implementing an iterative process of 'learning-by-doing' and 'doing-by-learning' within a multi-stakeholder partnership (Section 6.4); their expectations regarding the value and limitations of inserting systems co-modelling into different phases of multi-stakeholder partnerships (Section 6.5); and, finally, participants' recommendations regarding the future use of co-modelling to inform public-private initiatives carried out by members of multi-stakeholder partnerships (Section 6.6). First, however, we introduce methods employed in this part of the research project (Section 6.2).

## 6.2 METHODS

In this section, I outline the methods employed in the frontrunner workshop, including the selection of workshop participants (Section 6.2.1); prioritisation of Causal Loop Diagrams (Section 6.2.2); facilitator recruitment and training (Section 6.2.3); the original workshop design, data collection, and analysis (Section 6.2.4); and the Modified research design (Section 6.2.5).

### 6.2.1 Workshop participant selection

Pulling from TM literature (Loorbach, 2007, 2010; Frantzeskaki, Loorbach and Meadowcroft, 2012), I created a purposive sampling frame with the following criteria: ‘Representativeness’; ‘Inclusivity’; ‘Niche Engagement’; ‘Sources of agency’; and ‘Openness to the transition process’. This resulted in the successful recruitment of 31 attendees (see Table 7). Due to recruiting difficulties and a high no-show rate of 36%, the workshop failed to meet all criteria from the Transition Management literature. Whilst under-representation did not negatively impact my ability to observe participants’ interactions with the model and one another, it did theoretically impair the ‘real-world’ impact of the project, as critical perspectives were missing from the discursive debate (see Table E2 in Appendix E for a list of missing stakeholders from the frontrunner workshop).

*Table 7: Frontrunner workshop participants*

Breakout Group	Organisation	Actor role
Housing & Transport (H&T)	Greater Cambridge Partnership	Management
	SME developer	Director
	Citizens’ lobby group	Director
	National transport charity	Management
Housing & Health (H&H)	Cambridge Institute of Public Health	Senior Research Associate
	The Centre for Diet and Activity Research, Cambridge University	Senior Research Associate
	Cambridgeshire and Peterborough Public Health	Management
	South Cambridgeshire District Council	Officer

<b>Housing &amp; Community (H&amp;C)</b>	Cambridgeshire County Council	Director
	SME developer	Associate
	South Cambridgeshire District Council	Officer
	Cambridgeshire County Council	Policy advisor
	Community projects consultancy firm	Artist in Resident
	Housing Association	Director
<b>Housing Market &amp; Land Economy (HM&amp;LE)</b>	Housing Association	Management
	Cambridge City Council	Councilor
	Rural housing enabler	Management
<b>Housing &amp; the Environment (H&amp;E)</b>	Anglia Ruskin University	Professor
	Environment Agency	Management
	Local environmental charity	Management
<b>Housing, Energy &amp; Climate Change (H&amp;CC)</b>	Anglia Ruskin University	Senior Research Associate
	South Cambridgeshire District Council	Councilor
	UK Department of Business, Energy and Industrial Strategy (BEIS)	Policy advisor
	Solar energy company	Director
	Community Interest Company	Director
<b>Housing Inequalities (HI)</b>	SME developer	Director
	Housing Association	Chair
	Cambridgeshire County Council	Management
	Cambridgeshire County Council	Policy advisor
<b>Housing Design &amp; Spatial planning (HD&amp;SP)</b>	Architecture Firm	Principal consultant
	Cambridge City Council	Officer

Due to the high no-show rate, note-taker observations and audio recordings from the ‘Housing and the Environment (H&E)’, ‘Housing Market & Land Economy (HM&LE)’, and ‘Housing Design & Spatial planning (HD&SP)’ groups were excluded from my analyse of “social learning and capacity building” (Loorbach et al., 2015, p. 60) – reducing observations to the five remaining breakout groups. Regarding the analysis of systems learning, I had to rely fully on workshop questionnaire responses for members of the three under-attended groups (H&E, HM&LE and HD&SP).

For transparency, the remainder of this section reports criteria from my purposive sampling frame that were not met as a result. Having spent over 100 hours corresponding with stakeholders over email, phone calls and in-person meetings, this section hopefully demonstrates the difficulty in fulfilling TM criteria in a one-off workshop.

With regards to *'agency'*, the vast majority of participants were either directors or in senior management roles within their organisations, meaning the group had quite a lot of decision-making power, collectively. However, I was unable to recruit any chief executives from local authorities – critical actors for enabling high-investment projects. Also, I successfully recruited only two individuals operating at both the local and national governmental level, with one having recently left the civil service. In theory, this reduced the group's agency both in terms of scaling up innovations and lobbying Government to establish a more supportive *'selection environment'* for innovations to succeed (Späth and Rohrer, 2012). Of equal concern was the marked absence of the CPCA. With the ability to pump-prime new housing developments, and with a remit on transport, the Combined Authority was considered by participants to be a key partner in any large-scale regional housing initiative.

With regards to the *'representativeness'* criterion, geographical representativeness for local government was inadequate, with only Cambridgeshire County, Cambridge City and South Cambridgeshire District councils having attended the workshop, excluding East Cambridgeshire, Fenland, and Huntingdonshire district councils. There was also a lack of representation from all identified stakeholder groups. For example, only two of the six registrants for the *'Housing & Environment'* group attended, with no-shows from the regional water company; Cambridgeshire Local Access Forum; Natural Cambridgeshire; and flood management departments within district councils. As well, only one of four architecture firms attended, meaning niche actors from building and landscape architecture were underrepresented at the workshop. Their knowledge, however, was not entirely missing from the workshop, as these stakeholders

contributed to the co-creation of the systems model via 1-on-1 interviews conducted earlier in the research project (see Table 5 in Section 5.2.2 for a list of interviewees).

With regards to '*niche engagement*', many of the individuals present are already engaged in niche activity; however, few organisations in Cambridgeshire fall fully within that category, such as the community-focused developer Igloo or the specialist mortgage company, Ecology. Rather, small-to-medium size organisations having engaged in some degree of niche activity were invited, based on the assumption that this activity signals managerial interest in and commitment to sustainable housing.

### 6.2.2 Prioritising CLDs

Some of the subsystem models contained over twenty CLDs – far too many to review in a single-day workshop. To prioritise and limit the number of Causal Loop Diagrams (CLDs) used in the workshop, I hosted a half-day focus group where sector experts were asked to prioritise the CLDs according to their understanding of interventions being proposed in each of their sectors. Although this prioritisation risks excluding CLDs that have a greater impact on system dynamics, it does reflect the reality of siloed decision-making and helps 'meet participants where they're at' in terms of the interventions they are promoting. Experts assigned smaller models of about ten CLDs easily reviewed their set of diagrams in the space of an hour. As such, I decided to cap the number of CLDs provided to each breakout group to ten.

Experts were also asked to 'sense check' the variable names for each CLD and give feedback on how best to facilitate the model review and editing activity. All language edits were accepted, excluding those with sector-specific terminology as not to hinder interdisciplinary working, and the following recommendations for the co-modelling exercises were adopted: (i) include an activity where participants are explicitly asked to consider the future and model in any significant factors that may emerge in the coming four decades; (ii) have participants add variables using sticky notes and draw linkages using pencils so they can easily make changes to the diagram and their own edits; and (iii) give participants time to 'take

in' diagrams, individually or in pairs, before editing them. In addition to running the half-day focus group, approximately 50 hours were devoted to the recruitment of experts, preparation of materials, incorporation of feedback into the workshop programme and the post-review editing of roughly 90 CLDs (8 CLDs per subsystem model).

Regarding the selection of reviewers, we pooled first from the list of workshop attendees, prioritising experts with both a professional and academic understanding of subsystems were prioritised. For example, the 'Housing & Transport' expert is a transport modeller, with a degree in transport economics, who also runs an advocacy group on local transport issues. However, because the half-day focus group was voluntary, experts with more spare time and interest in the project, in part, self-selected. In the case of the Housing Inequalities model, a practitioner and senior researcher reviewed the model together. Two reviewers – a professional who runs their own architecture practice and advises local policy and an expert at the Anglian Centre for Water Studies – were unable to attend the frontrunner workshop, but still contributed some edits to their CLDs.

### **6.2.3 Facilitator recruitment and training**

In order to improve institutional awareness of the 'GCGP Housing & Wellbeing' model and workshop outputs (e.g., the multi-stakeholder initiative proposals that were meant to be developed in the last workshop activity), it was decided that middle management representative from each local government be recruited to facilitate the breakout group discussions and co-modelling exercises. A second, related motivation was to create social links between local authority teams and any regional transition network that might have been established or further progressed at the workshop.

Recruiting local authority officers, however, proved to be a difficult task given the number of hours required for training. Training included:

- 1-hr online training

- Half-day pilot workshop
- 1-hr post-pilot phone call

A post-pilot phone call was scheduled for each facilitator to run them through changes to the workshop programme and to teach facilitators how to use the open-source modelling programme, Kumu, to access and review their CLDs prior to the workshop. One of the facilitators was hired on a 30-hr contract to act as a project assistant to conduct the post-pilot workshop phone calls and to try and fill participant cancellations 1-2 weeks before the workshop.

Despite spending approximately 80 hours trying to recruit local authority officers, this was only achieved for two of the eight breakout groups. Three were recruited from the pool of participants, one was a volunteer, and my doctoral supervisors filled the last two groups in their related areas of expertise, namely energy and the environment.

#### **6.2.4 Original workshop design, data collection, and analysis**

As discussed in *Chapter 3: Methodology*, the rationale for integrating participatory systems modelling into Phase 5 of the Transition Management framework is to generate hypotheses on the intended and unintended consequences of stakeholder-proposed interventions using the co-constructed systems model, as in Esensoy and Carter (2015) and Martone et al. (2017). This activity would replace back-casting which, I argue, facilitates linear theorisations around socio-technical development.

To build consensus around the system structure, participants were meant to edit the coproduced, qualitative, systems model; map their interventions onto it; then complete a ‘causal tree’ activity designed to uncover potential unintended consequences of proposed interventions. See Table E1 in Appendix E for a full list of originally envisaged workshop activities and their associated role (or “purpose”) in the research project.

Data collected during the workshop were meant to answer my eleven research questions (Sections 2.4.1 and 2.4.3). Regarding the theoretically motivated integration of systems co-modelling, four of the research questions were posed to investigate the benefits of and barriers to stakeholder-led, systems analysis as it was designed to be conducted in the transition arena:

- (1) How, and to what extent, did participatory systems modelling facilitate systems learning?
- (2) How, and to what extent, did participatory systems modelling facilitate social learning?
- (3) How, and to what extent, did participatory systems modelling help build consensus around 'system leverage points'?
- (4) How, and to what extent, did participatory systems modelling affect stakeholder buy-in?
- (5) How, and to what extent, did participation engender a sense of 'ownership' over the transition challenge and solution(s)?
- (6) How, and to what extent, did the frontrunner workshop help strengthen or initiate a new 'Transition Network' in Cambridgeshire and Peterborough?
- (7) What technical barriers arose during the co-modelling activities?

Regarding the use of the 'CPCA Housing & Wellbeing Evaluation Framework' to (i) mitigate stakeholder co-optation and (ii) ensure initiatives are informed by the values and preferences of those most negatively affected by unsustainable housing development, the following research questions were posed:

- (1) How, and to what extent, did the use of the Evaluation Framework [...] affect stakeholder buy-in to the transition experiments (i.e., multi-stakeholder initiatives)?
- (2) How, and to what extent, did the use of the Evaluation Framework affect the perception of process legitimacy by participating stakeholders?



- (3) Did the use of the 'evaluation framework' sufficiently steer outcomes? If not, why not (e.g., stakeholder co-optation, workshop design, etc.)?
- (4) What technical barriers arose when evaluating interventions against the 'Housing & Wellbeing Evaluation Framework'?

I do not assume that all of the intended outcomes of TM (e.g., a shared sense of 'problem ownership') can be achieved in a single-day workshop. However, I wanted to investigate whether the integration of systems co-modelling and the use of a prescribed Evaluation Framework positively or negatively affected these intended outcomes.

The methods of data collection and analysis, designed to answer the aforementioned research question, are provided in Table E3 in Appendix E. Whilst most of the data were to be collected during the workshop, some questions would have required a follow-up survey to be conducted four months after the frontrunner workshop; for example, to answer the research question: "Did the use of the 'evaluation framework' sufficiently steer outcomes? If not, why not (e.g., stakeholder co-optation, insufficient time to complete activity, workshop design, etc.)?"

#### **6.2.5 Modified research design**

A pilot workshop was scheduled three weeks prior to the actual workshop, with each facilitator attending as part of their training. This enabled the formation of two breakout groups to test the envisaged workshop agenda presented in Table E1 in Appendix E. The pilot revealed that the list of workshop activities was too large to tackle in a single-day workshop. As such, the workshop had to be reimagined, and the decision was taken to restrict the agenda to the following activities: (1) participants propose and rate interventions; (2) review and edit the qualitative 'Cambridgeshire and Peterborough Housing & Wellbeing'

model; (3) re-rate interventions; and (4) complete a post-workshop questionnaire (i.e., activities i-iv, viii, and xi in Table E1 in the Appendix E).

Restricting the workshop to these activities meant that the research objectives had to be significantly altered. First, participants were no longer able to conduct systems analysis via the ‘causal tree’ activity, meaning ‘systems learning’ was restricted to learning about the system’s structure and not dynamics. Second, the Evaluation Framework presented in Chapter 4 was excluded from the frontrunner workshop. As such, I was unable to observe how powerful actors responded to having their proposed interventions filtered out by a prescribed evaluation framework embedded with the values and preferences of visioning workshop participants.

As well, the key ‘action research’ objectives: (1) disseminate a list of proposed initiatives having resulted from the workshop; and (2) facilitate the formation or further development of a transition network committed to the delivery of sustainable housing – were aborted.

The amended process of stakeholder engagement, however, was still carried out and the impact of the co-modelling activities on systems and social learning were investigated. Unable to carry out my envisaged workshop, I added a ‘post workshop group discussion’ to the agenda to investigate a few hypotheticals. The first half of the discussion handled participants’ experiences with past multi-stakeholder initiatives in the region, including specifically the benefits of and barriers to working in voluntary partnerships. This discussion included the hypothetical question of whether or not local stakeholders would commit to an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ within a partnership framework. This question was posed, as theoretical literature from the Transition Management suggests that the iterative process of experimentation and systems learning is a necessary condition for transition (Kemp et al., 2007). These discussions were audio-recorded and transcribed after the workshop. An inductive thematic analysis was first carried out on note-taker notes to develop codes for group transcripts.

The second half of the discussion (also recorded and analysed) focused specifically on participants' experiences reviewing and editing the qualitative systems model. Furthermore, participants were asked to consider how the systems model could be of use to members of a hypothetical multi-stakeholder partnership. This discussion was limited by stakeholders' imaginations, as the causal tree activity was removed from the workshop itinerary, meaning participants were prevented from experiencing how the systems model could be used, in practice, to analyse proposed interventions. However, their past experience participating in local multi-stakeholder initiatives, as well as their senior management roles within their respective organisations, provided useful and creative insights into how the co-modelling process would be most effectively utilised and where its ability to affect change might be limited.

## **6.3 PERCEIVED VALUE OF, AND BARRIERS TO MULTI-STAKEHOLDER PARTNERSHIPS IN GOVERNING**

### **TRANSITIONS**

Before investigating the impact of systems co-modelling, I first explore local stakeholder perceptions on the value of and barriers to multi-stakeholder partnerships – both in theory and in practice. What I found was a broad consensus that multi-stakeholder partnerships are necessary in the current policy landscape and are also a useful tool for expediting a transition toward sustainable housing. However, I also found that several barriers prevent such partnerships from reaching their transformative, co-governance potential in practice. In the discussions chapter, I reflect on how the integration of systems co-modelling and Transition Management (TM) could address these barriers or create barriers of their own.

#### **6.3.1 The value for multi-stakeholder partnerships**

Across the five recorded breakout groups, there was a shared consensus that voluntary, multi-stakeholder partnerships are needed to secure or improve long-term wellbeing in the region. Given the “current political system” (H&E) and absence of “top-down steer” (H&CC) from Government, partnerships

would have to play a “*primary role*” (H&CC) in governing a transition toward energy-efficient housing and renewable energy. Another participant acknowledged that local authorities (LAs) in the UK are already “*mobilizing themselves*” (H&CC) given the national policy vacuum.

However, even LAs do not have the capacity to govern regional transitions and therefore must act in partnership with the private and third sectors to “*pool resources*” (HC) and achieve a coordinated approach needed to tackle key sustainability challenges in the housing sector. Given the nature of complex challenges, they are said to require coordinated action by stakeholders operating at different “strategic, tactical and operational levels” so that actions are reinforcing, rather than counterbalancing (Kemp et al., 2007, p. 6). This view was shared by one of the practitioners: “*I just think that it’s easier to do things as a collective for something like this, because we’re looking at a whole system*” (H&CC). Other practitioners spoke specifically to the coordination of public, private and third-sector actions, as no one group of actors have an authoritative understanding of or intervening power in complex societal systems:

*“It feels quite essential to me that you would have public-private partnerships. That there is not enough of an interest on the private side to do it on its own, but equally it feels that the public side doesn’t capture all of the various affects we discussed today and doesn’t bring the whole perspective to the table. [...] So, it seems that it’s the only way, in partnership with the third-sector actors, we’re going to transition to sustainable housing.”* (H&C)

*“The systems model shows [multi-stakeholder] initiatives are likely to be most effective. Simply increasing public funding would not get key stakeholder buy-in [needed to realise a transition toward sustainability].”* (H&E)

In addition to be a perceived necessity, multi-stakeholder partnerships were considered to expedite transitions in five ways. First, participants claimed that partnerships enable stakeholders to share

the burden of delivery (H&CC), particularly where partners can *“capture value from an intervention in one system to compensate [unintended] costs in another system”* (H&E). Second, multi-stakeholder partnerships are theorized to support the diffusion of socio-technical innovations via demonstration. Moreover, a representative of BEIS suggested that the ‘demonstration’ function of multi-stakeholder initiatives is particularly important in the context of austerity or welfare state retrenchment:

*“I was told there’s not enough money to do things wholesale across the whole country, so we want certain areas, larger market towns, non-metropolitan cities, [etc.] to lead the way. So... [there’s] probably going to be some form of limited resource to pump prime those, because they’re saying, ‘If we can get 15-20 cities to show that it can be done, then that can be replicated nationally.’ So, I definitely think that’s another reason to [promote a bottom-up approach to transition governance].”*

Third, involving a diverse set of stakeholders was said to prevent foreseeable missteps that ultimately prolong the transition process. *“Partnerships are terribly inefficient, until you look at the alternative”* (H&CC). *“They inevitably slow down matters because they require a broader consensus or discussion, but if you work through that, you’re more likely to get a better-quality outcome”* (HI) that *“is deliverable and acceptable to your market”* (H&CC). In other words, *“you do something right the first time and save [time later]”* (HI). Participants agreed that this requires involving a diverse set of stakeholders: *“You can only foresee [unintended consequences] if there’s a lot of people sitting around a table discussing it in the first place”* (H&CC). So not only was coordination between a diversity of stakeholders perceived as necessary, it was considered to be more efficient due to time savings in the medium- to long-term.

Fourth, multi-stakeholder partnerships were viewed as providing a more *“innovative”* and *“imaginative approach”* (H&T) to problem-solving if truly collaborative and inclusive. *“New groups of delivery partners would provide new blood, which brings different perspectives and new business models...”*

*that kind of thing*” (H&T). Similarly, Wittmayer et al. (2016, p. 939) argue that, even with a radical orientation toward sustainability, governments are inhibited by status quo governance structures that lack reflexivity and opportunities for experimentation. As such, transition governance is about “finding creative ways for opening spaces for participation, change, and experimentation, that is, for creating alternative ideas, practices, and social relations.”

Fifth, multi-stakeholder partnerships were said to improve initiatives by tailoring solutions to place-based issues. As one participant put it, *“Geography matters”* (H&CC). It matters for the appropriateness of initiatives, and it matters for garnering political support. A local authority representative said, *“locating some of the complex issues in a real context around places is quite an important driver in policy. [...] Rooting how we think about the world at the neighbourhood, community, town, village point-of-view is quite important”* (H&C). These contributions also reflect insights from Transition Management, whereby a governance framework that facilitates bottom-up experimentation is theorized to accelerate transitions by facilitating the natural, evolutionary process of “variation and selection” and helping socio-technical innovations find alignment with place-based selection environments (Späth and Rohrer, 2012; Boschma et al., 2017).

In conclusion, there was a consensus across all of the groups that multi-stakeholder partnerships are necessary in the current policy landscape and also a useful tool for expediting a transition toward sustainable housing by (1) pooling resources; (2) supporting the diffusion of socio-technical innovations via demonstration; (3) preventing counterproductive interventions and their associated unintended consequences by including, from the outset, a wider set of stakeholders; (4) fostering innovation; and (5) tailoring solutions to place-based ‘selection environments’. Perceived barriers for establishing multi-stakeholder partnerships with the capacity to deliver these benefits are presented in the following subsection.

### 6.3.2 Perceived barriers to developing affective, multi-stakeholder partnerships

Despite the mutually perceived, inherent value of multi-stakeholder partnerships, a number of barriers were cited by workshop participants that either prevent multi-stakeholder initiatives from forming or that prevent them from being truly transformative.

First, it was suggested that key stakeholders, particularly incumbent actors in the private sector, often do not share the transition agenda:

*“In new housebuilds, having public-private initiatives can be useful. But from our perspective, as people who are going to be installing solar panels, the partner is going to be big housing developers, and they don’t want strict regulations. They’re going to be telling the regulators, ‘Oh no, that’s impossible’. Whereas we want really strict regulations, that means that they have to have a serious PV system, for example, rather than just ‘tick-box’ two panels. And the house builders aren’t trying to get more solar panels on the buildings, they’re trying to get fewer.” (H&CC)*

This barrier is particularly challenging when initiatives are perceived as being reliant on incumbent actors, *“[Initiatives often fail when they lack the] commitment of the most important stakeholders” (H&CC).*

There was also a reference made to the crucial, but often constrained, role of intermediaries: *“I think one of the issues is trying to find leaders who are willing to lead outside their professional interest. I’m sure those people exist, but they need to be allowed to do that [within their own organisations]. Otherwise, we’re equally silo-ing ourselves from one another” (HI).*

Third, although multi-stakeholder initiatives are meant to be inclusive, collaborative and creative, several participants concluded that, in practice, their top-down nature limits engagement: *“Public Finance Initiative (PFIs) can be a bit ‘command and control’ – ‘We’re going to do this; this is the way we’re going to do it; you now provide it’. And that puts people off. [As a result, they’re] not very imaginative or creative”*

(H&CC). As was previously stated, greater inclusivity is assumed to increase the level of creative input and innovation. Deterring wide participation at the early design phase is also said to reduce the ability of multi-stakeholder partnerships to mitigate otherwise foreseeable challenges:

*“Typically, we’d be tagging on at the end after the initiatives have already happened, and we’d be carrying out the installation. And yet often, being involved earlier would mean that problems that would have been foreseen earlier would have been because technology changes. It might be that, when that first initiative was planned, they didn’t know about the technology or they have an outdated view of what the technology can achieve. So, the earlier we’re involved in an initiative, the easier it is to carry out what was intended in the first place.” (Housing, Energy & CC)*

Although collaborative initiatives were said to be favourable to top-down PFIs, participants still felt it is necessary that Government or, in this case, local governments provide a political directive, so that initiatives achieve multiple social, economic and environmental objectives in the public interest. After reviewing the systems model, one participant concluded, *“I think what this session has shown is that there are so many objectives that could be achieved through housing development, or any other initiative, when you have that ‘broad public sector, many responsibilities, kind-of-view’”* (H&T). This remark supports the wider argument that business-led innovation – governed by “liberalized, market-based and decentralised decision-making structures in modernised European democracies” (Loorbach, 2010, p. 161) – is limited in its ability to steer transitions toward sustainability.

Lastly, participants noted that multi-stakeholder initiatives tend to be highly technocratic, excluding end users (e.g., home buyers, renters, bus riders, etc.) from the decision-making process, particularly during the early design phase, with implications for the legitimacy and quality of decisions taken: *“I think historically, and perhaps still, despite the fact that there is this move to have residents much*



*more at the heart of our change-making, I think we still struggle to do it well. I think still think there's a long way for us to go to make sure citizens are genuinely at the heart of things" (H&C).*

Participants give two reasons for putting residents and end users at the heart of change-making. First, technocrats are presumed to have similar experiences and world views. Thus, restricting value-based decision-making to this cohort excludes the preferences and values of end users:

*"Maybe partnerships would provide the opportunity for channelling other views into the process. But I guess my only worry would be... looking around the room, aren't we the 'usual suspects'? [...] We want to be working with communities. I was chatting to the guy who works on homelessness and he was looking around the table saying, 'We've all got similar agendas... probably similar beliefs of what 'good housing' looks like'." (H&T)*

The second reason participants gave for including end users in the design phase of interventions is their situated knowledge that would presumably improve the quality and effectiveness of interventions. When discussing an 'intervention gone wrong', members of the 'Housing Inequalities' group concluded that the exclusion of end users (in this case, social housing tenants) resulted in an intervention that exacerbated the problem that decision-makers sought to address.

These criticisms echo past criticisms of the initially prescribed TM framework, namely that its top-down, technocratic model of 'participation' produced initiatives that predominantly reflect stakeholder interests (Chang et al., 2017, Hendriks, 2008, Hendriks, 2009, Smith and Kern, 2009, Voß et al., 2009).

In summary, workshop participants believed that multi-stakeholder partnerships would produce more equitable, innovative, and transformative initiatives if: (1) they included powerful actors with enough agency to transform the system, whilst safeguarding initiatives against co-optation by vested interests; (2) member organizations allowed their internal 'champions' to devote time to intermediary activities when

needed; (3) bottom-up processes governed the design and selection of multi-stakeholder initiatives; (4) stakeholders were actively recruited at the early design phase to improve the diversity of perspectives and knowledge informing initiatives; and (5) the design process was also opened up to end users.

## 6.4 EXPECTATIONS REGARDING THE VALUE AND BARRIERS TO IMPLEMENTING AN ITERATIVE PROCESS OF 'LEARNING-BY-DOING' AND 'DOING-BY-LEARNING' WITHIN A MULTI-STAKEHOLDER PARTNERSHIP

Before exploring the integration of systems co-modelling and TM, I investigate stakeholders' perceptions regarding the value of and barriers to establishing a subregional partnership committed to *ongoing* experimentation and learning. Interestingly, when asked explicitly about ongoing 'learning' and 'doing', most participants' perceptions of multi-stakeholder partnerships grew pessimist, followed by discussions focus more on the barriers than the value of developing a co-governance framework for transition. This suggests that, when first asked about multi-stakeholder partnerships, workshop participants had imagined short-term partnerships established to design and carry-out stand-alone projects. When considering a long-term programme designed to deliver a series of initiatives, each informing subsequent initiatives, participants listed four inter-related barriers.

First, it was assumed that most organisations discount long-term gains, meaning they are unwilling to incur significant costs in the short-term (e.g., by diverting human resource to monitoring and evaluation) for the purpose of improving or even securing performance in the mid- to long-term:

*"People would commit on paper, but actually when it came to it... would people be able to keep going through that iterative process? [...] We're bad enough as individual people and individual organisations, at being iterative."* (H&T)

*“I really like the idea of it being an iterative process, and I really like the idea of learning. Even within my organisation, nothing frustrates me more than not learning from our mistakes. So, I definitely see the value in it. It’s just whether real life gets in the way with time pressures, personnel moving on, a new director coming in and saying, ‘We haven’t got time to be going through this process, we have to deliver X, Y, and Z first’” (H&T).*

Scaled upward, the expectation is that partnerships would also prioritise the short-term delivery of one-off initiatives over the long-term performance of a programme of initiatives. This conclusion is reflected in several of the participants’ statements:

*“I think it will only get traction – when it relates to issues we’re facing in the next 5 to 10 years. To get the buy-in, people have got to feel the tangibility in order to commit the time and resources.”*  
(H&C)

*“At some point, especially from a private-sector perspective, you have to see some benefit coming from this and it can’t be so far down the road, [...] It’s got to be quite a rapid thing [...] And if it’s only one partner [benefiting in the short-term], you’ll very quickly lose impetus in continuing it.”* (HI)

Not only are “quick wins” with predefined deliverables considered necessary for stakeholder participation, they are treated as necessary to raise funding and investment. This is the second barrier to establishing a co-governance structure that generates bottom-up ‘transition experiments’. Even if partners agree a ‘transition vision’ (e.g., indicators of a sustainable housing system), this vision would lack project-specific deliverables required by funders and investors:

*“As soon as you have something that’s in front of you that’s a bit vague, a bit meandering... as soon as there’s any sort of ambiguity [...] it slips down [the priority list and doesn’t get funded]” (H&T).*

*“When I think about the longitudinal studies within our organisation, it’s fully funded, very clear what they are meant to deliver, over what time scale” (H&T).*

As such, funding – much like partner engagement – would have to be piecemeal and reliant on short-term deliverables. The finding, therefore, is that stakeholders would need to develop a programme of initiatives over time, each with their own short-term benefits.

Moreover, participants’ suspect that only a very small portion of the funding would be devoted to monitoring and evaluation:

*“We generally rush every project because the money is only available for a limited period of time [...]. And then [we’re not] iterative... we don’t have the resource or the money (and possibly not the will and possibly not the desire) to find that we actually made a mistake, or it wasn’t as successful as we thought because we’d like to get on with delivering the next project. So definitely conflicting pressures there.” (H&T)*

*“Do you not also think that some of these organisations have solutions embedded in the system, so that... they might not actually want to know that their ‘holy cows’ are the right things?” (H&T)*

This barrier is allegedly compounded by the fact that private-sector actors are not committed to post-intervention monitoring beyond what is legally required. ‘

*“For local authorities, I think there’d be quite a lot of value in doing this because their responsibilities aren’t all being met, and they want to know why that’s happening. [...] But for [commercial] organisations, they’ll think, ‘Well, we made our money here, we’re not really interested in monitoring [the social and environmental outcomes] afterwards’.” (HI)*

Because civic universities and governments are better positioned to think longer-term relative to private-sector actors, they can more easily adopt an iterative approach and engage more meaningfully with academia to revisit and pivot both their objectives and strategies.<sup>20</sup> Indeed, LA representatives and public health researchers present at the workshop claim to already be engaged in the informal, iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ in partnership with one other. For example, the researchers referenced the ‘Healthy Aging’ work that fed into the Northstowe development in Cambridgeshire and their comments on the design code for the development’s second phase. *“We do work collaboratively and are affective because we do take a [collaborative and iterative,] evidence-based approach to our interventions”* (H&H). The finding, therefore, is that multi-stakeholder partnerships would have to rely quite heavily on partnerships between local authorities and academic institutions to support a programme of ‘learning-by-doing’ and ‘doing-by-learning’ in the current political-economic context.

Having engaged with local governments in this iterative, evidence-based approach, one participant concluded, *“We’re still making mistakes. We learned from Cambourne that there are these issues of social exclusion [...] There are things that people consciously say, ‘Try not to do that in Northstowe or in any of those other new developments’. So it’s not that we haven’t learned. It’s just that we haven’t learned how to do it quite right yet”* (H&H). The next section therefore investigates whether a co-modelling, systems approach could expedite this learning by helping multi-stakeholder partnership pre-empt, and thereby mitigate, potential unintended consequences of proposed interventions.

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<sup>20</sup> Although private-sector stakeholders may be commercially tied to ‘embedded solutions’, public-sector stakeholders can also fall victim to system lock-in, particularly when large investments are made in network-bound infrastructures (Späth and Rohrer, 2015).” such as public transport infrastructure (e.g., Cambridge Guided Busway) or district heating networks. The same is said to be true for academia, whereby epistemological ‘lock-in’ limits the bounds of knowledge creation (Stein, 2017; Spash, 2018).

## 6.5 EXPECTATIONS REGARDING THE VALUE AND LIMITATIONS OF INTEGRATING SYSTEMS CO-

### MODELLING INTO THE MULTI-STAKEHOLDER PROCESS

After participants finished reviewing and editing the qualitative systems model, they were asked to consider how the systems model could be of use to members of a hypothetical multi-stakeholder partnership. This discussion was inevitably influenced by stakeholders' imaginations of how systems modelling *could* be used to analyse interventions, as the causal tree activity was removed from the workshop itinerary as a part of evolving the workshop beyond the pilot stage. However, their past experience participating in local multi-stakeholder initiatives, as well as their senior management roles within their respective organisations, provided useful and creative insights into how the co-modelling process would be most effectively utilised and where its ability to affect change might be limited.

Responses were mixed; however, some points of consensus did emerge. Positive feedback is reported first, followed by critiques of the co-modelling process and materials used in the workshop. Participants' recommendations are subsequently presented in Section 6.

#### 6.5.1 Observed and perceived values of the co-modelling process implemented in this research project

Though not shared by all, some individuals felt that the co-modelling process facilitated discursive debate and learning about the system in which interventions are needed. In some cases, this learning changed some participants' opinions about which short-term interventions should be prioritised to enhance or secure wellbeing in the year 2060. Of the 21 participants who completed their questionnaires, 7 reported having changed impact ratings for at least one intervention. Due to the small sample size, we cannot judge whether this is a typical outcome; however, it is quite striking that one third of experts, who regularly engage in the design and selection of these types of interventions, experienced a change in view.

During the post-workshop discussion, some participants explained how the co-modelling exercise facilitated systems learning and revealed both negative and positive unintended consequences of interventions, with implications for their ratings:

*"I've upgraded [my rating of] intervention 8 from -1 to +1... mainly because I thought the intervention would reduce supply, but going through the [model], I found that, over-time, we'd probably end up with a change of ownership of those properties, with higher occupancy rates." (H1)*

*I've actually put [Intervention 9] up from a 2 to 3 because, using the model to support their reasoning, another participant from the 'Housing & Communities' group explained why this intervention might be more useful than I originally thought. [...] The impact for the community... having those green spaces and that feeling of wellbeing is probably more important than what we think would affect wellbeing." (H1)*

*"I upgraded the intervention from a 2 to a 3 because I found there were links to a number of other processes going on with property values, as well as climate and inequality. It was the one that seemed to have the most interactions with other processes, so I marked it up for that reason." (H1)*

When asked directly whether they believed the co-modelling process facilitated discursive debate and systems learning, one participant responded in the negative: *"I'm not sure the co-modelling exercise has helped in changing my thoughts"* (H1). However, negative responses were in the minority, and most participants responded positively, e.g., *"I think yes, I do, because [...] it facilitates the 'and then what, and then what, and then what' which isn't always present when you're doing decision-making. [It helps you] come to a conclusion that, in the immediate stage, you wouldn't have come to"* (H1).

According to theory, systems modelling facilitates a shift away from linear thinking, and helps refocus our attention toward the underlying causes of complex problems, rather than the symptoms

(Sterman *et al.*, 2000). Based on participants' reflections, it seems that, in some cases, the co-modelling activities were successful in this regard: *"I now have a greater understanding of what can be done to influence change within a system"* (H&H). One participant thought that participants' original interventions seemed quite *"reactionary"*, and the ones that they had come up with in the afternoon were a lot *"deeper"* (H&C). At the end of the workshop, another participant concluded, *"I think I could far more effectively [...] come up with a number of interventions that could be potentially useful [...] now that I've gone through this process"* (HI). A representative of the Environment Agency even said they would like to apply part of the model to a previous project and see, had the agency taken a systems approach, if they would have foreseen the unintended consequences of their intervention.

In many cases, the modelling activity facilitated systems learning simply by revealing subsystem interlinkages. When discussing energy retrofit programmes targeted at low-income households, a participant from the 'Housing Inequalities' group, having visited the 'Housing & Health' subsystem model, learned that, without simultaneously providing mechanical ventilation, an energy retrofit programme could have perverse outcomes for public health, as smoking prevalence is higher in low-income households. *"You design something, not taking into account that someone smokes, and that one thing you've done has rendered it useless or counterproductive."* / *"Yeah, you've spent thousands of pounds on something and discover it's useless"* (HI).

The colour-coding of elements made subsystem interlinkages accessible when reviewing one's assigned model (see Figure 27). Participants found that this aided systems learning: *"I actually think the model was quite useful in showing the interconnectedness of issues. [...] If I'm in this space trying to do*



something here [points to assigned subsystem element], actually, I just need to be mindful of these bits [points to connected elements from other subsystems]... it's a great map" (H&C).



Figure 27: Visualisation of subsystem interlinkages

Because 'outgoing' connections were removed from the otherwise busy CLDs, participants had to visit other models in order to learn how elements in their sector, including interventions, affected others (see Figure 28), which too supported systems learning: *"I think it was quite an eye-opener going through the various [subsystem] models"* (HI).

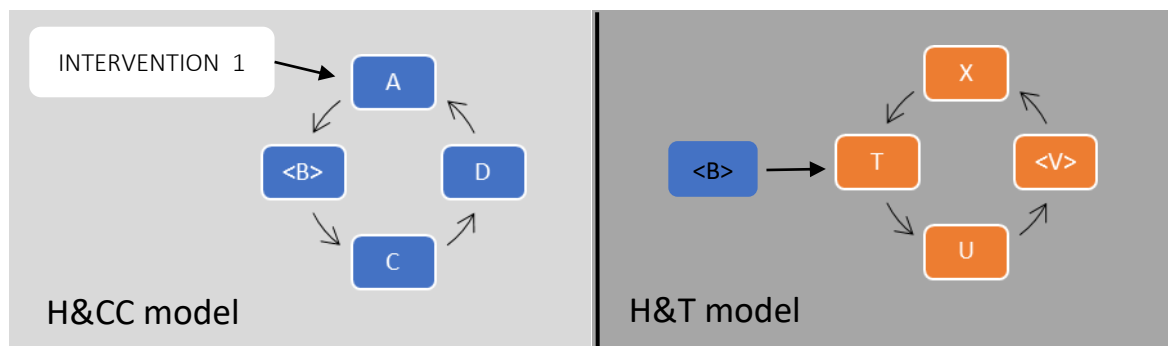


Figure 28: Observing the potential impact of interventions in one's sector on others

Did this learning then lead to consensus on problem or solution definitions? To investigate this, I planned to calculate variance in each groups' intervention ratings before and after the co-modelling exercise to see whether views converged or diverged. However, the post-workshop surveys suffered from non-response and, in the end, most groups had a sample size of two to three participants. However, participants did share the perception that the co-modelling process built consensus between them. For example, when asked if the co-modelling process could facilitate consensus-building, one participant

responded, *"I think it already has. I think it probably would help people understand one another's perspectives better"* (H&T), followed by agreement from other members of the group. Another participant admitted, *"From the discussions I've had with all of you, it's really given me some food for thought. [...] I've been swung around [on a number of interventions]"* (HI).

From their observations, one note-taker believed the process was effective at building consensus because the model acted as an *"external object"*, providing *"an objective way of querying theories without it being a query of other people's opinions/values."* For example, theoretical relationships modelled in the Causal Loop Diagrams (CLDs) could be challenged by anecdotal evidence from participants' professional experience. Rather than having their personal views challenged, participants challenged the model.

In addition to facilitating systems learning and (at least giving the impression of) consensus-building, the co-modelling process helped some participants to develop an appreciation for complexity:

*"It really shows the complexity of interactions. I think that's probably helpful. You know, that we don't take decisions based on one particular view. This model gives you a much broader overview of the interactions, of the consequences, of the decisions we make. Which, in theory, should stop us from making these knee-jerk decisions."* (H&H)

*"Imagine if this was communicated to policy-makers; to say, 'Look how complex it actually is!'"*  
(H&H)

Despite the perceived value in demonstrating complexity, other participants warned the model *"risked disempowering action"* because *"the complexity demonstrated in the model was rather overwhelming [and] shows the challenges are so complicated."* Interestingly, however, not a single workshop participant reported a smaller sense of 'problem ownership' in the post-workshop questionnaire. In fact, over half of

participants reported an increased sense of 'problem ownership' due, in part, to improved confidence in the deliverability of multi-stakeholder initiatives.

In the post-workshop, individual questionnaire, two participants wrote that they witnessed “*a greater level of commitment from partners than expected*” and learned “*there are willing people to work with and new initiatives to try and help deliver better outcomes*” (HI). One participant even reported an increased sense of confidence and ability to work with other stakeholders, as the workshop have given them “*a far better understanding of the issues each sector/person is facing*” (HI). In the pre-workshop questionnaire, participants were asked to report the level of trust they felt toward working with a number of public, private and third sector actors. At the end of the workshop, one participant commented, “*It was interesting... the amount of sectors I said I’ve had no contact with at all, and I’ve actually had some contact with them now. And, actually, it gives me the sense that there could be collaboration. Far more than we’ve had before*” (HI). Participants also learned that interventions in other sectors, that would have beneficial impacts in their own, were indeed deliverable: “*Going through the various [subsystem] models [and discussing them with] people who have a better understanding of that area [taught me that the intervention] could be managed quite successfully*” (HI).

To conclude, evidence presented in this section suggests that the co-modelling activities helped build consensus around an improved understanding of and appreciation for the complex ‘housing & wellbeing system’, as well as built confidence in the deliverability of multi-stakeholder initiatives. It is uncertain, however, if this finding holds for the majority of participants. It was also found that an improved understanding of the system *structure* (albeit incomplete) did not translate into an improved understanding of system *dynamics* due to a number of limitations presented in the following subsection.

### 6.5.2 Observed and perceived limitations of the co-modelling process implemented in this research project

The co-modelling exercises were quite frustrating for participants, as they struggled to see tangible benefits of the workshop: *"It didn't feel we reached a point of practicality"* (H&T). Most claimed to have learned something new but did not feel they were any more qualified to compare interventions or to use the CLDs as an evaluation tool. The workshop data suggests six reasons for this.

First, participants felt there were too many CLDs to review in a single-day workshop, despite the fact that the number of diagrams had already been reduced to a maximum of ten:

*"My observation going around to other groups is that I felt quite reassured that everybody else was having the same experience with these as we were... That there was just too much there for people to take in in a short period of time."* (HI)

*"Me personally, I haven't quite grasped it well enough yet [...]" / "So you'd need more time to understand the model?" / "Yeah."* (H&H)

Second, most, though not all, participants felt that reviewing purely theoretical relationships, without concrete examples, was too demanding:

*"I think it would have to be translated in a way that was a bit more accessible with real-world scenarios [...] so that people could get a hold of it."* (H&C)

*"I think most [people] would need a simpler route into the model."* (H&E)

This was especially true for members working in subsystem models which included causal relationships from multiple spatial scales (e.g., local, regional and national) or in models which predominantly featured higher spatial scales such as the 'Housing Market & Land Economy' model:

*"I was talking to someone from the housing, energy, and climate change model, and they were saying that the scale of the intervention, or the scale of the systems model was so big, that it was really challenging. For the transport one, it was much easier because it was much more micro-scale with individual behaviour change... So, understanding their systems model was much easier."*

(Housing & Health)

The participant making this comment, however, works on behaviour change, meaning others (e.g., macro-economists) might find it easier working with macro-level theories. Indeed, participants in the 'Housing, Energy & CC' group were more engaged than other participants and made the most edits to their model. Another possible example is that there is a greater volume of anecdotal evidence at the local level, which participants often used to help other members of their group grasp the implications of a given balancing or reinforcing feedback loop:

*"We [used] examples from the cycleway on Hills Rd. that's been put in, in terms of unintended consequences on [bus services]... the potential displacement of people from public transport to cycling. Using practical examples to think through some of those unintended consequences is useful."* (H&H)

*"It's very broad what we've been doing, and when we narrow it down to some more specific things happening locally, it felt much more tangible."* (HI)

Although interviewees' qualitative reflections are provided as embedded quotes in the electronic CLDs, these were not made available at the workshop. Causal relationships appearing in the CLDs were most often modelled from interviewees' stories, meaning these narratives were first simplified before being presented to workshop participants.

The third problem, related to this simplification, was the ambiguity of terms used in the CLDs. Often, sector-specific terminology was avoided, as this would be a barrier for cross-sector planning and evaluation. In some cases, then, no participant felt they had the authority to define a term. This was especially problematic for groups reviewing subsystem models rich in abstract nouns such as the 'Housing & Community' model:

*"Who chooses the language that's being used here? Is there some kind of agreed notion of what "anti-social behaviour" means? [...] I find so many of these phrases slippery. They're not set in stone, and that creates even more complications."* (H&C)

As recommended by (Robison and Foulds, 2017), one could commit time and space to building a lexicon between academics and practitioners mid-workshop, as the process of reflection on terminology difference is helpful in moving beyond this barrier toward meaningful collaboration. Given time constraints, I prioritised other activities, demonstrating, again, the insufficiency of a single-day event.

The fourth, and perhaps most significant, limitation of the co-modelling process was the elimination of workshop activities outline in the methods section. As a result, participants were no longer able to analyse their proposed interventions using the systems model. This limited the research project in three ways. First, the systems analysis was not conducted and findings could therefore not be drafted for regional stakeholders regarding the potential unintended outcomes of proposed interventions. Second, because the 'causal tree' activity was not tested with practitioners, I was unable to observe the value and limitations of involving participants as co-investigators in the systems analysis phase of Transitions

Management. Third, the real-world impact of demonstrating the value of systems modelling to key stakeholders and providing them with a new set of skills was not realised.

Limited to discussing the system *structure*, any learnings about system *dynamics* were circumstantial, not facilitated by workshop activities. As such, participants were left confused about the tool to which they were being introduced:

*It's one thing trying to interpret this and kind of go, 'Oh yeah... I can follow the links' or 'I can make the links', but it's another order of magnitude to properly understand it to the point where you could actually get something out of it or apply it to your own [work]."* (H&C)

*It has been useful, and it is a different way of thinking for a lot of people. But then it's... 'How does that translate into practice?' [...] That's what I'm struggling to get my head around at this minute."* (H&T)

*"I can see the learning bit. I have still yet to see how I translate this to the doing bit. It doesn't feel like an evaluation framework. So, I'm not sure how I would use this when I'm doing something to learn, because that's what you need when you do that. Conversely, I can see this is informative, but I have yet to understand how I do anything more effectively or stop doing something, or put my resource 'here' because it has greater impact than doing something 'there', which is what other models do try and do."* (H&C)

Much of the confusion inevitably stems from the fact that the systems analysis was removed from the workshop agenda. Indeed, the co-modelling activities only introduced a new way of conceptualizing the 'Housing & Wellbeing system', whereas the causal tree activity was designed to help participants think through some of the unintended consequences of intervention (see activity vii from Table E1 of Appendix E). For example, the causal tree activity could have revealed feedback loops existing across subsystem models (see Figure 29), facilitating learning on how 'Intervention 1' in the H&CC system (taken at Time<sub>x</sub>) impacts upon the H&T subsystem, and feeds back to reinform element 'A' (at Time<sub>x+1</sub>).

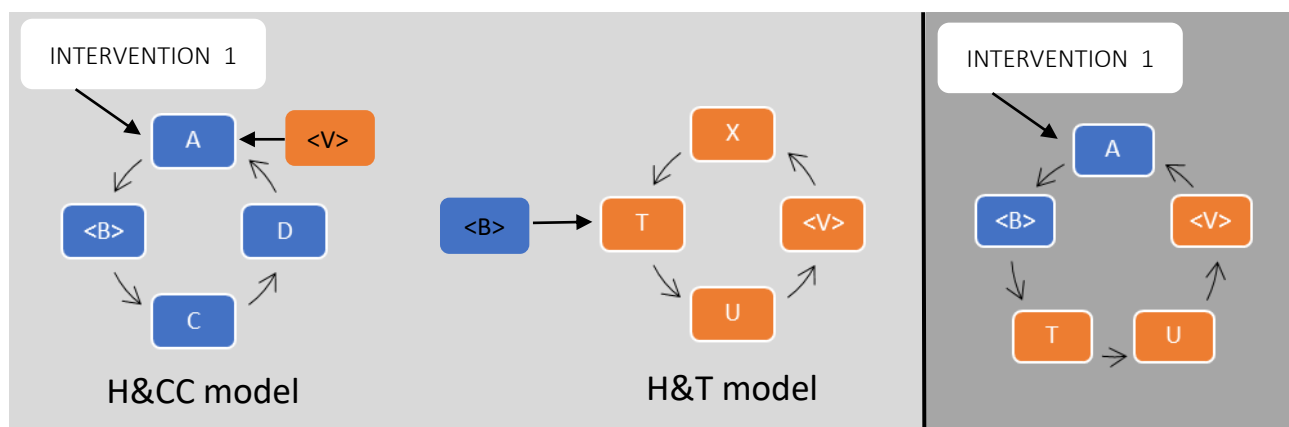


Figure 29: Example of cross-system feedbacks

The causal tree activity would have been highly challenging, however, given the difficulty participants experienced with workshop materials. Because it was recommended that CLDs be reviewed individually or in pairs, multiple copies of each CLD were printed on A3 paper with edits to be drawn on the group's master copy (also printed on A3 paper). During the rotation activity, where participants visited other group models, the extra printouts (separate from the master copy) were not cleared away. In retrospect, the master copy should have been printed onto posters to avoid participants getting lost in numerous sheets of paper. Alternatively, the workshop could have been held in a computer lab where participants could review the model digitally. It is impossible to say, however, whether completing the



causal tree activity using either medium would have resolved participants' confusion, as this activity was removed from the agenda.

The fifth limitation, *complexity* itself, is of course independent of the workshop design.

*"Certainly, today it was almost quite overwhelming in terms of the layers and the complexity and the... literally 'joining up the dots'." / "I couldn't take this to my team." / [Group agrees] (H&C)*

But how much of this 'complexity' is owed to poor modelling, planning and workshop design, and how much is owed to the inherent nature of complex systems? This question is unanswerable. However, data suggests that participants felt they should achieve the impossible: An understanding of the full, system-level implications of their interventions: *"If we had a greater understanding of the whole system, that might help us understand if this might help us with the iterative process of 'learning-by-doing' and 'doing-by-learning'"* (H&H). Due to cognitive limitations discussed in Section 3.6.5, however, it is impossible for humans to achieve a full understanding of system dynamics without the aid of computer simulation (Sterman *et al.*, 2000). As such, qualitative systems modelling is inherently limited. Though, even *quantitative* system dynamics modelling is limited, not only by data availability and faulty assumptions but, by the need to define system parameters. One workshop participant with more familiarity in complexity theory picked up on this limitation:

*"The thing I find the hardest about systems modelling is that it feels that it's never-ending. It feels like you can always have a bigger system. And what we've been talking about is having local policies which are specific to the local area. But that means that your system is closed and you're ignoring other systems outside and those effects can be huge. The first one is about increasing population in the city which can have an effect on house prices, but those people have come from other towns,*

*so that's another thing to consider. And if you go past that system you get the European and then the global system. [...] But you can't include it all."* (H&H)

The finding, therefore, is that, simply by introducing systems modelling, participants were introduced to the limits of knowledge production and largely left feeling dissatisfied. Rather than accept this limitation inherent in the analysis of complex systems, many participants rejected the exercise as 'incomplete'. It is hard to say, however, how much of this sentiment was driven by the incomplete nature of the workshop and how much was the product of complexity itself. The literature suggests that this feeling of dissatisfaction may be partially alleviated by restricting participatory modelling exercises to small models that "emerge after extensive examination of a larger model allows for the identification and isolation of only the most dominant feedback loops" (Ghaffarzadegan et al., 2011, p. 40).

Finally, participants' understanding of system dynamics was limited by their understanding of the structure itself due to biases in the modelling process:

*"I think there's a whole network of perspectives that is not here and not collected. The dark matter in between. The people who think very differently from the people like us."/*

*The non-green people. So, the people who think that saving energy is a complete waste of time and want to drive a gas-guzzling vehicle. How do we get their perspective on this?" /*

*"For a start, you need councillors from the South End and Sheppey rather than from the Cambridge area who have a different political approach to life. [...] My concern is that [critical interactions/relationships will be missing from the model and then it's misleading]. It's almost like creating climate models. It's a huge matter of research."* (H&CC)

However, some participants questioned whether this limitation could ever be resolved:

*“I agree with you, but the push-back then is how many times do you have to review this and with how many people? [...] The fact that we’ve got to this stage, you could argue, is more than anyone else has done to-date. That’s not to say you can’t take it to another level and bring it to a wider audience of non-specialists.” (H&CC)*

Recommendations provided by participants to address these six limitations are presented in the following section.

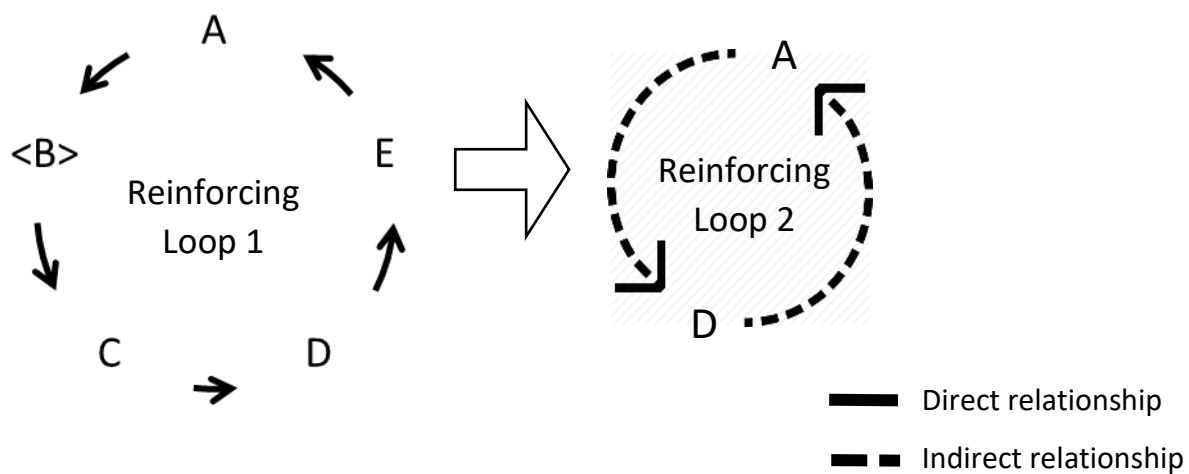
## **6.6 STAKEHOLDERS’ RECOMMENDATIONS REGARDING THE FUTURE USE OF CO-MODELLING TO INFORM PUBLIC-PRIVATE INITIATIVES**

Participants made a number of recommendations regarding the integration of system co-modelling into multi-stakeholder, co-governance processes. For reasons explained in the text, I challenge the following recommendations: (i) Change the model parameters; (ii) Practitioners to build the initial model from scratch; (iii) Practitioners to build the model from the starting point of proposed interventions, rather than the starting point of future wellbeing; and (iv) Establish short-term partnership objectives to attract funding and participation. The following three recommendations, on the other hand, are acknowledged as positive contributions: (i) Use systems analysis as a method of ‘option appraisal’; (ii) Define objectives and a clear role for actors and systems modelling within multi-stakeholder framework; and (iii) Improve inclusivity of stakeholders to reduce model bias. I consider practical steps that could be taken to implement these recommendations. The decision whether to ‘bring modelling back in house’ or to maintain participatory systems modelling and analysis was also considered and further discussed in Chapter 7.

### **6.6.1 Simplify the model**

First, participants felt there was insufficient time to review all of their group’s CLDs. As described in the previous methods section, the maximum number of CLDs (10) was chosen based on pre-workshop

focus group with sector-specific experts. Although participants were asked to quietly review the CLDs on their own or with a single partner, most groups decided to walk through each diagram together. This significantly increased the time needed to ‘digest’ diagrams before editing. In the end, several groups failed to review all CLDs provided. A recommendation from the pre-workshop model review was to merge CLDs into a smaller number and simplify them (see Figure 30). By simplifying Reinforcing Loop 1 via the elimination of variable B, C and E, participants can more quickly process the reinforcing relationship between variables A and D.



*Figure 30: Simplifying CLDs*

However, this recommendation was rejected due to a number of drawbacks. First, the indirect relationship between A and D might not be obvious to participants, particularly those who work in a different sector. Second, this simplification may come at the cost of further systems learning. For example,

if variable E belongs to a second reinforcing loop, such as in Figure 31, eliminating variables E, F, H and J inhibits learning about the reinforcing relationship between A and G.

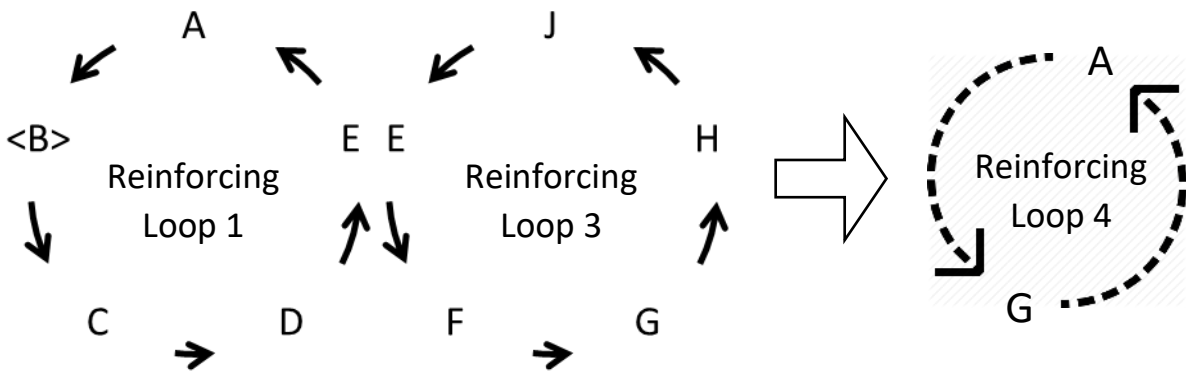


Figure 31: Example 1: How the simplification of CLDs limits systems learning

Third, systems learning is also negatively affected when considering subsystems in their relation to one another. If Reinforcing Loop 1 is simplified to Reinforcing Loop 2, then suddenly it has lost its connection to the ‘Housing, Energy and Climate Change’ model, which has an intervention targeted at variable B (see Figure 32).

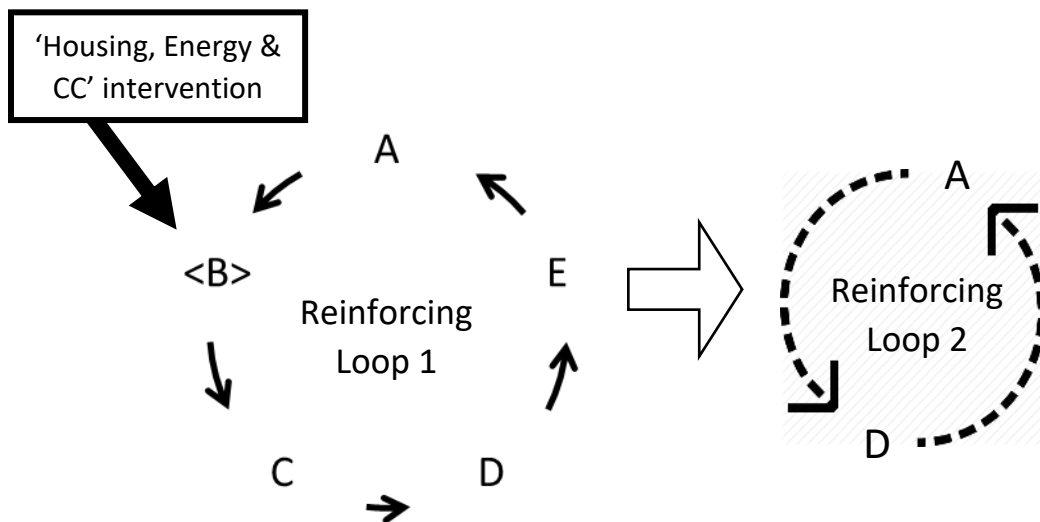


Figure 32: Example 2: How the simplification of CLDs limits systems learning

When preparing the model for the frontrunner workshop, the decision was therefore made to retain as many variables as necessary to preserve interlinkages between CLDs, both within and between subsystems. This decision was made naively, however, as participants deemed the model “too complex” (H&C) for a single-day workshop. As such, the recommendation would either be: (1) to pull modelling back ‘in house’ and only present small models of dominant feedback loops post-analysis, or (2) to retain all the necessary variables for a longer 3-day workshop.

It was additionally recommended that the model’s parameters be limited to the local or regional level (i.e., excluding any national-level factors such as national policy): *“I think it would be much more useful used in a place. For example, if you could go into New Market, and build this [model] in New Market and applied it, then you could look at gap analysis and things like that”* (H&C). However, I would posit that limiting the model in that way would not resolve the underlying problem, which is that participants are seeking examples or anecdotes in order to understand theoretical relationships observed at the local level.

As a governance tool, if the model were to be too specified to the local context, it would lose its transferability to similar regions – a perceived benefit of the existing model: *“I’m thinking about regional variations. [...] With some [adaptations], you could develop the [systems model] to better suit your regional context”* (H&CC).

On a more fundamental level, it is important to understand how landscape factors at the local-level interact with regional and national-level factors to produce system dynamics. If national factors are such that the positive effects of local action would be negated, this should be included in the model to inform the analysis of multi-stakeholder initiatives. Going one step further, local stakeholders might find that the most attractive action is to build alliances and lobby Government for policy reform.

Perhaps another solution, such as providing participants with access to quotes embedded in the model from local stakeholders, would be sufficient in addressing the co-modelling limitation described by the 'Housing & Community' group.

### 6.6.2 Practitioners to build the initial model from scratch

It was recommended by participants of the 'Housing Inequalities' group that the first draft of the model be developed initially by practitioners, not by modelers:

**Participant A:** *"There was just too much there for people to take in [...]. But actually, had you built something from the ground-up yourselves... If you owned it and you understood it, that would be very useful and powerful."*

**Facilitator:** *"Do you think that could come through just further workshops. You know... if you had more exposure to this?"*

**Participant A:** *"My instinct, and my view from talking to others, is that if you built it up yourselves, and you feel it's your model and you understand it, you've got more commitment to it... rather than something that's dropped down on you from an academic, and it's all very complex."*

**Participant B:** *"Maybe it'd be better to have academics go away and test/fact-check something we've produced."*

**Participant A:** *"I think it could work. [Describes a process of building the model themselves] and [then once you get it to this] stage it's like... 'Wow! Ok!'"*

There are, however, four problems with this recommendation and its perceived benefit. The first relates to inherent limitations of qualitative systems modelling. Although systems learning is a product of systems modelling, one does not gain a comprehensive understanding of the system or its dynamics by simply

building a model of its structure. Having spent several months adapting the HEW model, I cannot say I ever reached some ‘breakthrough’ moment in which I achieved a comprehensive understanding of the complex system, let alone an understanding of its dynamics. For this, analysis is needed – which, without the aid of computer simulation, is also very limited.

The second problem, already hinted at, relates to the time-intensive nature of qualitative systems modelling. The HEW project employed a team of modelers who required months to develop the ‘Housing, Energy and Wellbeing’ model. Unless practitioners are willing to participate in co-modelling sessions over several weeks, they will never fully ‘own’ the model.

Third, the expectation that practitioners develop broad familiarity with the system structure, is unrealistic even if they *could* commit enough time to the modelling process. Systems modelling requires several iterations of revision by a diverse range of experts and practitioners until the model is ‘complete’ – by which point the model may be unrecognizable by those who contributed to it at different phases. As such, there will always come a point at which co-modelers have to familiarize themselves with the work of others if the aim is to achieve a comprehensive understanding of the system’s structure.

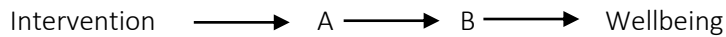
Fourth, having stakeholders review the systems model at too many stages of development could cause confusion, as CLDs often change as new information is introduced due to the interconnectedness of causal loops within and between subsystem models.

### **6.6.3 Build the model from the starting point of proposed interventions**

Another recommendation was for participants to build the model from proposed interventions: “*We felt that we’d probably reverse engineer the process and you’d start with the intervention and then build a [diagram] rather than trying to plug it into an existing [diagram]*” (HI). Although this approach might help reduce the amount of superfluous information in the model, it encourages linear cause-and-effect

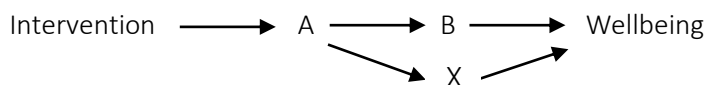


theorisations (see Figure 33) Indeed, during interviews, experts and practitioners tended to focus on the problematic relationships between housing and wellbeing linked to their ‘silver-bullet’ interventions.



*Figure 33: Linear cause-and-effect theorisation*

However, by exploring, as well, positive relationships between housing and wellbeing, a density of relationships formed around wellbeing indicators. Factors contributing positively to wellbeing – for which no intervention was proposed (e.g., variable ‘X’ in Figure 34) – were included in the model, after which their relationships to interventions were investigated, thus revealing an ‘unknown unknown’ about the proposed intervention’s impact on wellbeing.



*Figure 34: Uncovering variables in the ‘Housing & Wellbeing’ system*

Another benefit of focusing on wellbeing is that it enables the investigation and recording of personal definitions of wellbeing to which further links can be drawn. For example, during interviews I asked, “What does ‘wellbeing’ mean to you?” Once this question revealed a new indicator, ‘Y’, I responded with the prompt: “And how does housing positively/negatively impact upon ‘Y’?”, further developing the model beyond direct relationships between the intervention and wellbeing.

#### **6.6.4 Move the workshop into a computer lab**

It was recommended by one participant to move the workshop into the computer lab to ease the model review process:

*"I think this would work better online, because it's so 3-dimensional. It would just help to create the [mental] links in a simpler way. I think it's more complicated with paper. I understand why we've done it with paper. It's more dynamic and gets people moving around. But it has been quite hard doing that today and take it all in." (H&C)*

When reviewing large model printouts dispersed throughout the room, it is difficult to grasp how the subsystems are interconnected. On Kumu, participants could quickly search the modelled relationships of one specific variable across all eight subsystem models, for example.

However, moving the review process online could negatively impact networking and meaningful discussions between members of different subgroups. In a computer lab, participants from different subgroups would have to work in pairs to review interconnections between each other's subsystem models. Half of the participants would stay logged in at their computer, and the other half would rotate around the computer lab. The activity would be highly structured. Not all discussions require the same length of time, meaning some conversations would be cut short whilst other participants would be stuck waiting to rotate. In a room with subsystem models printed and displayed at different 'stations', participants are free to join any discussion at any table at any time, perhaps leading them to other frontrunners they are keen to work with on issues they are keen to tackle. This freedom may improve alliance-building and enthusiasm in the activity. It may also result in subsystem linkages being neglected. These trade-offs in co-modelling projects require further investigation.

#### **6.6.5 Bring modelling back 'in house'**

It was alternatively recommended by the 'Housing & Environment' and 'Housing & Transport' groups that the co-investigator role of local practitioners be significantly reduced and that the systems modelling and analysis be carried out independently:

*"[The PhD student has] probably done hours and hours of work. I mean... if someone's willing to do it for me. [Laughter]. It's been useful, and to see some of those unintended consequences..."*

*"A recurring theme [from group's previous discussion] has been the complexity of this model. [...] Is a transport professional going to be able to get something useful out of delving into this? Possibly, if someone is holding their hand and guiding them through."*

*"Maybe what it needs is someone to come in who is trained as a systems thinker, talk to key actors about a specific problem and the proposed solutions or options, goes away and spends some time mapping that out and looks to see if they can identify any unintended consequences in that. And if they do, then that would flag up, 'Maybe we should invest more thought in this, because otherwise we might end up wasting all that money and we're not going to get the outcome we want.'"*

Although groups found some value in editing and reviewing the model, ultimately, they wanted an end product (e.g., policy recommendation): *"I think you can kick-off something with something like this if you want to stimulate thinking. But eventually, you've got to narrow it down to some kind of product, policy, or whatever"* (H1). The question remains, however, whether counter-intuitive or even ambitious recommendations would have resulted from the systems analysis, whether stakeholders would have accepted these recommendations if they themselves didn't participate in model-building or analysis.

One way of achieving buy-in without involving stakeholders as co-investigators would be to *"map a prior intervention to demonstrate past unintended consequences and how they could have been mitigated or avoided"* (H&E). This approach would not only build confidence in the methodology, it would also act as an introduction to CLDs, which would be used again as visual aids to support recommendations around future interventions.

### 6.6.6 Use systems analysis as a method of 'option appraisal'

At the end of the workshop, participants were asked, “Do you think members of a multi-stakeholder partnership would commit to an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’, e.g., by monitoring the outcomes of their interventions and using that knowledge to inform future intervention?” As was discussed in Section 4 of this chapter, participants were highly pessimistic about the prospect of partners committing to an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’. However, as per the recommendation made by the ‘Housing & Environment’ group, there is an expectation that the investigation of past interventions using systems analysis could be highly impactful. The question then is how to institutionalise systems analysis in a way that fosters an evolving understanding of the ‘Housing & Wellbeing’ system as it evolves over time. Who would own the model? What interest would there be in returning to it post-intervention?

Simply mentioning the word ‘monitoring’ triggered discussion: *“In terms of monitoring, [many contracts now] stipulate that you have to monitor the outcomes and you end up filling in these little forms... ‘What did you think of it?’... To the point I don’t even fill them in anymore. It’s a nightmare”* (Housing&CC). Although participants were averse to the idea, they did agree that systems modelling should play a role in the design phase.

*“I believe [CLDs would be useful at] the design phase. [...] This is what doesn’t happen before projects. [...] Even when Innovate UK put out a call for innovation, if they’ve gone through this before they put out their calls, they would do things in a very different way. It’s only when we all moan to them after they’ve put out a call that they go, ‘Well, alright...’ because they didn’t involve us before they did that.”* (Housing&CC)

One participant even went as far as to suggest that systems co-modelling be made *“a contractual obligation. [...] I think this way of working is an emerging way of working, and there’s no harm in formalising*

it in a new partnership, or at least trying” (Housing&CC). Another member responded with scepticism, claiming that partners, such as “waste companies in 25-years contracts,” would simply dismiss this obligation to “limit costs” when delivering large-scale planning projects. Given the perceived value of systems co-modelling, a third member pushed back:

*“I’m wondering if you did this before issuing a 25-year waste contract for an incinerator, if you wouldn’t build an incinerator or do the waste contract in the first place. So that’s just a thought. I’ve seen big incinerators built and that’s frozen the waste management system in a place. Because if you start recycling too much, the incinerator isn’t fed, contractual obligations aren’t meant, and the council has to pay-out because it’s recycling too much.”*

This theoretical, balancing feedback loop is illustrated in Figure 35 as an example of how systems modelling could help pre-empt unintended consequences of intervention during the design phase.

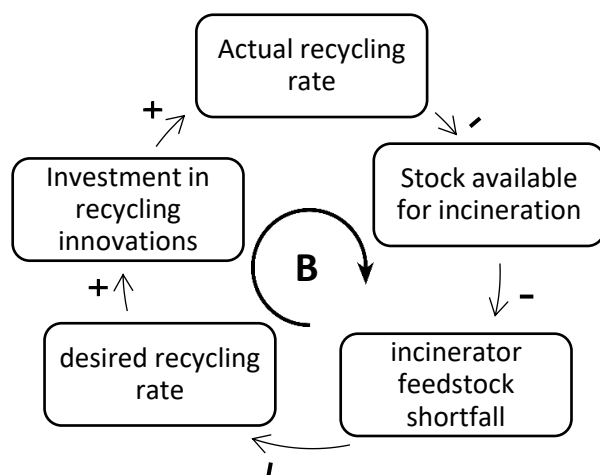


Figure 35: Causal Loop Diagram of the theoretical ‘freezing’ impact of the waste incineration industry on councils’ recycling rates

Participants from the ‘Housing & Transport’ shared the view that systems analysis is best utilized in the evaluation phase:

**Participant A:** *“It seems worthy inserting it into the process so that, at the very least, you’re sense checking to make sure it’s likely to deliver the expected outcomes. Because even if there’s a great urgency to spend the money on something very specific, actually, we may be better not doing it at all.”*

**Participant B:** *“And stopping doing things are more important than doing things that are a waste of money or have harmful consequences. [...] [Maybe the tool could help foster] greater acknowledgement [or acceptance] that that [i.e., ‘doing nothing’] is a better outcome.”*

**Facilitator:** *“That could be a key conclusion, actually. That this could be used as a tool to stop projects that wouldn’t deliver intended outcomes.”*

**Participant C:** *“From the academic literature, that’s what systems thinking is designed to facilitate. From a public health point of view... stopping doing things that are harmful or doesn’t have any overall benefit is one of the things that systems thinking is used for.”*

Regarding the exact timing of the analysis, one participant suggested systems modelling be used for option appraisals:

*“Maybe that’s the point where you need to get someone to do some systems analysis. And then see if that’s turning anything up that goes against what the people who are selling those options are saying. So, if someone says, ‘We definitely need to put a cycle lane in there because X, Y, and Z are going to be the results,’ and then someone says, ‘Well, actually, it has this interaction with something else that isn’t in your remit,’ then it may trigger [partners] to think a bit more carefully about this before they commit too much money and resource.” (H&T)*

One participant even suggested publishing CLDs in Government consultation documents, as they were perceived to be an effective explanatory tool:

*“I think it’s a good system of testing your decision-making and I think it would be helpful in helping bring in some challenging policy – to try and find solutions. I think that often policies are brought in that haven’t been thought through properly and... well, the devil’s in the detail. And when you get the detail, you think, ‘this is totally workable’. I’m thinking of central Government policy here. And if actually, when they’re doing their consultation documents, if there was some kind of systems modelling behind it that they could use in the evidence base, that would be really helpful.” (HI)*

#### **6.6.7 Define objectives and a clear role for actors and systems modelling within multi-stakeholder framework**

Workshop participants agreed two requirements for the formation of a multi-stakeholder partnership (MSP). First, clearly defined actor roles are needed:

*“As long as they know what’s their stake and what’s required, then most people are willing to [participate].” (H&CC)*

*“It’s vitally important how clearly structured the roles of the partners are; otherwise, this won’t work. [...] People will just get bored or muddled up” (H&CC).*

This finding reflects findings from three urban climate change MSP case studies conducted by Surminski and Leck (2016). Second, “platforms for stakeholder involvement [should] be very clear on what the participatory process aims at and can realistically achieve” (Warner, 2006, p. 15):

*“Being clear on what the output is going to be [is really important]. I think we’ve all been part of these groups where it starts out and everyone’s really excited, and then six months down the line, there’s only three of you around the table, because it’s not been quite clear what the value is for each stakeholder.” (H&T)*

In order to integrate systems co-modelling into the co-governance framework (e.g., to inform the design and selection of multi-stakeholder initiatives), two requirements would need to be met. First, the exercises would need to be simplified, e.g. by simplifying the model parameters, taking more time to introduce the concept of CLDs, or through greater hand-holding: *“They’re going to see there’s value and they’re contributing towards something they’re a part of [...] so long as [the exercises are] reasonably simple, not too complicated or lengthy”* (H&CC). Second, the integration of systems co-modelling into the wider MSP co-governance process would need to be highly structured and clearly communicated: *“When you’ve got lots of stakeholders, you need [structure and facilitation]... a bit like today. [...] I think when it’s a bit nebulous or unstructured, people start to drift, and you lose them”* (H&CC).

#### **6.6.8 Establish short-term partnership objectives to attract funding and participation**

As was discussed in Section 4, participants believe the MSP would need to *“start off with quick wins and smaller local initiatives to actually build that momentum and keep the good faith going towards some kind of purpose”* (H&T). However, if initiatives are not *“translated into [...] a long-term perspective to act, this is not regarded as transitioning (but rather a type of ‘window dressing’)”* (Bosch-Ohlenschlager, 2010, p. 146). The only compromise, then, would be to develop a programme of projects, some of which will incur short-term losses, but begin with the projects that incur short-term gains to build confidence in the MSP and to possibly invest short-term gains back into the programme to support stakeholders that incur short-term losses in subsequent projects.

#### **6.6.9 Improve inclusivity of stakeholders to reduce model bias**

Across breakout groups, participants noted that politically conservative views, as well as the knowledge and views of end-users, were largely missing from the co-modelling exercise (see Section 6.5.2). It was thus recommended that the model be peer reviewed not only by experts, but by the general public:



*"I wonder if this is the master version, and then it gets taken into the community where you're doing the work and you do it again. And it gets tailored. Because whenever the council comes into our area and says, 'We're going to do this.' Everyone goes, 'No! Don't do that because you're missing this...' There's a local knowledge that is valuable." (H&CC)*

*"It's about getting a 'mini public' for consultation [...]. Also, tapping into local knowledge. And then bringing in expertise beyond what is available within the local authorities." (H&T)*

The extent to which the model should be consulted was unclear, however.

*"Do [users] need to know or review all of this?" [Points to model] (H&CC Facilitator)*

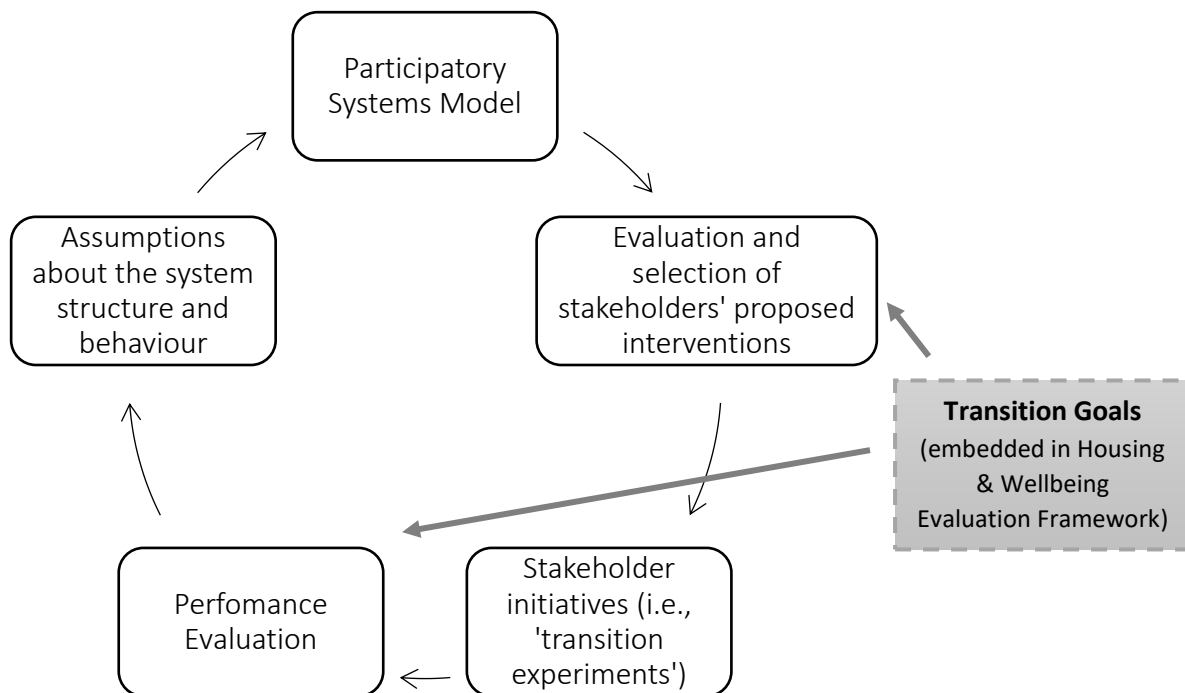
*"That's the million-dollar question." (H&CC)*

## 7 CHAPTER 7: DISCUSSION

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### 7.1 INTRODUCTION

The purpose of this chapter is to further the discussion of my research findings for the advancement of TM methodology and practice. Thus, the lessons presented in this chapter are intended for transition scholars and practitioners. In this project I proposed and investigated methodological adaptations to the Transition Management (TM) framework that could facilitate the iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ via participatory, qualitative systems modelling and external visioning workshops (see Figure 36).



*Figure 36: An adapted, iterative process of ‘learning by doing and doing by learning’*

The first major adaptation involved the removal of visioning exercises from the transition arena, so that ‘transition goals’ could be defined by residents who experience, first-hand, the negative consequences of unsustainable housing development. This adaptation was motivated by a common critique of TM,

namely that its top-down, technocratic model of ‘participation’ produces initiatives that predominantly reflect stakeholder interests (Chang et al., 2017, Hendriks, 2008, Hendriks, 2009, Smith and Kern, 2009, Voß et al., 2009). Findings from this experiment are further discussed in Sections 7.2.1 and 7.3.

To hold ‘frontrunners’ accountable to these goals, an evaluation framework with participant-assigned weights was created. The evaluation framework was to be introduced into the ‘transition arena’ as a tool to mediate the selection of interventions and the design of transition experiments by frontrunners. This fuller investigation was dropped, however, when a pilot workshop revealed that the program was too ambitious for a single-day event. Thus, this project did not support the investigation of certain research questions which had originally been considered, as discussed in Section 6.2.4.

The second major adaptation to the TM framework involved the replacement of ‘back-casting’ with participatory, qualitative systems modelling. This adaptation was motivated by a second critique of TM, namely that it lacks tools for predicting which experiments will ultimately contribute to sustainability transitions and thus to which experiments valuable resources should be allocated (Chang et al., 2017, Loorbach and Wijsman, 2013, Van Eijck and Romijn, 2008). Findings from the co-modelling process (Chapter 5) are further discussed in Sections 7.4.

The group model was created to facilitate systems learning as well as the analysis of proposed interventions by frontrunners. Whilst enabling the analysis of the system structure, the final workshop program *excluded* the analysis of its potential behaviour in relation to proposed interventions. As such, the benefits of and barriers to stakeholder-led, systems analysis for transition management were not fully investigated. Thus, this project did not support the investigation of all research questions, as discussed in Section 6.2.4.

Lessons from these major adaptations are highlighted in this chapter as well as a number of unanticipated insights for TM that go beyond critiques discussed in *Chapter 2: Literature Review*. In my case

study, I found a number of gaps between TM theory and practice (Section 7.5). Some of these gaps resulted from lack of resource and missing buy-in from local government, both of which are preventable. Other gaps, however, resulted from practical challenges associated with recruitment and the execution of TM in an urban-rural setting. Finally, and most critically, this case study revealed theoretical limitations of TM that could account for gaps between theory and practice across TM case studies.

## **7.2 ADDRESSING THE TENSION BETWEEN INCLUSION AND AGENCY IN TM**

Innovators “understand aspects of urban wicked problems, hold innovative ideas or engage in activities in urban development, are committed to their city and sustainability and have the potential to influence change” (Frantzeskaki et al. 2019, pg. 137). They are also a relatively homogenous group, despite their professional diversity. Compared to the general public, frontrunners welcome innovation and change, are educated on and concerned about sustainability challenges on a local and global level and find themselves in positions of power or influence.

As mentioned in the literature review (Section 2.5.1), selective participation, as in the case of TM, neglects the role of power and politics in transition processes, since it privileges the views and priorities of technocrats, and often “exclude[s] the knowledge, preferences, and values of the people affected or concerned by the outcome” (Lynam et al., 2007, p. 2). To foster the scale-up of socio-technical solutions, however, there is a need to maintain the intervention role of powerful actors participating in TM. I thus designed, in detail, a creative, novel solution of turning the visioning exercises over to those who experience (or are expected to experience) first-hand the negative, local consequences of unsustainable housing development (see Section 4.2). In this adaptation of TM, frontrunners would be responsible for developing initiatives, or ‘transition experiments’, that reflect the priorities of those most affected by the outcome. To hold frontrunners to this external vision, they would be forced to apply an evaluation framework, co-constructed in the visioning workshops, to their selection of proposed interventions. This solution was not

ultimately trialed in the multi-stakeholder workshop due to time constraints, as revealed in the pilot workshop. As such, its impact on the TM process went unobserved leaving my original research questions unanswered (see Section 6.2.4).

There were, however, practical lessons to be gained from the challenges I faced in recruiting visioning workshop participants (Section 7.2.1) and reflections to share from the co-modelling workshop, which included only 'transition frontrunners' (Section 7.2.2).

### **7.2.1 Lessons from recruitment challenges**

As mentioned in Section 4.3.3, time-intensive efforts to recruit my target audience for the visioning workshops (residents living in flood zones, farmers, key workers, first-time home buyers, those with limited mobility and accessibility including the elderly and disabled, and those living in high deprivation) were unsuccessful. Ironically, the decision to open the Cambridge workshop to the general public led to a greater representation of my target audience than the closed workshop in Peterborough. In this subsection, I review, in detail, some of the challenges I faced and how they might be overcome.

The first challenge was the introduction of the EU's General Data Protection Regulation (GDPR), confusion around which made gatekeepers wary to advertise the visioning workshops. In the end, only one third of gatekeepers contacted agreed to advertise the workshops via email, social media, printed flyers, or their organization's website. GDPR was only my first hurdle, however. Despite my successful recruitment of 40 gatekeepers, only two gatekeepers managed to successfully recruit attendees, namely Peterborough City Council and Cambridge Housing Society (CHS).

Both organisations sent an email invitation with a £20 voucher offer, albeit to very different listservs. Peterborough City Council's invitation was sent to 470 households on their social housing waiting list (pre-GDPR), and CHS' invitation was sent to a small group of tenant representatives with whom they have good relations. Thanks to a clearly worded and designed electronic flyer and large list-serv, the

Peterborough workshop quickly booked out. However, 70% of registrants did not show up to the workshop, resulting in an under-attended event. Conversely, all of CHS' registrants were present at the Cambridge workshop.

I have taken several learnings from this experience for those wishing to recruit hard-to-reach communities to transition visioning workshops. First, gift vouchers were a helpful incentive, but their effectiveness was much improved when there was a positive, trusting relationship between the gatekeeper and invitees. In retrospect, recruiting local volunteers already embedded in the community and with regular contact to our target audience would have yielded better results. Rather than sending electronic invitations through large listservs with a financial incentive, these volunteers could have discussed the non-financial benefits of participation in-person and reiterated these to registrants in the weeks leading up to the workshop. This would necessitate time and effort to set up and coordinate; however, much of this time could be allocated from the time wasted recruiting an exhaustive list of less trustworthy gatekeepers to advertise the events on my behalf.

Second, it is important to identify who, within the gatekeeper organisation, is best placed to recruit participants. For example, every community centre administrator that agreed to advertise the two events posted flyers on their community bulletin boards, which turned out to be a highly ineffective means of recruitment. In hindsight, it would have been more effective to contact those who run weekly events at the centre and who work with members of my target audience directly. Of the hundreds of flyers I handed out over multiple days at the venue (Arbury Community Centre), only one person attended the workshop. Some members of the community were even upset that “yet another” foreign student was “studying” them rather than providing solutions. This tension speaks to the importance and role of trust in recruiting participants. Again, my time should have been allocated to recruiting and coordinating with group leaders who have already established positive relations with invitees. Given the recruitment challenges I faced, I

would recommend that the transition team contain at least one individual with expertise in recruiting ‘hard-to-reach’ groups and that sufficient time be allocated to recruitment.

Yet, had a more successful recruitment strategy been developed, it is still unlikely that all of the stakeholder groups identified would be represented in a single workshop. Alternatively, questionnaires could be sent out to reach the full target audience – a method used to develop indices such as the PwC’s ‘Good Growth for Cities Index’ (PWC, 2014, PWC, 2017). However, group discussion, particularly around local sustainability challenges, is critical to support processessing of new information. A third option is for the transition team to host workshops with each, individual target group, allowing the transition team to ‘go to the participants’ rather than asking participants to ‘come to them’. However, diverse representation within a single event is also critical to the visioning process. In a workshop setting a list of ‘transition goals’ is developed bottom-up, collectively discussed, and then individually weighted. This group discussion has the potential to widen one’s problem definition and thus responses in the weighting activity. An additional objective of the visioning workshops, as reimagined in this research project, is to expose a small representation of frontrunners to the situated knowledge of those who experience, first-hand, the negative consequences of unsustainable development.

So, it seems there is no way around this recruitment challenge. If transition scholars wish to include hard-to-reach communities in the visioning process in a meaningful way, they will need an expert and well-resource recruitment strategy and team – something I did not have access to as a PhD student. In fact, I later became acquainted with an expert consultant who developed and led recruitment strategies for youth and other hard-to-reach populations for governmental consultations on the United Nations Sustainable Development Goals. I encouraged this consultant to pitch a 2-day ‘recruitment strategy’ training to the doctoral school, but management was unwilling to fund this. Interestingly, fellows at my research institute

also expressed interest, suggesting that even senior researchers may be lacking training on such practical aspects of their research.

Even with this training, however, no recruitment strategy is fail-proof. The inherent challenges associated with recruiting hard-to-reach populations may account for the tokenism I have observed in other TM processes, as discussed in Section 2.5.1. Narrowing the problem definition would likely reduce the target audience significantly and improve the feasibility of achieving representation at visioning workshops.

### **7.2.2 Lessons for inclusion in group modelling**

Participatory systems modelling is not only used as a tool to improve decision-making, it is also meant to build consensus, generate commitment and reduce “fragmentation” (Carnohan et al., 2016, p. 3), or address the lack of integrated planning amongst key decision-makers (Rouwette et al., 2011, Rouwette et al., 2002, Mendoza and Prabhu, 2006). Similarly, TM exercises are meant to generate consensus, buy-in, and coordination amongst ‘frontrunners’ with the power to trial and help scale-up niche innovations. ‘Agency’ is thus an implicit prerequisite for participation in both TM and participatory systems modelling. In this subsection, I review tensions that arose between inclusion and agency in the co-modelling process.

In my adapted TM framework (see Figure 36), frontrunners would be asked to update their system conceptualisation in group model-building sessions post-intervention. This is a significant improvement from back-casting – the method for selecting interventions in traditional TM (Rotmans and Loorbach, 2008) – because, if participants’ assumptions are explicitly modelled, they can be rigorously re-examined post-intervention.

At the frontrunner workshop, I asked participants to reflect on their group modelling experience and to discuss the potential benefits and pitfalls of this methodology for group decision-making – a seldomly evaluated question in the participatory SDM literature (Freebairn et al., 2018). Furthermore, they



were asked to reflect on the pitfalls of this methodology, should it be integrated into the TM framework (i.e. if it were integrated into an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’).

One pitfall raised by participants was the exclusion of situated knowledge of end users. In participatory SDM literature, ‘end users’ typically refer to key decision-makers and opinion leaders that will use the model to make collective decisions and coordinate their actions (Thompson et al., 2010). In my case study, participants were referring to the ‘users’ of their interventions (e.g. households on the social housing waiting list). There was a perceived risk that this exclusion could produce poorly designed interventions and inhibit learning. Indeed, the systems analysis of interventions is limited to the system model’s conceptualisation, meaning aspects of the housing system that are missing from the model would also be missing from the analysis/evaluation of stakeholder-proposed interventions. Yet, the inclusion of such participants in participatory SDM is relatively rare (Fowler et al., 2019, Trani et al., 2016)

An ‘end user’ workshop could be developed in which frontrunner-proposed interventions are introduced in the context of the systems model. End users would then be asked to consider unintended consequences of proposed interventions, and their potential impacts on wellbeing. New theorisations would then be added to the group model, either by a modeller present at the workshop or post-workshop using audio recordings. By hosting ‘frontrunner’ *and* ‘end-user’ workshops, the design of transition experiments could be improved without compromising agency in the TM co-governance process.

A few participants recommended that the systems model be simplified and presented in end-user workshops. It is impossible to know in advance, however, which CLDs, causal chains, or even individual elements may be superfluous to theorisations arising in end-user workshops and should therefore be excluded from the simplified model. Alternatively, researchers familiar with the group systems model could facilitate breakout discussions at end-user workshop(s) to investigate their situated knowledge in relation

to stakeholder-proposed interventions. Cognitive mapping (Section 5.2.3) of end-user theorisations could be conducted in small breakout groups and maps could be modified post-workshop using audio recordings.

## 7.3 FURTHER LESSONS FROM EXTERNAL VISIONING EXERCISES

### 7.3.1 Researcher role in framing the group vision

By introducing ‘Risk Cards’ as a procedural component in visioning work, I sought to update participants’ problem identification with known economic, social, and environmental risks to long-term wellbeing. For those already familiar with local sustainability challenges, I sought to bring this information to the fore to frame discussions around utopian and dystopian housing systems. This intervention framed the qualitative vision, as evidenced by the pre- and post-Risk Card ‘transition goals’ or components of groups’ utopian visions written on different coloured sticky notes. In this subsection, I reflect on my concerted effort to frame group visions and how this amounts to *participation* in the creation of the GCGP Housing & Wellbeing Evaluation Framework.

In a systematic review of urban ‘visioning’ workshops, John et al. (2015) found that workshops containing presentations or modules on sustainability produced visions of more sustainable cities. These unsurprising results are in line with findings from literature on ‘cognitive media effects’ and the influence of priming or frame-setting on human decision-making (Scheufele, 2000, Plous, 1993), as with findings from the Cambridge and Peterborough visioning workshops.

The extent to which Risk Cards influenced the participants’ point allocations, and thereby the final evaluation framework, is unknown. One could argue, however, that the disproportionate weight assigned – by diverse participants alike – to transition goals falling under the ‘Low-impact infrastructure and living’ theme (36%), compared to the second-highest priority, affordability (15%), provides some indication that environmental Risk Cards had a significant framing affect. That said, there were an equal number of Risk

Cards covering social sustainability challenges. Another potential explanation for this outcome is the number of co-benefits associated with environmental interventions (e.g. more equal accessibility and health outcomes resulting from mixed used planning).

If Risk Cards did have a significant impact on participants' point allocations, then so too did I through the preliminary sustainability analysis and creation of Risk Cards. Through its use in the transition arena, the evaluation framework is meant to mediate the selection of stakeholder-proposed interventions, meaning researchers' framing power could translate into concrete outcomes of the transition management process. Indeed, this is already the case in traditional TM, as a systems analysis is presented prior to visioning activities with frontrunners. However, my proposed adaptations to the TM framework are intended to break down existing power structures and give voice to those who experience, or are likely to experience, the negative consequences of unsustainable development. The influence of the research team was partly mitigated by the fact that Risk Cards were introduced mid-visioning, meaning participants' transition goals free of framing were also introduced into group visions and assigned weights at the end of the workshop. However, it is important that researchers recognise their role as *participants* in the visioning process and openly report how their own personal values shape the analysis and decisions on what material is presented at visioning workshops.

In the case of this study, the sustainability challenges were identified in extensive desktop research, starting with the county council's 2017 Joint Strategic Needs Assessment (JSNA), which "aims to describe the current and future health, care and wellbeing needs of the local population and to inform the local Health and Wellbeing Strategy"(Cambridgeshire County Council, 2020, no pagination). The collection of data for the JSNA is directed by central government, and thus reflect priorities of Government. "Need" is thus determined in techno-economic terms, with a focus on housing supply in relation to local population growth. To expand the definition of 'housing need', I reviewed grey literature from interest groups such as

Age UK and Shelter with an interest in better understanding the experiences and needs of low-income households, those living with disability and carers. I took several more decisions, such as this, regarding my selection of grey literature related to housing and social sustainability. These decisions were motivated by my concern over growing polarisation in housing opportunity in the UK and the related growing inequality in wellbeing. I wanted the project to explore how the right to adequate housing (OHCHR, 2014) is not being met and how this failing may interact with other trends such as an aging population, growing geographic health and education disparities in Cambridgeshire and Peterborough, and an overstretched National Health Service. This was a values-based decision that strongly influenced which academic and grey literature I chose to review.

The values, perspectives, and concerns of those interviewed to construct the qualitative systems model also shaped which academic and grey literature were included in the sustainability review. For example, two major events expected to create new or worsen existing social and economic trends, namely the '4<sup>th</sup> industrial revolution' and 'Brexit', repeatedly emerged in stakeholder interviews and were thus included in my sustainability review. As such, the group vision is not fully 'external' to the TM arena.

### **7.3.2 Does the evaluation framework facilitate learning and decision-making around trade-offs?**

Systems modelling was intended to support the analysis of stakeholder-proposed interventions. With an improved understanding of subsystem interlinkages and the potential unintended consequences of intervention, frontrunners would have a better understanding of 'trade-offs' when evaluating their proposed interventions against the GCGP Housing & Wellbeing Evaluation Framework.

Trade-offs can be accounted for using the evaluation framework, as negative ratings affect an intervention's overall score. Trade-offs between conflicting transition goals, however, were not explicitly discussed in visioning workshops. As such, it is impossible to achieve all aspects of the group vision concurrently (e.g. 'car-free developments' and 'more parking'). Interestingly, the evaluation framework

provides frontrunners with a tool to present trade-offs to the public when explaining their decisions. This would, in theory, support public debate and, potentially, consensus-building.

If the evaluation framework was scrapped, and frontrunners were asked to focus on delivering initiatives that tackle participants' top priorities, namely environmental sustainability and housing affordability (as proposed in Section 2.1.2), the discussion of trade-offs would be limited to these two priorities. Interestingly, assumed trade-offs between environmental sustainability and housing affordability accounts for much of Government's inaction on building regulations. As such, requiring frontrunners to simultaneously tackle these two challenges, using systems learning they gained from the co-modelling process, would be a meaningful exercise. It is these experiments that, collectively, may 'unlock' a transition to sustainable housing.

As previously alluded to, there are also trade-offs across time. As such, a housing system that meets today's needs does not necessarily indicate a positive "state of becoming," and a housing system that falls short on meeting today's needs does not necessarily indicate a negative "state of becoming". As future-oriented artefacts, the utopian vision for housing in 2060, its priorities, and the resulting evaluation framework, seeks to account for trade-offs across time. Given current trends, local residents expect housing affordability to worsen with time, as well as environmental crises such as climate change, water scarcity and biodiversity loss. Thus, these priorities can be considered legitimate for the protection of future generations. Problematically, however, the vision does not consider trade-offs across geographies. Not only is the resulting vision human-centric, it also Cambridgeshire and Peterborough-centric. Other visioning frameworks and methods of public engagement are being developed to address this shortcoming. For example, the Doughnut Economics Action Lab is developing methods to facilitate visioning activities that explicitly ask participants to consider the *global* environmental and social impacts of local economies, in addition to the *local* impacts (DEAL, 2020).

## 7.4 LESSONS FROM MY ATTEMPT TO REPLACE BACK-CASTING WITH PARTICIPATORY SYSTEMS

### ANALYSIS

‘Systems thinking’ is an approach for problem solving that views problems as parts of an overall system rather than reacting to specific parts (Ackoff et al., 2010). My motivation for replacing back-casting with participatory systems modelling was to help transition frontrunners shift from linear thinking (facilitated by the back-casting activity) to systems thinking (facilitated by participatory systems modelling) when analysing proposed interventions. Because my frontrunner workshop did not progress to the analysis phase, I was unable to provide full responses to the following research questions:

- (8) How, and to what extent, did the participatory modelling facilitate systems learning?
- (9) What technical barriers arose during the co-modelling activities?
- (10) How, and to what extent, did participatory systems modelling help build consensus around ‘system leverage points’?
- (11) How, and to what extent, did participatory systems modelling affect stakeholder buy-in?

As presented in Chapter 6, there was evidence of systems learning and improved consensus around the system’s *structure* as a result of reviewing and editing the group model. Could agreement on the system’s structure translate into agreement on “system leverage points” (Meadows, 1999, p. 1)? Would results of the systems analysis produce counterintuitive findings that frontrunners found hard to believe? Would the use of frontrunner built CLDs, as a facilitation tool to explain these counterintuitive findings, convince sceptics or would the qualitative models be considered unreliable? These questions were left unexplored due to practical barriers that arose when attempting to integrate group systems modelling into the TM framework (Section 7.4.1). There were, however, suggestions that cognitive barriers might also

create barriers to systems learning and consensus building, calling into question the efficacy of *qualitative* systems modelling (Section 7.4.2).

#### **7.4.1 Practical barriers to integrating systems co-modelling into Transition Management**

Practical barriers to integrating systems co-modelling into Transition Management included time constraints, on the part of the TM team and participants, and a lack of facilitators trained in qualitative systems modelling.

In the original frontrunner workshop itinerary, I devoted less than an hour to the review of subsystem models. As I discovered in the pilot workshop, this time was insufficient to review CLDs in groups of four to five participants. At the frontrunner workshop, multiple groups did not manage to review all of the diagrams assigned to them. Even those who contributed to the formation of the model via one-on-one interviews needed more than an hour to review the CLDs, as the final group model varied significantly from individual mind maps. At both workshops, I also witnessed the unequal accessibility of CLDs. Some participants found it easy to grasp causal theories modelled in the CLDs whilst others struggled and rather sought verbal explanations, stories, and examples. These participants would have benefited from accessing interview quotes embedded in the digital model. Taking time to read and reflect on these quotes would have slowed the model review process further, as well as training participants on how to navigate and edit the digital model using Kumu.

To complete all of the envisioned tasks with improved accessibility, the workshop would need to span three days. This, however, would require significant stakeholder buy-in. Because the Combined Authority had made no commitment to fund or even consider resulting proposals, it is unlikely that participants would have agreed to commit so much time to the co-modelling process. To improve buy-in, stakeholder engagement could be re-imagined as a 3-day continued professional development (CPD) course at the partner university (see Table 8 for a rough outline).

*Table 8: 3-day practitioner modelling course to support the analysis, selection and design of multi-stakeholder initiatives*

Day 1	Intervention proposal and rating; Introduction to Causal Loop Diagrams; Review of assigned subsystem models Kumu
Day 2	Integration of proposed interventions into group model; Modelling 'future' variables
Day 3	Causal tree activity and reporting 'unintended consequences' back to the class; Re-rating of proposed interventions; Initial brainstorming of multi-stakeholder initiatives

Inviting co-investigators into an academic setting has two benefits. First, the modelling activities could take place in a computer lab so that participants could make edits directly into the online model and have access to embedded quotes. The former would reduce the amount of modelling work by circumventing the digitalization of hand-drawn edits, and the latter would provide participants with variable definitions. Second, working in a computer lab could facilitate a simpler route into and navigation of the model (see Section 6.6.4).

Third, inviting practitioners into an academic setting would likely improve their willingness to engage more deeply with the model and invest more effort in learning the various modelling and analysis methods being taught. Owning the model fully, i.e., building it from scratch, may also improve engagement, but I would not recommend this adaptation for reasons explained in Section 6.6.2.

Challengingly, a three-day training would likely attract a different cohort of practitioners than those targeted in TM. The workshop was designed to attract senior managers for reasons explained in Section 6.2.1. If invited, these individuals would likely send middle managers if they felt the training and networking



opportunity would be of value to their organization. There is a question, however, as to whether or not the systems learning by middle managers would translate upward to key decision-makers.

*“I think in any organisation, where you end up with strategies [...] they have to be pretty simple because they’re playing to either a board, that’s not going to sit here for a day, so you dilute a lot of sophistication, quite often. So, you get the middle-manager world of geekiness, and then they simplify up for those who ultimately have to do something. In the end, you lose a lot of nuance in what you do. I think in a governance context, it would be critical to find the people willing to give time to unpick some of this complexity and then find out how you would translate it into the governance of single KPI’s, for example. That’s just the reality.” (H&C)*

I would thus recommend the participation of both senior management (in the case of visioning and decision-making regarding the selection of multi-stakeholder initiatives) and middle-management as critical “intermediaries” (Bush *et al.*, 2017). As co-modelers and co-investigators in the 3-day workshop, these intermediaries would carry out the boundary work of building relationships with a wide range of stakeholder representatives; coming to understand their diverse perspectives; learning about, discussing, and modelling subsystem interlinkages; discovering unintended consequences of intervention; building consensus around problem and solution definition; and returning to upper management equipped with CLDs and new insights informed by qualitative systems modelling. This solution could also help ‘institutionalise’ an iterative, systems approach to local, multi-stakeholder initiatives, as organisations would commit to “double loop learning” (see Section 7.5.3).

Another option is to bring co-modelling and analysis back “in-house”, as proposed by participants of the co-modelling workshop (see Section 6.6.5). This would require a shift away from *participatory* toward *participative* systems modelling, as in Maas *et al.* (2018). Unlike Maas *et al.* (2018), however, systems analysis would also be used as a method of “option appraisal”, as recommended by participants of the co-

modelling workshop (see Section 6.6.6). Although systems analysis was removed from the frontrunner workshop itinerary due to time constraints, participants were asked to reflect on if and how the group model could be used to improve decision-making in multi-stakeholder partnerships. Participants largely agreed that systems analysis would make a valuable contribution to the group selection of proposed interventions, provided that the transition team conducted the analysis. The transition team would be responsible for exploring how the complex system might react dynamically to proposed interventions creating emergent system behaviour and unintended consequences. The team could also investigate the potential synergistic or counter-productive effects of combining interventions. This analysis would enable a greater consideration of unintended consequences, trade-offs, and the potential need to compensate organisations where the costs and benefits are not shared by members of the multi-stakeholder partnership. Findings would then be reported in a follow-up workshop with frontrunners. With findings fresh in mind, frontrunners would select interventions based on their expected performance against the 'transition vision'.

Bringing systems analysis back 'in-house' is perhaps the most realistic option, as it requires very little upfront commitment from participating stakeholders. It has three drawbacks, however. First, there would be no check against modeller bias (Sterman, 2002), which is significant when it comes to the selection of data (e.g. academic and grey literature) as well as the interpretation of interview data. Second, frontrunners would no longer be involved as co-investigators, meaning they may not trust the outcomes of systems analysis, particularly in the case of counterintuitive findings. Indeed, Thabrew et al. (2009) argue that transparency and participation in scientific analysis improves responsible decision-making in multi-stakeholder contexts. Third, as was evidenced in my action research project, interpersonal trust is not easily built between participating frontrunners and the transition team in single-day workshops. A 3-day CPD course would feel less like a professional 'networking' event and more like an opportunity to experiment

and learn. By spreading activities across these days, participants would also have more opportunities for informal, social interaction and trust-building.

There is a final technical barrier that has not been discussed. Integrating participatory systems modelling, in any form, significantly extends TM's timeline. In its entirety, the process of model co-construction took over 1000 hours of work executed over a period of 1.5 years. Similarly, the iterative process of participative systems analysis carried out by the transition team in Ghent spanned six months with the support of six transition team members (Maas et al., 2018, p. 169). This lengthy process may be of particular concern if partnering organisations on the transition team, such as the local authority, are working on shorter timelines.

#### **7.4.2 Cognitive barriers to integrating qualitative, participatory systems modelling into Transition**

##### **Management**

Whilst interviewees appreciated the exercise of mind mapping, frontrunners having attended the co-modelling workshop found it difficult to work with the CLDs. On the one hand, participants experienced difficulties working with such a large model and called for its simplification (see Section 6.6.1). This highlights the benefit of drawing more limited system boundaries such as those employed in the UCL Housing, Energy and Wellbeing project. On the other hand, many participants found the diagrams difficult to work with regardless of size, as they do not, in isolation, provide answers regarding the best course of action. Part of their frustration may be explained by the fact that the activity was not carried out to its conclusion (i.e. systems analysis). Although systems learning is a product of systems modelling, one does not gain a comprehensive understanding of the system or its dynamics by simply building a model of its structure. It is unclear how much of this frustration would be resolved by *qualitative* systems modelling and analysis given known cognitive limitations: "Decision makers exhibit rationality but only within the constraints of their bounded view of the problem—thus the term bounded rationality (March and Simon

1958). [...] Thus, some form of computer-aided group decision support system is required (Eden 1992a)” (Eden, 1994, p. 268).

Proponents of *quantitative* systems modelling argue that “bringing in real world data to develop small pieces of computer simulation from the collaborative maps is an important next step to test these collective theories and support learning – about the maps themselves as well as about what they mean for trends over time” (Macmillan et al., 2014, p. 9). However, there is the acute issue of data availability at the local level which precludes quantitative systems modelling. Despite the controversy surrounding qualitative systems modelling in SDM literature (Stermann, 1994), advocates argue that quantification can be highly misleading when parameters are excluded due to missing data (Coyle, 1997, Coyle, 1999, Wolstenholme, 1999, Wolstenholme, 1992). In these cases, “The choice for the interventionist is then to either simply walk away from the management problem or to use the rigour of diagramming to aid the debate and increase the group's information processing capacity. After all, diagrams help to keep track of complex structures (Anderson and Crawford, 1980, Larkin and Simon, 1987, Lippitt, 1983)” (Vennix, 1999, p. 382). Moreover, qualitative models have greater texture and depth, allowing users to explore things that cannot be explored with quantitative data (Luna-Reyes and Andersen, 2003).

This texture and depth come at a cost, however. In their analysis of system-wide effects of patient flow policies for the Ontario Ministry of Health and Long-term care, Esensoy and Carter (2015, p. 15) concluded that “qualitative whole-system modelling is a highly valuable but resource-intensive approach to facilitate systems thinking for policy development”. This is even more so the case for qualitative system models that are large in scope. Much like this research project, Esensoy and Carters’ work did not seek to answer a pre-defined policy question. Thus, the project required a qualitative systems model with an intentionally broad scope. From my experience with this action research project, I would recommend that

researchers avoid setting intentionally broad system boundaries if they do not have the time, human resource, and stakeholder buy-in to invest in the time-intensive process of group modelling and analysis.

## **7.5 GAPS BETWEEN TRANSITION MANAGEMENT THEORY AND PRACTICE**

In my application of TM, I experienced a number of deviations from “ideal-type” TM (Hölscher and Wittmayer, 2018, p. 205). As with all action research projects, context-specific conditions affect the way methodological frameworks are implemented on a procedural level. In applied TM, the gap between TM theory and practice is well documented. For example, transition scholars have cited conditions such as local elections, existing/well-developed local sustainability policies, resource constraints, and lack of political will as factors influencing the quality and depth of the systems analysis, the level of ‘transformative’ thinking, the redefinition (or reconfirmation) of actor roles, and whether or not the process resulted in concrete actions (Wittmayer et al., 2016, Hölscher and Wittmayer, 2018, Wittmayer et al., 2018a). This section (7.5) contributes further to the list of gaps between TM theory in practice and their causes.

### **7.5.1 The gap between ‘ideal’ and recruited frontrunners**

In my application of TM, I was unable to recruit an ‘ideal’ group of frontrunners. In this section, I outline factors specific to this case study that created challenges for meeting participant selection criteria. I then discuss inherent tensions between selection criteria that may arise in any case study.

According to TM literature, ‘ideal’ participants are system innovators who demonstrate an openness to change, have some form of power or agency, and are ‘like-minded’ regarding their commitment to sustainability (Loorbach, 2007, 2010; Frantzeskaki, Loorbach and Meadowcroft, 2012). Collectively, they should also hold diverse perspectives on and knowledge about the transition challenge and represent different sectors of society (e.g., government, businesses, and community groups).

In my project, I was the only TM scholar on the transition team. Relatedly, I was the only member of the transition team committed to fulfilling TM selection criteria on the individual and group level. Other members of the transition team – involved for many years with local sustainability initiatives and local governance – focused mainly on the ‘agency’ criterion, due to their personal theories of change. This led to the invitation of participants with varying levels of commitment to sustainability, engaged in varying levels of niche-activity. Whilst the majority of participants were truly ‘frontrunners’, some did not meet this criterion.

Much like members of the transition team, several frontrunners believed that certain ‘key stakeholders’ in the city-region would need to be involved for initiatives, or ‘transition experiments’ to be successful. In addition to the Combined Authority, these included large housing developers. These developers were not invited into the transition arena due to their lack of commitment to social and environmental sustainability and institutional rigidity (i.e. inability to innovate). In fact, TM selection criteria discourages the involvement of incumbent actors with sunken investments and interest in maintaining the status quo. Rather, the transition arena should be a space for niche actors, such as housing associations and small-to-medium size developers with a demonstrated desire to innovate.

In their case study in Carnisse, Wittmayer et al. (2018a, p. 390) found that the limited involvement of key decision-makers resulted in a feeling of “limited leverage” amongst arena participants. The authors concluded that “there is a need to mediate across diverse actors and resource bases”. In other words, there is an inherent tension between the ‘agency’ and ‘innovator’ criteria. The only resolution is to include a small number of “change-inclined, innovative regime players” surrounded by niche actors so as to maintain an environment supportive of niche activity, as recommended in Loorbach and Rotmans (2010, p. 243). Another implication of this finding is that small-group facilitators need to be well-trained in facilitation methods that mitigate power dynamics in group discussions.

Having applied TM at the sub-regional level, I expanded the 'representation' criterion, to include geographical representation. In other words, I sought an equal share of participants from the two cities and four rural districts of Cambridgeshire and Peterborough. What I discovered, however, is that the majority of 'innovators' were located in the cities of Cambridge and Peterborough. I even found myself inviting national frontrunners that operate in the region but are London-based, such as the community-focused developer Igloo and the specialist mortgage company, Ecology. All national frontrunners declined my invitation. Because the workshop was held in Cambridge, there was a low turn-out from Peterborough invitees. As a result, the majority of participants represented organisations in Cambridge City or South Cambridgeshire – a rural district surrounding Cambridge City and that fully falls in the city's 'travel-to-work area' – despite my concerted effort to recruit individuals and organisations based outside of Cambridge.

I have drawn two recommendations from my experience. First, when working in city-regions with two or more urban areas, I would advise running parallel but separate transition processes to improve geographic representation. If appropriate, these processes can intersect, and potentially merge, in a region-wide workshop to link initiatives during the 'getting into action' phase. This may not be possible with limited resources, meaning projects with smaller budgets and human resource, such as mine, should focus on single urban areas. Second, transition scholars applying TM in a city-region should think carefully about how to represent the knowledge, perspectives and priorities of rural communities (e.g. in the visioning phase) if the same urban bias is found in the group of transition frontrunners.

As previously mentioned, I had difficulty with recruitment in general, as my contacts at the original partner organisation, the Cambridgeshire and Peterborough Combined Authority, each resigned one-by-one. In the end, the regional association of local governments co-hosted the frontrunner workshop. Had I achieved buy-in from the mayor of the Combined Authority (CPCA), I would have secured its institutional involvement in the project. This was no small set-back, as the CPCA controls a 30-year Invest Fund totally

£600 million in addition to its annual housing infrastructure budget (DCLG, 2017). Unfortunately, some of the region's leading innovators (architects based in Cambridge and Peterborough), RSVP'd when the CPCA was advertised as the co-host but did not attend the final event, co-hosted by the regional association of local governments. This experience highlights the role of power and politics in transition processes and the need to secure and maintain institutional buy-in from the subnational government.

### **7.5.2 The gap between 'ideal' and practiced co-governance**

In my execution of TM, I mostly worked as a one-woman team with supervision from my PhD supervisors, occasional support by research interns, and support from workshop facilitators. Because I did not pursue a genuine partnership with the Combined Authority, I was free to carry out my experiment with external visioning workshops and participatory systems modelling. This freedom (or control over the TM process) came at the cost of institutional buy-in. The TM literature lists a number of practical limitations that arise when partner governments are not bought in to the TM process. For example, when partner governments do not commit political capital, finance, and human resource, the TM process can produce an incomplete systems analysis and inaction on the transition vision (Hölscher and Wittmayer, 2018, Wittmayer et al., 2016, Loorbach and Rotmans, 2010).

In my project, the lack of institutional buy-in made it difficult for me to recruit LA officers as small-group facilitators for the frontrunner workshop and thereby foster links between LAs and transition frontrunners (Section 6.2.3). It simultaneously made it difficult to recruit 'ideal' frontrunners (Section 7.5.2).

Although the project would have benefitted from greater involvement of the Combined Authority, there is also a risk that, with more political and financial investment, the CPCA would seek to control outcomes of the TM process. For example, in the Ludwigsburg case study, the local government misused the TM process to consult frontrunners on policies that are already well developed (Hölscher and



Wittmayer, 2018). Governments could also misuse TM to raise finance and procure services from local organisations for predetermined projects. Such actions by local government go against the governance principles of TM and preclude the benefits of co-creation, creating a gap in TM theory and practice. This risk was raised by participants of the GCGP frontrunner workshop. They argued that partnerships with local government too often adopt the top-down, ‘command and control’ model of private finance initiatives that stifles creative problem-solving and innovation. In other words, there is a tension between institutional buy-in and institutional commitment to co-governance. It is, therefore, the responsibility of the transition scholars/practitioners to mitigate this risk by convincing government partners of the merits of TM governance principles (Wittmayer et al., 2018b).

For co-governance to take place, however, transition scholars must first manage to secure buy-in from government. In my case study, the governance partner was largely missing, creating recruitment challenges, limited resource to conduct the preliminary and participatory systems analysis, and a leadership vacuum preventing progression to the “Getting into Action” phase. In my review of TM, I did not come across practical tips for partnering with local government – only lessons from limited government buy-in. Transition scholars, particularly early career researchers, such as I, would benefit from transparent discussions around partnership building and how to secure institutional buy-in.

### **7.5.3 Iterative ‘learning-by-doing’ and ‘doing-by-learning’: An impossible pursuit?**

In theory, transition researchers and frontrunners are meant to commit to an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ (Loorbach, 2014). Although the project was cut short, participants were asked to discuss, hypothetically, whether their organisations would commit to an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ within a partnership framework. Participants were intuitively pessimistic about the prospects of such an iterative learning process.

First, it was suggested that individuals, let alone institutions, are not very good about ‘learning from their mistakes’. This phenomenon is analysed in the seminal work of Argyris (1977) on “double loop learning”. Participants at the frontrunner workshops considered time constraints to be the key barrier to organisational learning. In other words, organisations are too busy meeting short-term demands to devote time to monitoring and evaluation. There was a recognition that organisations discount long-term gains and are, thus, unwilling to incur significant costs in the short-term for the purpose of improving or even securing performance in the mid- to long-term. In the words of Argyris, however, “the bottom line is not a tough enough criterion to use to evaluate the importance of double loop learning. It is not enough to ask, for example, what the profit of the company is. A tougher question is whether the company can continue to make a profit” (p. 124). Applying the theory of Argyris (1977), individual employees will continue to adopt this prioritisation of short-term costs/benefits if management does not make a concerted effort to deconstruct this practice and lead by example.

A local sustainability expert noted that *“Issues around committing time for individuals in organisations that need to allocate that time against specific outputs presents one of the biggest challenges to solving sustainability problems.”* This is particularly true, as sustainability problems are complex, meaning the costs and benefits of action do not fall to one societal actor, or organisation. There was near-unanimous agreement that members of a multi-stakeholder partnership would *not* contribute to transition experiments that do not yield short-term benefits for their individual organisations regardless of the long-term outcomes, and that partners would not accept short-term losses without compensation. According to complexity theory, however, interventions to improve conditions in the mid- to long-term may require losses in the short-term (Sterman, 2006). This calls into question the sufficiency of iterative systems of learning and raises questions around the role of power and politics in transition processes – questions that are largely neglected in TM literature (see Section 2.5.1).

Local authorities with a stable majority, however, should in theory be interested in long-term social, economic and environmental performance. As such, participants suspected that local authorities would be the most likely actor to participate in an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’. However, LAs in the UK do not have the power to regulate markets and effectively change the cost-benefit analysis of private companies. This reality calls into question the level of governance with which TM scholars are most engaged (Frantzeskaki et al., 2018b). The local turn has moved TM scholars further away from national policy makers who do hold this power.

There is also the case of academic institutions, which participants believed would have an interest in engaging in this iterative process. Perhaps this explains the one example participants provided of this iterative learning process in practice: an informal partnership between South Cambridgeshire District Council and a Cambridge University research institute (see Section 6.4). In TM, researchers are meant to facilitate and participate in the iterative learning process by systematically collecting, analysing, interpreting, and reporting scientific research and supporting theory development in relation to the system’s structure and dynamic behaviour. This learning informs the design and selection of ‘transition experiments’ around which transition researchers are meant to coordinate applied research. From a critical realist ontology, applied research addresses shortcomings in frontrunners’ situated knowledge, as experiential learning reshapes actors’ beliefs about the system in which they are intervening. Based on complexity theory, new system properties are also expected to emerge throughout the iterative process of ‘learning-by-doing’ and ‘doing-by-learning’. Applied research is conducted to update frontrunners’ understanding of the system as it evolves.

In practice, however, the involvement of transition researchers is short-lived (Hölscher, 2018). The limited timeframe of TM case studies precludes transition research involvement in the iterative process of ‘learning-by-doing’ and ‘doing-by-learning’. Indeed, there is even a call for transition researchers to study

the impacts of past ‘transition experiments’ to assess if TM is even an affective governance framework for sustainability (Schäpke et al., 2017, Kivimaa et al., 2017, Hölscher, 2018). So, not only is the involvement of commercial stakeholders called into question, so too is the involvement of academic actors for iterative processes of ‘learning-by-doing’ and ‘doing-by-learning’.

In summary, there seems to be a *significant* gap between theory and practice regarding the transformative power of co-governed transition experiments. This gap is seemingly owed to the role of power and politics in transition processes, which is largely ignored in TM theory. As per the recommendation made by the ‘Housing & Environment’ group, it was suggested that the investigation of national policy interventions using systems analysis could be highly impactful, however. If national policy is explicitly handled in the systems analysis, the local application of TM can also improve consensus around and advocacy for policy innovations at the national level, and thus facilitate bottom-up change processes. At the local level, participatory systems modelling could support the discovery of place-based solutions, carried out by local multi-stakeholder partnerships, with the support of policy reform at the national level.

## 7.6 CONCLUSION

When planning this research project, I sought to design and implement methodological adaptations to the TM framework that addressed two critiques found in the literature: (1) TM’s top-down, technocratic approach to co-governance (Section 2.5.1); and (2) the overreliance on ‘variation and selection’ to trigger transition processes (Section 2.5.3). Although my work around these two criticisms was originally distinct, findings from both pieces of work (visioning and co-modelling) brought me to a shared conclusion: The absence of power and politics in TM’s theoretical foundations has produced significant blind spots in its conceptualisation and calls into questions its efficacy as a governance framework for niche experimentation and regime destabilisation.

In my case study, I made a significant effort to include underrepresented voices in the visioning process. Yet, as an academic, decision-makers and opinion leaders were easier for me to access and recruit than those who suffer first-hand from unsustainable development (Section 7.2.1). This realisation has led me to question my position in society and relation to the incumbent regimes my work seeks to dismantle. In fact, the position of power I held in this research project produced a number of adverse outcomes. Like many systems modellers before me, I prioritised the knowledge of experts and key decision-makers, only to be reminded of the value of the situated knowledge of end-users and non-experts (Section 7.2.2). Even when my project sought to raise the values and priorities of those who suffer first-hand the negative consequences of unsustainable development, I framed the visioning exercises around sustainability issues about which local practitioners and I are knowledgeable and concerned (Section 7.3.1). Given the focus on *local* sustainability issues, visions, and interests, the evaluation framework does not take into account the wellbeing of those outside the region (Section 7.3.2). As such, the TM governance framework, as applied in my research project, reinforced, rather than challenged, regional and global power dynamics entangled in unsustainable housing development in Cambridgeshire and Peterborough.

Power and politics not only mediated the transition *vision* that was developed outside the transition arena, it also affected the transformative capacity of the transition *network* operating inside the transition arena. Concerns over agency, particularly from members of the funding organisation, led to the inclusion of individuals who do not qualify as ‘transition frontrunners’ (Section 7.5.1). Because the project lacked buy-in from the Combined Authority, local frontrunners had little incentive to participate in the research project, resulting in a high no-show rate at the frontrunner workshop (Section 7.5.2). Lastly, the transition management framework assumes that frontrunners can invest in an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’, when, in actuality, commercial frontrunners, in particular, operate in a highly competitive environment and cannot afford the short-term costs of monitoring and

evaluation when their competitors, incumbents of the regime, already have a significant advantage. A public body, it was suggested, is better placed to bear the costs of monitoring and evaluation, but even this body, in the local application of TM, does not have the power to intervene when the *collective* short-term costs of intervention outweigh the short-term benefits (Section 7.5.3).

So, although this research project sought to advance TM methodology, my action research project revealed just as many insights for TM theory as for TM methodology. Methodologically, my research project produced two main findings. First, a number of practical barriers make it difficult for TM practitioners to resolve the tension between inclusion and agency in TM. If the meaningful inclusion of those who experience first-hand the negative consequences of unsustainable development cannot be achieved, TM scholars should investigate the theoretical implications of this challenge for TM *in practice*. Second, time constraints pose a significant barrier for the systems analysis of frontrunner-proposed interventions. Findings from participatory SDM suggest that narrower system boundaries and reduced demands on transition frontrunners as co-investigators may help to address this practical barrier.

## 8 CHAPTER 8: CONCLUSIONS

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In a unique policy window provided by English Devolution, this research project aimed to experiment with two methodological adaptations to the prescriptive governance framework, Transition Management, to uncover knowledge that may help accelerate present-day transitions toward sustainability. In addition to investigating my proposed adaptations to the TM governance framework, my action research project facilitated the creation of a vision for sustainable housing development in the Cambridgeshire and Peterborough city-region (Chapter 4) and a qualitative systems model of the 'Housing & Wellbeing system' (Chapter 5). Together, these research outputs can be used to generate hypotheses around the intended and unintended consequences of interventions (e.g. national policy reform or local multi-stakeholder initiatives) on future wellbeing. Although these two research outputs can be considered contributions in their own right, the purpose of my action research project was to study procedural elements of the Transition Management framework. Thus, this chapter draws conclusions from the *process* of creating the group vision and systems model.

Due to practical barriers experienced at various stages of the research project, I was unable to investigate all of my initial research questions to their natural conclusion. Because my research focused on procedural elements of TM methodology, however, I found myself in the unique position to reflect on these barriers and their wider implications for TM. What emerged was a number of findings regarding the widely reported gap between TM practice and theory (Chapter 6). This chapter summarises my research findings discussed in Chapter 7, draws conclusions for the operational governance application of TM, and provides recommendations for future research.

## 8.1 RESOLVING TRANSITION MANAGEMENT'S TENSION BETWEEN INCLUSION AND AGENCY

- Did the use of the 'evaluation framework' sufficiently steer outcomes? If not, why not (e.g., stakeholder co-optation, insufficient time to complete activity, workshop design, etc.

The GCGP Housing & Wellbeing Evaluation Framework' was co-constructed in early stages of the research project, but its use in the Transition Arena was never tested. Due to limited resources and the lack of institutional buy-in from the Cambridgeshire and Peterborough Combined Authority, I could host only one workshop with transition frontrunners. In this workshop, frontrunners proposed housing-related interventions intended to secure or improve long-term wellbeing and edited the group systems model. The pilot workshop revealed there was insufficient time to then evaluate proposed interventions using the qualitative systems model and their expected performance against the evaluation framework. As stated in the Discussion Chapter (Section 7.4.1), additional workshops would need to be scheduled to investigate whether and how the evaluation framework steered outcomes of the TM governance process.

- How, and to what extent, did the use of the Evaluation Framework affect stakeholder buy-in to the transition experiments (i.e., multi-stakeholder initiatives)?

For reasons stated above, this research question was not investigated.

- How, and to what extent, did the use of the Evaluation Framework improve the perception of process legitimacy by participating stakeholders?

For reasons stated above, this research question was not investigated.

- Related findings having emerged under this theme



- ❖ I attempted to resolve the tension between inclusion and agency through the creation of an external transition vision which, in the form of an evaluation framework, could hold transition frontrunners accountable to the priorities of those experiencing, first-hand, the negative consequences of unsustainable housing development. I learned, however, that this tension exists *throughout* the TM process, not only in the visioning phase. In Phase V: Exploring Dynamics in your city, this tension emerged during co-modelling exercises, as frontrunners noted the risks of excluding ‘end user’ knowledge from system conceptualisation. Presumably, this exclusion would also negatively impact the iterative process of ‘learning-by-doing’ and ‘doing-by-learning’.
- ❖ As an academic researcher, I found it much easier to recruit powerful actors than those suffering the negative consequences of unsustainable housing development. As a result, the situated knowledge of those who have first-hand experience with failings of the housing system received less attention than the situated knowledge of those with intervening power in the housing system (e.g. planners, architects, and developers). Given the potential effects of this representation bias on the transformative power of TM, I call on TM researchers to report openly and honestly on their recruitment challenges and to share best practice in their efforts to mitigate this source of bias.
- ❖ Findings from the visioning workshop suggest that ‘Risk Cards’ significantly influenced participants’ point allocations. Indeed, TM practitioners are asked to frame visioning exercises by first presenting findings from their sustainability or ‘systems analysis’. For the sake of improved transparency, I call upon TM practitioners to openly reflect on how their personal values, knowledge, and priorities have influenced the group vision through their *participation* in the research project.

- ❖ A trade-off exists between the accuracy and time-intensity of methods for point allocation.

Having chosen the least time-intensive method, the resulting evaluation framework inflated the relative value of participants' greatest priorities and deflated the relative value of criteria that were of lower priority, but still considered important for securing future wellbeing. If an evaluation framework is created in future applications of TM to help resolve the tension between inclusion and agency, I recommend the use of more accurate methods of point allocation, likely requiring a post-workshop questionnaire or extension of the visioning workshop.

## 8.2 APPLYING SYSTEMS LEARNING TO THE DESIGN AND SELECTION OF TRANSITION EXPERIMENTS

Due to limited resources and the lack of institutional buy-in from the Cambridgeshire and Peterborough Combined Authority, I could host only one workshop with transition frontrunners. The pilot workshop revealed that a one-day workshop was insufficient to trial the replacement of back-casting with participatory systems analysis. As such, I was unable to investigate the impact of this adaptation on the following:

- **Social learning**

In the post-workshop questionnaire, multiple frontrunners reported an improved understanding of the issues each sector/person faces and a greater sense of commitment from partners than they originally expected. Over half of participants reported an increased sense of 'problem ownership' due, in part, to an improved confidence in partners' ability to co-deliver multi-stakeholder initiatives. This finding signals social learning in support of transition governance. One note-taker believed the systems model acted as an affective 'boundary object' around which participants could comfortably share and discuss their views and knowledge (Section 6.5.1). In other words, participatory modelling supported social learning.

- **Systems learning**

During the recorded, post-workshop discussions, some participants noted concrete examples of systems learning that affected the ratings they assigned to stakeholder-proposed interventions pre- and post-modelling. For most participants, however, an improved understanding of the system *structure* did not translate into an improved understanding of system *dynamics*. This finding indicates what we already know from SDM literature, which is that certain analytical tools are needed to overcome cognitive limitations in the analysis of complex systems (Section 3.6.5).

- **An understanding of and appreciation for complexity**

Many participants found the systems model to be “*overwhelming*” and struggled to see “*the bigger picture*”. Despite this, multiple participants verbally recognised the value in grappling with complexity and to take decisions based on a whole-systems perspective:

*“It really shows the complexity of interactions. I think that’s probably helpful. You know, that we don’t take decisions based on one particular view. This model gives you a much broader overview of the interactions, of the consequences, of the decisions we make. Which, in theory, should stop us from making these knee-jerk decisions.” (H&H)*

- **The selection of initiatives based on the results of systems modelling and analysis**

For reasons stated above, this research question was not investigated.

- **Confidence in the analytical findings that participants, themselves, helped to produce**

For reasons stated above, this research question was not investigated.

- **Related findings having emerged under this theme**

Practical barriers including time constraints, a lack of facilitators trained in qualitative systems modelling, and a lack of buy-in from the city-regional government prevented me from trialling my adaptations to the TM framework. These barriers are responsible for several known gaps between TM theory and practice (Hölscher et al., 2016, Nevens and Roorda, 2014, Maas et al., 2018, Hölscher et al., 2018, Wittmayer et al., 2016).

- **Recommendations for improving the application of systems learning to the design and selection of transition experiments**

To facilitate social and systems learning, I recommend that the systems model be co-constructed in the second phase of TM, as in Maas et al. (2018), and that transition researchers then *use* this model to analyse stakeholder-proposed interventions, with a particular focus on unintended consequences for future wellbeing. Results can then be presented to transition frontrunners in a subsequent workshop to facilitate the selection and design of transition experiments.

For well-resourced TM projects with high institutional buy-in from local government and transition frontrunners, I would recommend a three-day systems professional development course, as explained in Section 7.4.1 to help overcome barriers to double loop learning (Argyris, 1977, Argyris and Schön, 1978) and thereby improve the likelihood that TM will support the iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ in *practice* as proposed in *theory*.

### 8.3 HOW DID MY ADAPTATIONS TO THE TM FRAMEWORK (AND EXECUTION THEREOF) AFFECT OTHER STATED AIMS OF TM?

- **Creation or strengthening of a ‘transition network’ of frontrunners**
  - ❖ A one-off frontrunner workshop is insufficient for facilitating the creation of a ‘transition network’.
  - ❖ The high no-show rate in some groups negatively impacted networking opportunities, highlighting, again, the importance of institutional buy-in from local government (in this case, the Combined Authority).

- **A sense of ‘ownership’ over the transition challenge and solution(s) by members of the transition network**

For reasons stated above, this research question was not investigated.

- **Commitment to the iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ by members of the transition network, including the city-regional government.**

My findings suggest that commercial organisations are unlikely to invest in an iterative process of ‘learning-by-doing’ and ‘doing-by-learning’ and that public organisations are best positioned to lead this work. There was a consensus view, however, that organisations will stop participating in multi-stakeholder partnerships if initiatives no longer yield short-term benefits. Even if a systems analysis revealed that short-term costs are necessary to secure long-term benefits, participants still believed that organisations would opt-out of the TM process.

This finding calls into question the capacity of TM to overcome larger systemic constraints to reflexive, adaptive governance. Future TM research could investigate this question by interviewing stakeholders having participated in past TM processes.

- **Willingness of the city-regional government to experiment and adopt a more reflexive and inclusive approach to governance**

I was unable to secure a partnership with the Combined Authority, and the TM approach to governance was never explained to participating local authorities.

## **8.4 REFLECTING ON LIMITATIONS IN TM PRACTICE**

Exploratory action research is notoriously fraught with practical limitations that emerge mid-project and lie outside the control of the research team. When faced with these limitations, researchers may adapt their methodology or, even, their initial research questions. Because I set out to investigate and adapt TM as a process-based methodology, I had the unique and valuable opportunity of shifting the focus of my research project away from methodological adaptations I proposed for the TM framework toward the practical barriers that prevented the full investigation of these adaptations. In other words, what started as a caveat – the ‘limitations’ section of my dissertation – became its central focus. This was a conscious and valid decision, given the extra-scientific aspirations and application of TM. My concluding remarks are based around the three types of limitations I encountered:

- i. Common resource limitations of the research project;
- ii. Practical limitations specific to the context in which TM is applied; and
- iii. Inherent, theoretical limitations of TM.

#### 8.4.1 Common resource limitations of the research project

I experienced many of the **resource limitations** commonly cited in TM literature (e.g. time, funding, and expertise in stakeholder facilitation). These limitations are compounded when government partners contribute little or no officer time to support the project (e.g. in organising workshops and gathering data for the systems analysis). Having reflected on these commonly experienced limitations, I have two recommendations for those wishing to replace back-casting with a systems analysis of stakeholder-proposed interventions. First, I would recommend that researchers avoid setting intentionally broad system boundaries if they do not have significant time, human resource, and stakeholder buy-in to invest in group modelling. Second, I would caution against setting high expectations for frontrunner participation in group modelling. Inviting frontrunners to review an entire systems model, after having already contributed their own insights and knowledge, was an unrealistic ask in the context of a not-yet-formed, multi-stakeholder partnership. As such, I recommend that the systems model is presented only in part when the transition team feeds back hypothesised, unintended consequences of stakeholder-proposed interventions. Although this reduces the demand on participating frontrunners, it extends the overall timeline of the TM process. This implies potential conflicts with much shorter timelines imposed by governmental partners and greater resource demands on the academic partner.

On the latter point, it was unwise to undertake a TM research project outside a *team* of Transition researchers. Not only was the workload too great for one researcher, I would categorise my status as an early-career researcher, and related inexperience with stakeholder engagement and project management, as a significant resource limitation. My research project also suffered from a lack of expertise in the recruitment of frontrunners and those that suffer, first-hand, the negative consequences of unsustainable housing development. Although TM practitioners report such limitations, it is worth noting that I have yet

to come across a lack of ‘recruitment expertise’ as a cited limitation. Indeed, very few authors actually report whether and how participating frontrunners fulfil TM selection criteria.

I suspect ‘recruitment expertise’ and other, similar, resource limitations are under-reported given structural incentives to underemphasize the importance of extra-scientific skills in academic research projects. Because these skills are critical for the application of TM as a purposive *governance* framework, I call upon transition practitioners to report more openly on these resource limitations and, as well, extra-scientific, human resources available to their team that were responsible, in part, for the successful implementation of TM. In summary, TM should come with a warning: “Do not try this alone!” – not as a single researcher, not as a team without the necessary set of extra-scientific skills, and not as a well-equipped team without a committed governmental partner.

#### **8.4.2 Practical limitations specific to the context in which TM is applied; and**

In addition to these resource limitations, there were two significant limitations specific to my case study that arose mid-project. First, I was unable to achieve geographic representation in the sub-region in which I conducted my TM action research project. The sub-region was too large for all frontrunners to meet in one town or city, and the majority of frontrunners were based in urban areas, making it difficult to represent rural market towns and villages. My recommendation to TM practitioners is to either run parallel arenas or limit the geographic boundaries of the project. Second, the political instability of the Combined Authority created a revolving door for senior officers and political representatives. This revolving door made it difficult to achieve institutional buy-in. My recommendation, when seeking buy-in from a politically unstable governing body, is to target those who are most likely to remain in their positions of influence for the duration of the project, such as the Mayor in my case study.



### 8.4.3 Inherent, theoretical limitations of TM

The last set of limitations relate directly to TM theory and methodology. My findings suggested that members of a multi-stakeholder partnership, in particular, commercial companies, would *not* contribute to transition experiments that do not yield short-term benefits for their individual organisations regardless of the long-term outcomes. I also found that partners are unlikely to accept short-term losses without compensation. According to complexity theory, however, interventions to improve conditions in the mid- to long-term may require losses in the short-term. This calls into question the sufficiency of iterative learning in TM.

As discussed in Section 2.2.1.2, TM is an adaptive governance framework designed to overcome system lock-in by addressing the three sources of system rigidity: homogenisation, power, and complexity. Because TM is an “experimental and frontrunner-oriented process” (Frantzeskaki et al., 2012, p. 24), it creates space for social and technological innovators and empowers dissenting voices operating outside the regime. In theory, this helps to reverse homogenisation by allowing governing bodies to expand their understanding of ‘what’s possible’, create new preferences, and consider regulatory reforms that would be needed to achieve a new, more sustainable system. In theory, TM also helps manage complexity – the third source of system rigidity – by (1) generating a multi-dimensional understanding of the sustainability challenge and (2) coordinating actions between stakeholders with different points of influence on the system.

According to my findings, however, temporal misalignments between governance scales and problem scales are not resolved by TM. Temporal scale misalignment is a common feature of complex systems. Modelled as time delays, these different temporal scales may contribute to rigidity traps (Section 2.2.1.2). For example, in my case study, frontrunners agreed that interventions that do not produce net gains in first 3-5 years would not be supported by members of a multi-stakeholder partnership – even if

frontrunners agree a transition vision and there is a high level of confidence in the findings of the transition team's systems analysis. In other words, the temporal misalignment between commercial and problem scales was considered to be a significant barrier to action and thus a source of system rigidity or lock-in. The iterative process of 'learning-by-doing' and 'doing-by-learning' would be significantly limited by this reality, and a transition pathway to sustainability may not be possible.

One way to overcome this temporal misalignment is to artificially raise the short-term costs of inaction through various policy levers. If there are no such levers available to local governments in the UK, why carry out TM at the local level? I raise this question to provoke further discussion on the role of power and politics in transition processes – discussions that are largely neglected in TM literature (Section 2.5.1).

Moving forward, I recommend that TM researchers investigate partnerships where member organisations do accept short-term losses or where gains are uncertain and distant in time. If TM practitioners understand contributing factors, they may be able to help replicate these factors in their own practice, or at least use this information to select case studies and recruit frontrunners where this barrier to iterative processes of 'learning-by-doing' and 'doing-by-learning' can be overcome.

Alternatively, TM practitioners could host 3-day professional development trainings on systems modelling and analysis with intermediaries situated within frontrunner organisations. Such training may help institutionalise double-loop learning that, in theory, supports long-term decision-making (Section 7.5.3). In other words, TM scholars could try to intervene in the socially constructed, temporal scales that dictate decision-making within commercial organisations. It would also be interesting to study how an immersive, 3-day course supports network-building and buy-in to the TM process relative to a series of single-day, multi-stakeholder workshops.

Taken together, these three types of limitations, (i) common resource limitations, (ii) practical limitations that emerge in one's case study, and (iii) inherent, theoretical limitations, all contribute to the

gap between TM practice and theory. We do not know the implication of these gaps in terms of impact on local transition processes, as the mid- to long-term impact of applied TM is under-investigated. I would like to conclude my dissertation, however, by highlighting these limitations, inviting transition scholars to present more detailed, transparent accounts of the resource and practical limitations for applied TM, and joining others in calling for a greater theoretical focus on the intermediating role of power and politics in transition processes.

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# Appendix A: Project information sheets and consent forms

## A1 Project Information Sheet

You have been given this information sheet because you are being invited to take part in a research study. This information sheet describes the study and explains what will be involved if you decide to participate.

**Are you interested in how the local housing sector impacts upon human wellbeing?**

**Would you like to take part in a study about infrastructure development in the Cambridgeshire-Peterborough city-region?**

### Context of study

The Cambridgeshire & Peterborough Combined Authority has received £170 million from Central Government to deliver new homes over a five-year period in Peterborough and Cambridgeshire. Meanwhile, rapid development in transportation infrastructure is being funded by the £100m City Deal. The potential expansion and future of both schemes depends on delivery over the next few years.

### What is the purpose of this study?

In this study you will work with local private, public and third sector stakeholders in the housing, land development, health and social sectors to co-develop a model of human wellbeing as it relates to housing infrastructure development. Results will be presented to the Cambridgeshire & Peterborough Combined Authority. Together, policy-makers and participating stakeholders will learn how the infrastructure we build today affects the wellbeing of local residents tomorrow. We hope these insights will inform and inspire public-private initiatives in the housing sector that improve the wellbeing of individuals, families and the communities in which they live.

### Who is conducting the study?

My name is Lauren Stabler.

I'm a PhD researcher at the Global Sustainability Institute at Anglia Ruskin University. I am conducting this study in support of the Cambridgeshire & Peterborough Combined Authority with funding from Sustainability East.



**CAMBRIDGESHIRE  
& PETERBOROUGH**  
COMBINED AUTHORITY

SUSTAINABILITY  EAST

### What will participating in this study involve?

If you agree to participate in the project, you will be invited to take part in an interview, one full day and one half-day workshop over the course of 1 year. Any views you choose to express during participation are personal and do not represent the views of your organization.

## **The Interview**

The interview will last up to 1.5 hours and take place at a time and place convenient to you. An illustrative 'cognitive map' of your thoughts will be produced by the interviewer which you may revise post-interview. Following the interview phase, participants' maps will be anonymously combined into qualitative models organized by theme. These models will be discussed in workshops and ultimately inform the final quantitative simulation model.

## **Multi-stakeholder Workshops**

- (1) **'Co-modelling the 'Housing & Wellbeing System''** – In a full-day workshop, participants will debate and revise draft models presented by the research team. These draft models are amalgamations of interview data, desktop research, and scientific findings.
- (2) **'Getting into Action'** – In a half-day workshop, participants will brain-storm public-private initiatives in the housing sector based on insights from the final, co-produced model presented at the start of the workshop.

## **Do I have to take part?**

No, it's completely up to you whether or not you take part in the study. If you agree to take part, you are free to change your mind at any time without giving me a reason.

## **What will be done with the results of the project?**

Results will be presented to members of the Cambridgeshire and Peterborough Combined Authority and key actors in the housing and public health sectors.

## **What are the possible benefits of taking part?**

- Contributing to a local 'vision' of human wellbeing as it relates to housing infrastructure
- Potential input into the decision-making process for housing infrastructure development in the Cambridgeshire-Peterborough city-region;
- Ability to inform a qualitative model of the local 'Housing & Wellbeing System', which may be used to inform local decision-making;
- Networking with regional stakeholders active in the land development, housing, public health and social sectors;
- Ability to develop and/or participate in stakeholder-led initiatives with other private, public and third-sector representatives;
- Learning about the relationship between infrastructure development and human wellbeing via participatory modelling exercises and focus group discussions with a diverse group of professionals

## **What will happen to any information I give?**

A transcript of your digitally recorded interview will be produced to aid in the model-building process. Your name and contact details will be kept separately from the transcript and any details that could be used to identify you will be removed from the transcript.

Extracts from this transcript can only be quoted in written work. The quote, however, will be associated with the profession you are representing, and your name will never appear in written work.

All electronic data will be stored on a password protected computer. Any paper copies will be kept in a locked filing cabinet in my office. All digital recordings will be destroyed after completion of the project. Once the study is completed, anonymised transcripts will be deposited in the UK Data Archive. The anonymised transcripts will remain available in the data archive for 5 years.

### **Contact details**

I am the main contact for the study. If you have any questions about the project, please don't hesitate to ask. My contact details are:

Lauren Stabler

Email: [lauren.stabler@pgr.anglia.ac.uk](mailto:lauren.stabler@pgr.anglia.ac.uk)

Tel: +44 845 196 5117

Global Sustainability Institute (GSI), Anglia Ruskin University, Faculty of Science & Technology, East Rd, Cambridge CB1 1PT, UK

If you wish to contact a senior member of the University about the research or make a complaint please contact:

Professor Aled Jones

Email: [Aled.Jones@anglia.ac.uk](mailto:Aled.Jones@anglia.ac.uk)

Global Sustainability Institute (GSI), Anglia Ruskin University, Faculty of Science & Technology, East Rd, Cambridge CB1 1PT, UK

**Project team:** Lauren Stabler, Anglia Ruskin University  
Prof. Aled Jones, Anglia Ruskin University  
Dr. Chris Foulds, Anglia Ruskin University  
Dr. Rosie Robison, Anglia Ruskin University

*The study is funded by the regional social enterprise, Sustainability East.*

Thank you for considering taking part in this study and taking the time to read this information. If you are willing to be interviewed for this research project, please complete the consent form on the next page.



## A2 Consent forms

### Consent form for one-one-one interview

To participate in this interview, you must give your consent to the following terms. To do so, please check all boxes below. If you have any questions regarding the terms of consent, please feel free to contact the event organiser before completing the survey.

- ☐ I confirm that I have read and understand the information sheet provided for this study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
- ☐ I agree to take part in this interview. Participation will include answering interview questions and helping revise and/or extend my 'cognitive map' post-interview.
- ☐ I confirm that my data cannot be withdrawn from the study, but my participation is voluntary, and I am free to withdraw at any time without giving a reason.
- ☐ I understand that the interview will be digitally recorded and partially transcribed and my cognitive map will be digitized.
- ☐ I understand that an anonymised transcript of my interview and cognitive map will be deposited in the UK Data Archive for access by verified peer researchers only.
- ☐ I understand that my comments cannot be quoted in future publications, reports nor presentations without my written consent.
- ☐ I understand my 'cognitive map' will not appear in publications, reports or presentations without my written consent.
- ☐ I agree that information given in this interview may be used in future publications, reports or presentations.
- ☐ I understand that my name will not be identified in any publications, reports or presentations without written consent. However, I understand that the researcher is unable to guarantee my anonymity, given the need to transparently report the name of my organization/employer and my role at said organization (e.g., Cambridgeshire County Council adult social care provider).
- ☐ I understand that the socio-economic data I voluntarily provide in this interview can only be used to produce a demographic profile of the entire group of interviewees (e.g. distribution of age, gender, education level, socio-economic background, residence within the Cambridgeshire-Peterborough city-region).
- ☐ I confirm that I am above the age of 18

Participant's Reference #: \_\_\_\_\_

Participant's signature: \_\_\_\_\_ Date: \_\_\_\_\_

## Consent form for Visioning Workshop

To participate in the workshop, you need to give your consent to the following terms. To do so, please check all boxes below. If you have any questions regarding the terms of consent, please feel free to contact the event organiser before completing the survey.

- ☐ I agree to take part in one of Sustainability East's 'visioning' workshops. This includes participating in small-group discussions and providing written responses to questions around housing and well-being.
- ☐ I understand that my participation is voluntary, and I will not receive compensation.
- ☐ I understand that my participation is anonymous, meaning my contributions, written and verbal, cannot be traced back to me and my identity is protected.
- ☐ I understand that the Research Team will produce a '2060 Housing & Well-being Visioning Document' using written and digitally recorded material from the workshop, and that this document will be shared with the public and local Councillors.
- ☐ I agree that information given in the workshop (e.g., my written contributions or verbal comments) may be used in additional future publications, reports or presentations as verbatim quotes or paraphrased summaries.
- ☐ I confirm that my data (i.e., any written and verbal contributions) cannot be withdrawn from the study, but my participation is voluntary, and I am free to withdraw at any time without giving a reason.
- ☐ I understand that some workshop activities will be video recorded, and the recordings will not be shared outside the Research Team. I understand video recordings will only be used by the Research Team to prepare written publications, using anonymous comments from these recordings.
- ☐ I confirm that I am above the age of 18.
- ☐ I understand that the workshop will be held under Chatham House rules, and that no participant is to share my identity nor verbal/written contributions from the workshop.

Participant's signature: \_\_\_\_\_ Date: \_\_\_\_\_

## Consent form for the frontrunner workshop

To participate in the workshop, you must give your consent to the following terms. To do so, please check all boxes below. If you have any questions regarding the terms of consent, please feel free to contact the event organiser before completing the survey.

- ☐ I agree to take part in one the GCGP Housing & Wellbeing workshop. This includes participating in small-group discussions and activities and completing questionnaires during the workshop.
- ☐ I understand that my participation is voluntary, and I will not receive compensation.
- ☐ I understand that my participation is anonymous, meaning my contributions, written and verbal, cannot be traced back to me, and my identity is protected.
- ☐ I understand that all views expressed at the workshop represent individual views and not the views of one's employer/organisation.
- ☐ I agree that information given in the workshop (e.g., my written contributions or verbal comments) may be used in additional future publications, reports or presentations as verbatim (anonymised) quotes or paraphrased summaries.
- ☐ I confirm that my data (i.e., any written and verbal contributions) cannot be withdrawn from the study, but my participation is voluntary, and I am free to withdraw at any time without giving a reason.
- ☐ I understand that some workshop activities will be audio recorded, and the recordings will not be shared outside the Research Team. I understand video recordings will only be used by the Research Team to prepare written publications, using anonymous comments from these recordings.
- ☐ I confirm that I am above the age of 18.
- ☐ I understand that the workshop will be held under Chatham House rules, and that no participant is to share my identity nor associate any of my verbal/written contributions.

Participant's signature: \_\_\_\_\_ Date: \_\_\_\_\_

## A3 Support resources

# SUPPORT FOR YOU OR YOUR LOVED ONES

### **Age UK Cambridgeshire**

Formerly Age Concern Cambridgeshire.

Telephone: **0300 666 9860**

Email: [informationservices@ageukcambridgeshire.org.uk](mailto:informationservices@ageukcambridgeshire.org.uk)

2 Victoria Street

Chatteris

Cambs

PE16 6AP

<http://www.ageuk.org.uk/cambridgeshire/>

### **Anxiety UK**

Anxiety UK works to relieve and support those living with anxiety disorders by providing information, support and understanding via an extensive range of services, including 1:1 therapy.

Helpline: **08444 775 774** - open 09:30 to 17:30 Monday to Friday

Zion Community Resource Centre

339 Stretford Road

Hulme

Manchester

M15 4ZY

<http://www.anxietyuk.org.uk/>

Twitter: <https://twitter.com/AnxietyUK>

### **Arts and Minds**

Works across Cambridgeshire and Peterborough to include people of all ages with all forms of mental illness and learning disabilities in arts activities.

Telephone: **01223 353053**

Mobile: **07545 641810**

47-51 Norfolk St

Cambridge

CB1 2LD

<http://artsandminds.org.uk/>

Twitter: <https://twitter.com/mindsarts>

### **Cambridge Careline**

Rethink Helpline for carers of people with enduring mental illnesses.

Telephone: **01354 655 786**

### **Cambridgeshire & Peterborough NHS Foundation Trust**

A partnership organisation of Cambridgeshire County Council, Peterborough City Council, NHS Cambridgeshire and NHS Peterborough providing mental health and specialist learning disability services across Cambridgeshire and Peterborough. A member of Cambridge University Health Partners (CUHP), CPFT is a teaching Trust with the Department of Psychiatry at the University of Cambridge. Services include child, adolescent, adult and older people's mental health services; primary care and liaison psychiatry services; forensic and specialist mental health services; substance misuse services and specialist learning disability services.

Out of hours number for CPFT service users: **0800 052 2252** open 17:00 to 20:00 Mondays to Fridays (08:00 to 20:00 Saturdays, Sundays and Bank Holidays)

Trust headquarters: **01223 726789**

Elizabeth House  
Fulbourn Hospital  
Cambridge  
CB21 5EF

<http://www.cpft.nhs.uk/>

### **Citizens Advice Bureau (Cambridge)**

Helping People to resolve their problems by providing information and advice. Drop-in Monday to Friday 9.15am-12:45pm. Specialist mental health advice (benefits inc disability benefits & debt advice) and debt advice by appointment.

Telephone: **03448 487 979**

66 Devonshire Road  
Cambridge  
CB1 2BL

<http://www.cambridgecab.org.uk/>

Twitter: <https://twitter.com/CambridgeCAB>

### **Keep Your Head**

A new young people's mental health website **for young people, parents/carers, teachers and other professionals**. It is a central point for good quality information on keeping well, self-help and support services. The website covers a range of issues including stress, bullying, self-harm and what to do in a mental health crisis.

<http://www.keep-your-head.com/>

### **Life Amid Debt**

Life Amid Debt exists to help the growing number of people facing money and debt problems. LAD offers a free, confidential service to the residents of Cambridgeshire. Face-to-face advice is available in St Neots or Huntingdon with a phone and email service available to all local areas.

Helpline: **07768 681564** Text or call

<http://www.lifeamiddebt.org.uk/>

Facebook: <https://www.facebook.com/Life-Amid-Debt-625870130769476/>

### **Making Space**

Making Space is a national charity providing quality care and support to people with a wide variety of needs including those with physical and/or mental health conditions, learning disabilities and dementia. We also offer the same level of support to their friends, families and carers – enabling each and every user of our services to shape their life around personal aspirations and circumstances. Alternative email

[pauline.mansfield@makingspace.co.uk](mailto:pauline.mansfield@makingspace.co.uk)

Telephone: **01480 211006**

Email: [enquiries@makingspace.co.uk](mailto:enquiries@makingspace.co.uk)

Suite 4

The Stables

Church Street

St Neots

Cambs

PE19 2BU

<http://www.makingspace.co.uk/>

### **The Silver Line**

Free, confidential 24 hr helpline for older people.

Helpline: **0800 4 70 80 90**

<http://www.thesilverline.org.uk/>

### **Women's Aid Federation of England**

Women's Aid works to end domestic violence against women and children.

National Domestic Violence Helpline: **0808 2000 247** 24 hours (Free phone)

<http://www.womensaid.org.uk/>

## Appendix B: Visioning workshop appendix

### B1 Visioning workshop gatekeepers

**TABLE B 1: GATEKEEPERS BY TARGET AUDIENCE**

Target Audience	Workshop	Gatekeeper	Response	Advertising method
Flood zone	Peterborough	Life Church	Agreed	Posted flyer
		Stars Day Nurseries	Agreed	Posted flyer
		Belsize Community Centre	Agreed	Posted flyer
	Cambridge	N/A - Very few properties fall in flood zones in Cambridge		
Neighbourhoods with high-density of deprived households	Peterborough	Paston and Gunthorpe Community Association	Agreed	Posted flyer
		Ravensthorpe Primary School	Agreed	Email invitation to parents
		Gladstone Park Community	Confirmed	Posted flyer
		East Community Centre	Agreed	Posted flyer
		Life Church	Agreed	Posted flyer
		Belsize Community centre	Agreed	Posted flyer
		South Bretton Community	Agreed	Posted flyer
		Copeland Community Centre	Confirmed	Posted flyer
		Dogsthorpe Community Centre	Confirmed	Posted flyer
		Pyramid Community Centre	Confirmed	Posted flyer
		Bishop Creighton Academy	Rejected	n/a
		Honeyhill Community and	Confirmed	Posted flyer
		Stars Day Nurseries	Agreed	Posted flyer
		Nene Gate School	Confirmed	Email invitation to parents
		Highlees Primary School	Confirmed	Email invitation to parents
		Westwood Primary School	No response	n/a
		Saxon Community Association	No response	n/a
		East Community Pre-School	No response	n/a
		Masjid Ghousia	No response	n/a
		Shooting Stars Preschool	Agreed	Posted flyer
		Fazian E Madina Mosque	No response	n/a
	Cambridge	Buchan Street Neighbourhood Centre	Confirmed	Posted flyer and in-person recruitment over 2 week period
		Moon Beams Pre - School	Confirmed	Email to parents
		Arbury Community Centre	Confirmed	Posted flyer and in-person recruitment over 2 week period
		East Barnwell Community	Confirmed	Posted flyer
		The Meadows Community Centre	Confirmed	Posted flyer and in-person recruitment over 2 week period
		The Orchard Community	Confirmed	Posted flyer
		Brown's Field Youth and	Confirmed	Posted flyer
		St Laurence Catholic Primary	Agreed	Email invitation to parents
		North Cambridge Academy	Agreed	Email invitation to parents
		Chesterton Primary School	Confirmed	Email invitation to parents
		Abbey Meadows School	Confirmed	Email invitation to parents
		The Grove Primary School	Confirmed	Email invitation to parents
		The Fields Children's centre	Confirmed	Posted flyer

Target Audience	Workshop	Gatekeeper	Response	Advertising method
Poor accessibility from aging or disability	Peterborough & Cambridge	U3A	Rejected	n/a
		Sense Mini Magpies	Rejected	n/a
		Carers Trust	No response	n/a
Social housing waiting list	Peterborough	Peterborough City Council	Confirmed	Email invitation to 470 households on the social housing waiting list
		Home-Link.org	Confirmed	Website advertisement
	Cambridge	Cambridge & District Citizen's Advice Bureau	Confirmed	Website advertisement and flyers posted in kitchen and reception area
		Cambridge Housing Society	Confirmed	Email invitation to tenants
Farmers	Peterborough	East of England Agricultural Society	No response	n/a
		Peterborough Farmers' Market	No response	n/a
Key workers	Peterborough	Better Healthcare Services	No response	n/a
		Cambridgeshire Care Agency	No response	n/a
		4Passion Care	No response	n/a
		About Me Care and Support	No response	n/a
		Cambridgeshire County Council - Teach in Cams	Confirmed	Social media reaching teachers. Posted on their website.
	Cambridge	Better Healthcare Services	No response	n/a
		Cambridgeshire Care Agency	No response	n/a
		Cambridgeshire County Council - Adult Social Care	Confirmed	Emailed invitation
		Cambridgeshire County Council - Children's Social Care	Confirmed	Emailed invitation
First-time home buyers	Peterborough	33 estate agents were asked to forward invitations to first-time home buyers who qualify for programs such as the Starter Homes Initiative	32 of 33 rejected or did not respond. HXEA verbally inquired with first time home buyer but did not receive response	Emailed invitation
	Cambridge	25 estate agents were asked to forward invitations to first-time home buyers who qualify for programs such as the Starter Homes Initiative	Rejected	n/a



# CPCA Housing & Well-being Project: Visioning Workshop

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## WORKSHOP PROGRAMME

---

16:30 – 19:00 Wednesday

12/06/18

Anglia Ruskin University, Guild  
House 012, Peterborough

## Workshop Summary

The visioning workshop fits into a larger two-year project on housing development in the Greater Cambridge, Greater Peterborough region. The two-year project will culminate in the design and selection of real-life local initiatives to be carried out by select stakeholders having co-generated the project's research outputs.

These local initiatives, however, should reflect the values and visions of local residents. As such, three workshops are being hosted across the region to capture local visions and inform the stakeholder engagement process. 15 members of the general public and 10 experts are invited to participate, forming six, 5-person groups + table facilitator.

## Workshop Outputs

- 1) **'Vision document'** of housing development with well-being at the centre for current and future generations (to be shared with the public and local policy makers)
- 2) An **Index of Well-being (as it relates to housing)** to orient strategic operational planning of public-private initiatives as well as to monitor and adapt implemented plans
- 3) **Improved understanding of and empathy** for the knowledge, experiences and expressed views of those in your community

## Roles

- **Lead facilitators:** (1) Lead Researcher/Consultant and (2) Partner at co-host organization
- **Table facilitators:** 5 volunteers (including 2<sup>nd</sup> lead facilitator)
- **Local practitioners:** 9 volunteers

**TABLE B 2: GROUP ASSIGNMENTS**

Group	Topics	Local Practitioners
Small-group Facilitator 1	<b>Risk Card 1:</b> Housing affordability <b>Risk Card 7:</b> Future trade barriers & the local economy	1. Sustrans (transport charity) 2. Allia (innovative finance social enterprise)
Small-group Facilitator 2	<b>Risk Card 1:</b> Housing affordability <b>Risk Card 8:</b> Industry 4.0	3. Housing, Peterborough City Council
Small-group Facilitator 3	<b>Risk Card 2:</b> Housing, energy & climate change <b>Risk Card 4:</b> Too much & too little water	4. Peterborough Environment City Trust 5. Local building and landscape design company
Small-group Facilitator 4	<b>Risk Card 3:</b> Water scarcity <b>Risk Card 9:</b> Nature conservation	6. Nene Park Trust 7. Anglian Water

Small-group Facilitator 5	<b>Risk Card 5:</b> Social & Health Care <b>Risk Card 6:</b> Inequality across the region	8. Public health, Cambridgeshire County Council and Peterborough City Council 9. Housing, Communities & Youth, Cambridgeshire County Council & Peterborough City Council
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## Supplies

- **Plenary session material:**
  - o Workshop programme
  - o Video Camera & trip-pod
  - o 2 USB sticks
  - o 40 sheets of A4
  - o 40 notecards & pens
  - o Box
  - o Rubberband and paper clips
  - o 2 (different coloured) dry erase markers & eraser
- **Small-group visioning material:**
  - o 5 x 1 workshop programme
  - o 5 x 1 flip chart, black marker & red marker
  - o 5 x 1 dry erase board & dry erase markers
  - o 5 x 1 notebook & pen
  - o 5 x Pack of 'risk cards', including (more detailed) facilitator risk card
  - o 5 \* 6 packs of yellow and coloured sticky notes
  - o 8 paperclips

## Pre-workshop Set-up

1. 5 flipcharts to be divided between two rooms
2. 5 dry erase boards, spray bottle and rag to be divided between two rooms
3. A3 sheet of paper, 3x5 notecard and a pen placed at each participant's desk
4. Set up camera on tripod
5. Pass out small-group materials to facilitators
6. Set up PowerPoint presentations in each room; start PowerPoint presentation in overflow room at slide with small-group visioning session prompts + 'ground rules'.

## Workshop Itinerary

Time	Activity
INTRODUCTION	
16:30	Welcome and introduction (1st Facilitator)
DEFINING WELLBEING	
16:35	Collection of subjective indicators of wellbeing (1st and 2nd Facilitator)
ICE BREAKER	
16:45	Ice breaker: why are you here?
SMALL-GROUP VISIONING ACTIVITIES (led by table facilitators)	
16:50	Small group breakout & introductions Groups 1 & 2 move to 'spill-over' room + icebreaker continued
17:00	Visioning worst- and best-case scenarios of housing development
17:20	Introduction to 'Risk cards' + Q&A
17:35	Visioning a 'liveable region' - Discussion and revisions to best-case scenario story frame
17:55	Tea Break
18:05	Introduction to 'linking' exercise
18:07	Linking wellbeing and housing development through the creation of casual trees
PRESENTATION OF VISIONS	
18:25	Small-group presentations and synopsis
CREATING THE 'HOUSING-WELLBEING' INDEX	
18:55	Creating a 'Housing-Wellbeing Index' (2nd Facilitator)
CLOSING	
19:00	Closing thanks & 'next steps' (1st Facilitator)
19:05	End

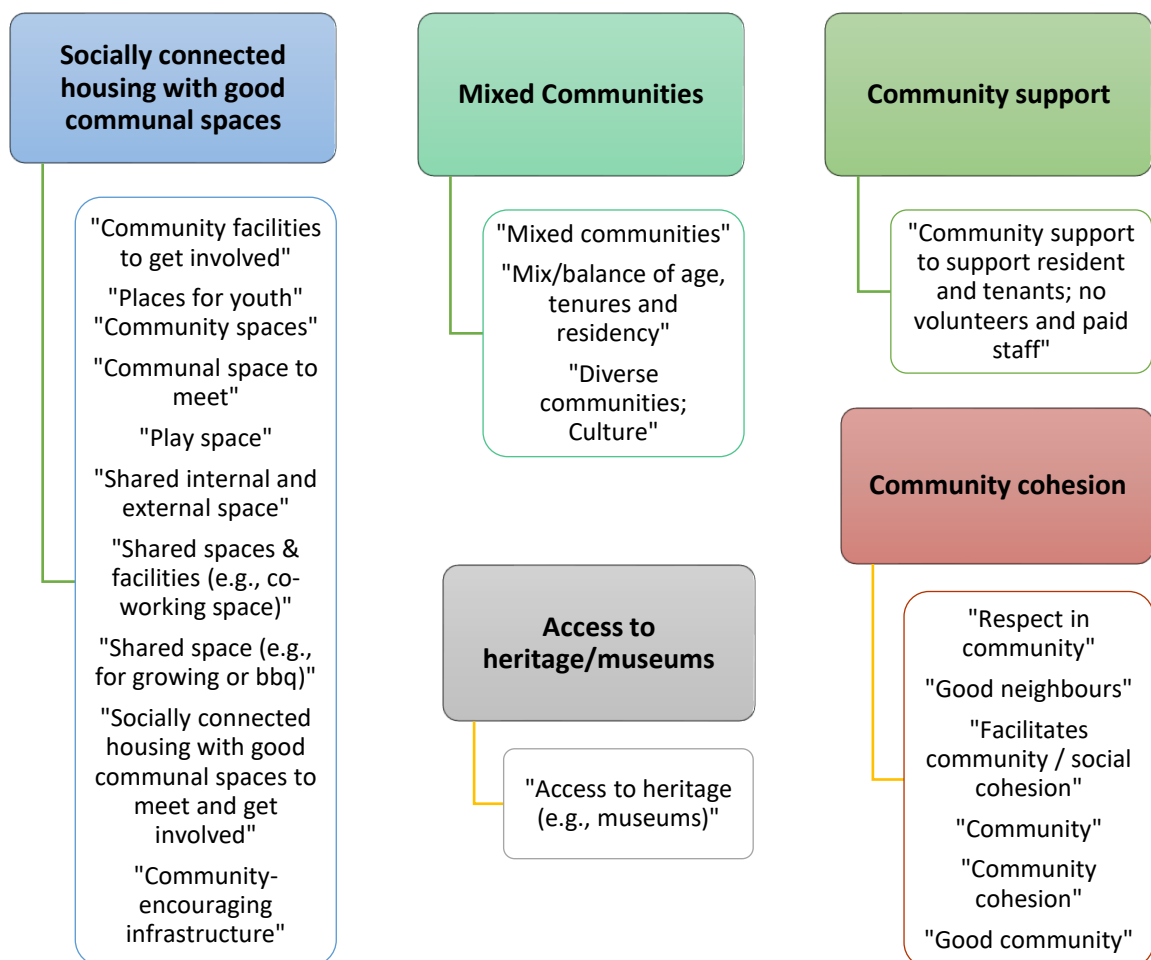
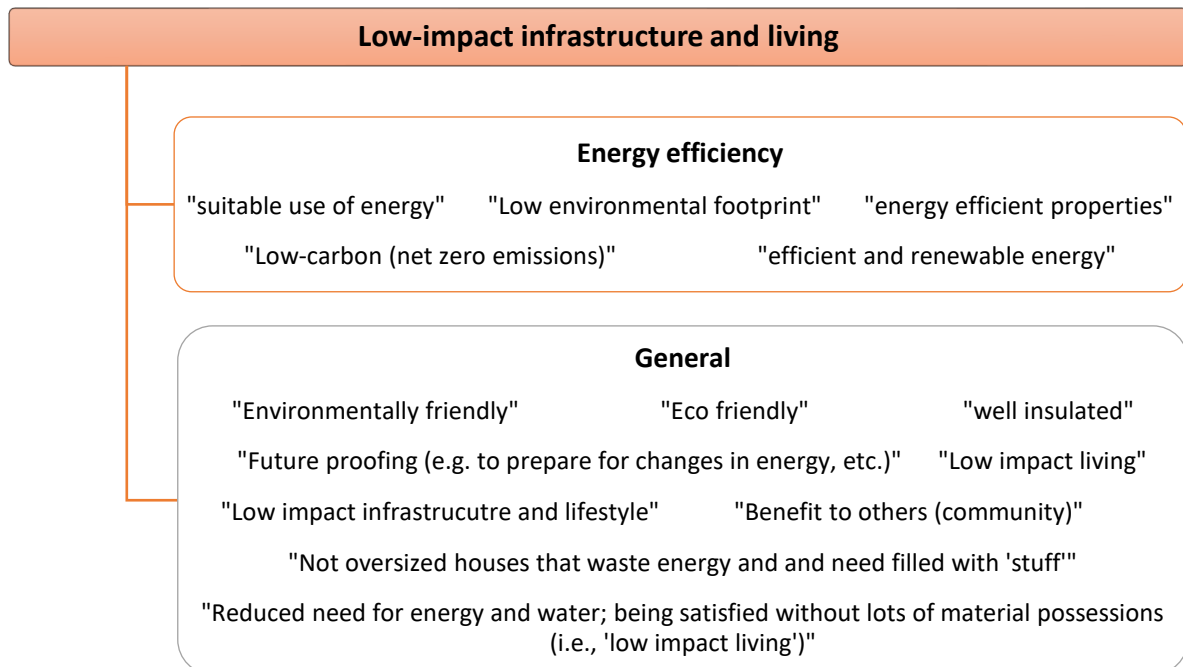
Ask participants to drop 'well-being' notecards in box at front of room after writing their group # on them.

- (1) Ask for (a) volunteer presenter(s)
- (2) Collect hats before returning and hand them to Lauren!

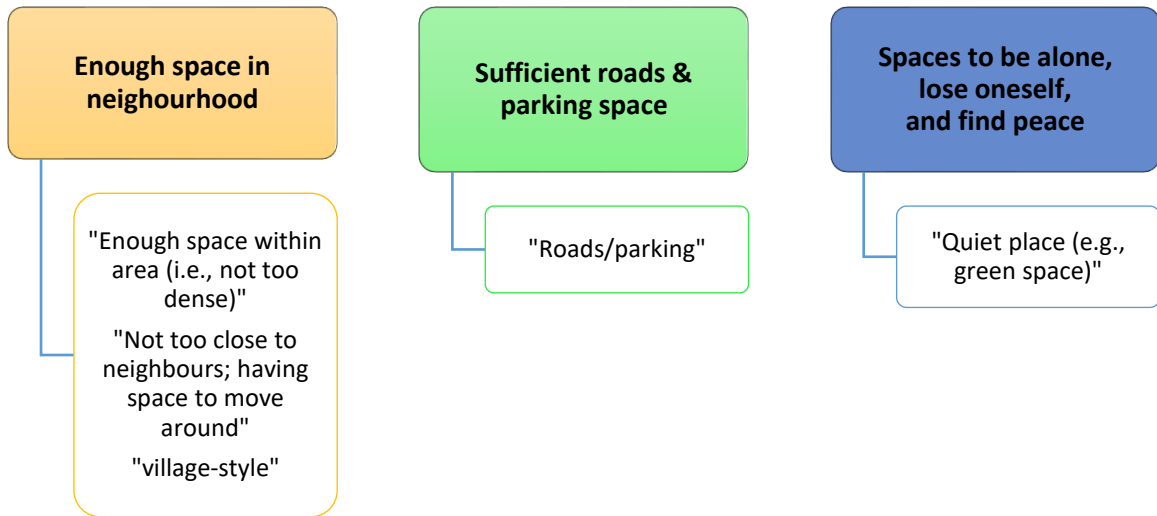
## B3 Researcher interpretation of participant-defined transition goals

TABLE B 3: THE CATEGORIZATION OF PARTICIPANT CONTRIBUTIONS AND POTENTIAL SOURCES OF RESEARCHER BIAS

Low-impact infrastructure and living		
<p><b>Close access to blue &amp; Green open &amp; wild spaces</b></p> <p>"Be surrounded by green, wild life"      "Green space"      "Close access to quality green space"</p> <p>"Good outdoor spaces nearby"      "Green and blue spaces"      "Green, open, wild space"</p> <p>"Everyone to have some green space, i.e., garden or park for kids to enjoy nearby"</p>		
<p><b>Access to local food and/or ability to grown one's own food</b></p> <p>"Vegetable patch in garden"      "Spce to grow"      "Local food"</p>		
<p><b>Good recycling</b></p> <p>"To have cameras at recycling areas at all times and more policing"      "Good recycling"</p>		
<p><b>Good water supply and sewage system</b></p> <p>"Good sewage treatment"      "Clean water"</p>		
<p><b>Modal shift to active and public transport</b></p> <p><b>A. Access to good public transport &amp; walking/cycling infrastructure</b></p> <p>"Transport/Environment"      "Good public transport links"      "Integrated cycle paths"</p> <p>"Transport to places I want to go - bus/train/cycle"</p> <p>"people, not car-dominated environment"</p> <p>"Good public transport ('good' = environmentally friendly, good coverage or 'proximity to links for all', reliable, efficient, affordable, handi-cap accessible) -- to reduce car millage."</p> <p>"Good transport system with (a) excellent walking, (b) world class cycling and (c) cars outside the area owned jointly"</p> <p><b>B. Walkable communities with amenities</b></p> <p>"Cycling distance from work"      "Work, shops, amenities"      "Walkable communities"</p> <p>"Walking distance to shops/pub"      "Community shops"      "Cycling distance to work"</p> <p>"Walking distance from schools"      "People, not car-dominated environment"</p> <p>"location"</p> <p>"Close to work and public transport (preferably walkable or cyclable"</p> <p>"Better planning of towns and cities to reduce emissions and congestion"</p> <p>"Local amenities to reduce travel &amp; strengthen communities"</p> <p><b>C. Connectivity (high-level)</b></p> <p>"Good macro connectivity"</p>		







### List of judgements needed to build themes and categories from participants' contributions

- Where participants wrote an 'input-output' pair (such as 'local amenities → strong communities'), the 'input' variable was used for the thematic analysis. This is based on the assumption that the participant wants to monitor/achieve the explicitly mentioned action/input.
- The co-benefits of improved accessibility and active transport mean that these features also play a social justice role in combatting health, economic, and other inequalities for human wellbeing. As such, some participants may have voted on 'walkability' (e.g., through writing 'ability to live close to work') for purely social (not environmental) reasons. Regardless, their points were assigned only to the 'Low-impact infrastructure and living' category to avoid double counting and frame these actions as 'win-win' solutions for nature and people. The implication is that this category may be over-weighted and others under-weighted. Below is an example list of attributes assigned to 'Low-impact infrastructure and living' that have social and economic co-benefits.

ATTRIBUTE	CO-BENEFITS
Access to local food	<ul style="list-style-type: none"> <li>Supporting local economy/farmers</li> </ul>
Ability to grow one's own food	<ul style="list-style-type: none"> <li>Increased physical activity</li> <li>Mental health benefits associated with contact with nature</li> <li>Social cohesion (in the case of community growing spaces)</li> </ul>
Sustainable transport	<ul style="list-style-type: none"> <li>Increased physical activity</li> <li>Community cohesion</li> <li>Equal opportunity (via affordable transport)</li> </ul>



	<ul style="list-style-type: none"> <li>Economic efficiency associated with reducing road traffic</li> </ul>
Access to local amenities (seen as facilitating 'sustainable transport' from a 'low-impact infrastructure & living' perspective)	<ul style="list-style-type: none"> <li>Equal opportunity (via reduced travel barriers)</li> </ul>
Digital connectivity	<ul style="list-style-type: none"> <li>Equal opportunity (via improved access to job market and web-based services)</li> <li>Economic efficiency</li> </ul>
Energy efficient homes	<ul style="list-style-type: none"> <li>Equal opportunity (via combatting fuel poverty)</li> <li>Economic efficiency</li> </ul>
Homes powered by renewable energy	<ul style="list-style-type: none"> <li>Energy security</li> </ul>
Sustainable Urban Drainages systems (SUDs)	<ul style="list-style-type: none"> <li>Financial security (re: mitigated flood damage)</li> </ul>
Other measures to protect the water environment	<ul style="list-style-type: none"> <li>Supply of clean water</li> </ul>

- Participants would sometimes combine features in one point, and so I would have to choose the prevailing feature:
  - "More sheltered accommodation and care homes for the elderly (with green spaces)"  
^^ No points were assigned to 'Close proximity to blue and green spaces'.
  - "Surrounded by green, garden, wildlife, ability to grow food & plant"  
^^No points were assigned to 'Access to local food and ability to grow one's own food'
  - "Aesthetically pleasing (including environment/green spaces)"  
^^No points were assigned to 'Close proximity to blue and green space'.
- In one instance ("community space/support") points were split evenly.
- Some variables (e.g., "Energy efficiency") fall under two categories ('low-impact infrastructure' and 'good design/build'). Again, the 'low-impact...' category is prioritized. Indeed 'design guides' typically include sustainable build requirements, so 'good design' could be seen as a subcategory of 'low-impact infrastructure'.
- Quotes that could have been interpreted differently:

Quote	Interpretation
<i>Benefit to others (community)</i>	The points were assigned to 'Low impact infrastructure and living'.
<i>"Protected from traffic"</i>	Points were assigned to 'safety & security', but the quote could have been interpreted as 'free from traffic'

<i>"Future proofing for changes in energy, etc."</i>	Points could have been assigned to 'Safety & Security' (for 'energy security'), but they were instead assigned to 'Low-impact infrastructure and living'.
<i>"Weather proof"</i>	Points were assigned to 'Good design...', but they could have been assigned to 'Safety and security' (for 'climate change adaptation').
<i>"Ability to increase nearby infrastructure &amp; amenities as required"</i>	This could have been interpreted as a governance issue, but points were instead assigned to 'Walkable communities with access to amenities'.
<i>"Good neighbours"</i>	This could be interpreted in many ways, but points were assigned to 'community cohesion'.
<i>"Reform of the mortgage &amp; renting system"</i>	This was interpreted as a way to address affordability.
<i>"Play space"</i>	Points assigned to 'Socially connected housing with good communal spaces', assuming the participant meant 'communal play space' based on group discussions/visions
<i>"Security of home in local area (knowledge of who lives locally)"</i>	Because the participant had already allocated points to 'Security of tenure', I assume the individual is expressing discontent with neighbours. As such, the points are assigned to 'social cohesion'.

## Appendix C: Risk Cards resulting from preliminary systems analysis

## THINKING CARD 2: WHAT IS THE [CLIMATE] COST OF HOUSING?

### SUMMARY

In 2008, the UK Government legally committed itself to an 80% reduction in greenhouse gas emissions by 2050. Because it's so costly to reduce emissions from sectors such as aviation, **housing would need to become carbon neutral by 2050 to achieve the UK target.**

Since 1970, housing emissions have nearly halved despite an increase in total energy consumption. This was mainly accomplished via (1) improvements in the fabric of homes, making them warmer and less energy-intensive, and (2) the 'dash for gas', during which gas-powered central heating displaced more carbon-intensive forms of heating (see **Figure 1**). This innovation was very effective in reducing the 'carbon footprint' of homes because 80% of buildings' energy use comes from space and water heating (see **Figure 3**).

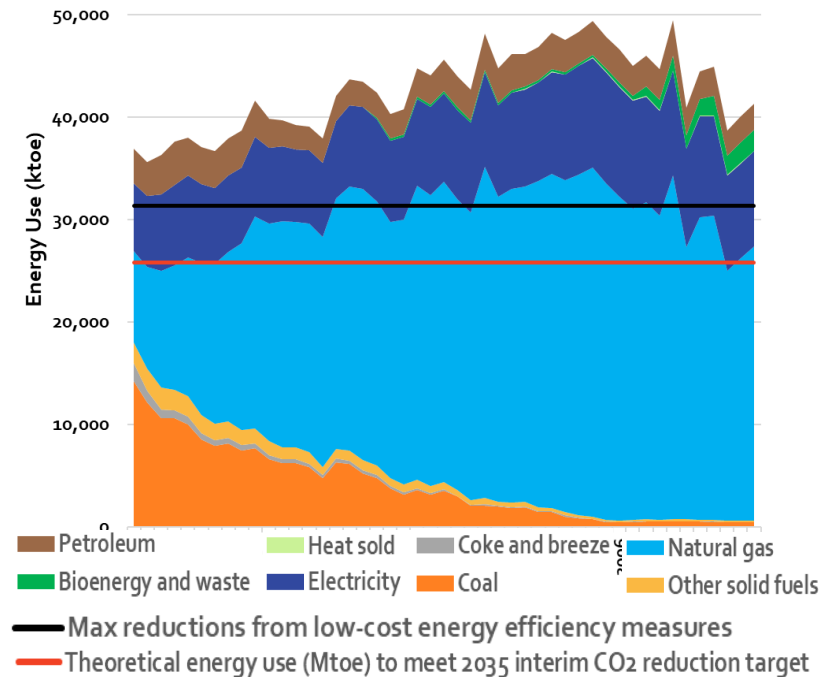
However, now that most homes have been converted to gas-powered central heating, **progress has stalled**. In 2016, residential emissions rose for the first time since 2004. **Based on current trends, the UK is expected to achieve, at best, half the reductions needed from buildings by 2030.** This is because:

- (1) Too few owners of **existing homes** have installed energy-efficiency measures (e.g. solid wall insulation) and even fewer have installed low-carbon technologies to heat their homes (e.g., solar panels).
- (2) **New homes** are no longer required to be 'zero carbon', meaning houses built today will need to undergo costly retrofits in the future to meet the UK's 2050 target.

**Looking forward:** In Cambridgeshire, and across the UK, the share of single-person households is steadily rising. This is mainly the result of an aging population. Because single-person households are more energy-intensive per person, we can expect a continued increase in energy use from the housing sector.

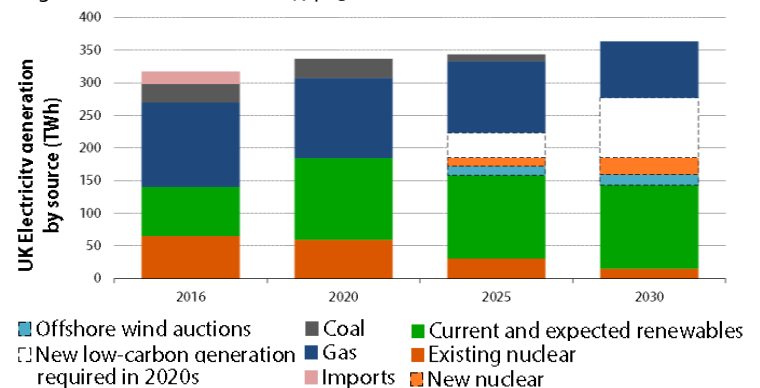
**Figure 1: The historic 'Dash for Gas'**

Figure produced using data from BEIS (2017c), BEIS (2017b) and CCC (2017)



**Figure 2: Forecasted gap in renewables (2025 and 2035)**

Figure taken from CCC (2017, p. 56)



### ❖ Solution 1? 'Transition' to low-carbon electricity

- How we generate electricity is changing. In 2016, 8.9% of electricity's 'energy mix' came from renewables.
- Yet, the transition is behind schedule (see **Figure 2**).
- Even if we did manage to generate electricity using 100% renewable sources, we would not achieve 'zero-carbon' housing. This is because electricity makes up less than ¼ of household energy use (see **Figure 1**) for things like cooking, appliances and lighting (see **Figure 3**).

### ❖ Solution 2? 'Transition' to energy-efficient housing

- Low-cost energy efficiency measures could unlock up to 15% energy savings (see black line in **Figure 1**).
- If these measures were taken without reducing fossil fuel use, we would still need to consume 30% less energy to meet the 2035 interim target (see red line in **Figure 1**).

### ❖ Solution 3? 'Transition' to new energy sources for heating

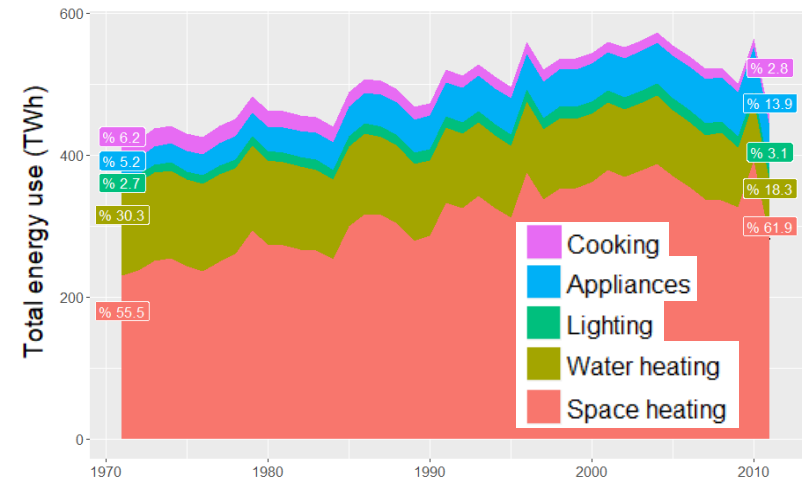
- Energy efficiency measures must be accompanied by a radical shift in the energy sources we use to heat our homes.
- One promising technology is **photovoltaics (solar panels)**. Peterborough and South Cambridgeshire are outperforming most other districts in England. However, given small number of installations, they generate less than 0.01% of the region's energy demand from housing.
- Another promising technology is 'biomethane injection' into the gas grid. However, the UK is 50% behind in meeting its biomethane injection target.

### ❖ Transition in where we build our homes?

- Given the **inseparable relationship between housing and transportation**, energy consumption and emissions from the latter should also be considered when envisioning a future housing system (see **Figure 4**)

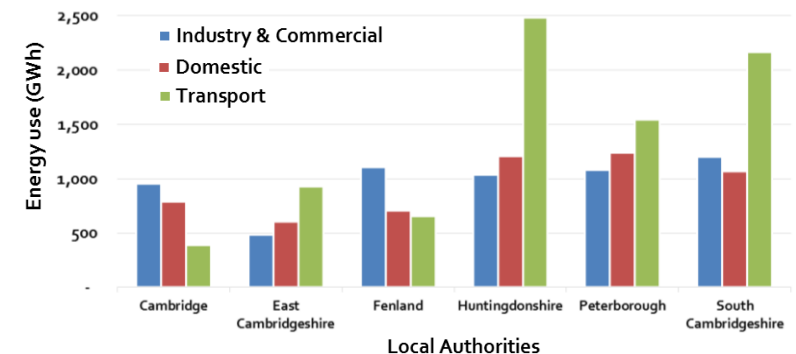
**Figure 3: UK annual household energy use by source (1971 to 2011)**

\*\*Figure produced using data from 2011 Cambridge Housing Model v3.02



**Figure 4: Energy consumption by sector (2015)**

Created using data from BEIS (2017a)



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## Risk Card 3: Pressures on the local environment harm future water supply

### SUMMARY

The environment cleans our water. The future supply of clean water depends on its protection. In the East of England, the 'water environment' is currently under threat. The two main threats are (1) pollution and (2) over-consumption of water by local households, businesses and industry.

To make matters worse, climate change is causing hotter, drier summers. This may reduce the amount of ground water being stored. Water shortage directly harms the environment. It also *indirectly* harms the environment by increasing the concentration of pollutants – also harming human health.

The Environment Agency is working together with Anglian Water and Cambridge Water to protect our water environment. At the same time, Cambridgeshire and Peterborough is experiencing major growth. This growth not only increases demand for water, it increases multiple forms of pollution. For example, pollution from waste water affects half of Anglian water bodies.

The 'ecological status' of the local water environment is 'poor'<sup>3</sup>

Anglian River Basin (Anglian Water source)



- **Surface water:** only 8.8% of water bodies at 'good' ecological status; 0% at 'high' status
- **Ground water:** 50% 'poor' status
- **Main polluting sectors:** water industry (26.0%), and agriculture and rural land management (38.8%), vs., for example, urban and transport (5.3%)

Cam and Ely Ouse Catchment (Cambridge Water source)

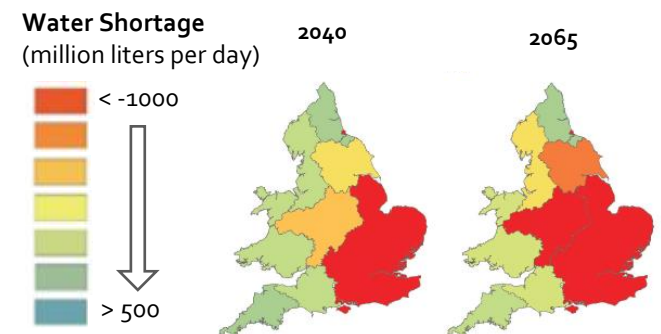


- **Surface water:** only 13.7% of water bodies at 'good' ecological status; 0% at 'high' status
- **Groundwater:** 'poor' status
- **Main polluting sectors:** water industry (28%), and agriculture and rural land management (30.6%), vs., for example, industry (3.9%)

Multiple growing pressures will lead to major local water shortages

- **To protect the water environment**, the Environment Agency estimates that water companies should reduce the amount of water they supply by 18.4%<sup>5</sup>
- According to Cambridge Water, **this reduction would lower supply below the level demand**, even assuming all newly built homes use recycled rainwater for toilet flushing and garden use.
- **Combining the effects of population growth, climate change and drought**, East Anglia could experience a water shortage of more than 1000 million litres per day (see **Figure 1**).
- This equals **60% of what we currently consume** and more than **3x the reduction needed for environmental protection**.

Figure 1: Combined effects of growth, climate change and drought; Adapted from Water UK (2016)



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## Risk Card 4: How can we have too much and too little water?

### SUMMARY

Climate change causes more frequent and more severe extreme-weather events. The East of England is at higher risk of flooding and drought, which harms homes, business, infrastructure, human health and the environment.<sup>2,12,13</sup> Across Cambridgeshire and Peterborough, Fenland is the region's most 'at-risk' district for both flooding and drought.

Although this may not sound logical, drought and flooding are interlinked. Heavier rains in winter increase runoff, causing freshwater to end up in the ocean rather than underground. The main cause of drought is not evaporation in summer, but low 'recharge' of groundwater in winter. That's why heavier rains actually *increase* the risk of drought. Drought harms the environment, which is needed to store water. This is one example of how mankind interferes with the environment's natural way to preserve balance.

#### Climate change worsens drought and flooding in the East of England

- 'Extreme drought' in the East of England could be 18% more severe in 2065 than today. In Fenland, the severity is expected to increase nearly 30%.<sup>12</sup>
- Across the UK, **the number of homes 'at-risk' of flooding is expected to increase 40% under a +2°C climate change scenario and 93% under a +4°C climate scenario.** That's assuming no new homes are built in flood zones.
- Our region is no exception. Because of its low-lying nature, **much of Cambridgeshire lies in flood zones** with Fenland at highest risk, followed by East Cambridgeshire<sup>3</sup>.

#### The costs of extreme weather events

- Costs from flood damage are estimated to more than double by 2080 (see **Table 1**)<sup>11</sup>.
- With **over 75% of land in the East of England used for farming**, one of the region's main climate change risks is the **availability of water resources for agriculture**<sup>11</sup>.
- **Infrastructure networks** (water, electricity, rail, etc.) are interdependent. When there is a disruption to one network, the others are affected. With 17,000 'exposed assets', Anglian Water is highly concerned about these cascading failures<sup>1</sup>.
- Extreme weather is not only costly in the short-term. **It can lead to irreversible environmental damage** that compounds the problem of climate change.
- Peatlands, such as the lowland fen peatland in East Anglia, are significant global carbon sinks, storing ~30% of Earth's organic carbon. During drought, **carbon releases from these soils and contributes to global climate change, thus reinforcing the problem**<sup>9</sup>

Link to Risk Card 3:  
Water Scarcity

The region is rapidly growing and water sources have already been identified as 'at-risk' due to over-consumption from homes, businesses and industry.

**Table 1: Expected annual cost (£) of flood damage under a 4°C climate scenario**

Note: The following figures from HM Government (2015, p. 100)

Country	% Increase – 2080s		
	Coastal	Fluvial	Surface Water
UK	175%	130%	138%
England	135%	148%	135%
Wales	296%	158%	129%
Scotland	462%	54%	160%
Northern Ireland	64%	164%	136%

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# Thinking Card 5: Increased demand for health and social care

SUMMARY: Increased population + Aging population = Demand for health and social care services → spending cuts, which results in greater unmet need and future demand.

## ❖ Trend of aging population

- In the UK, the # people aged 65+ is expected to increase by about 20% between 2015 and 2025<sup>11</sup>.
- **Figure 1** shows the projected change in age profile of Cambridge City compared to other local districts from 2011 to 2036 (red arrows are placed at 65+ and black arrows at 80+).

## ❖ Health and social care cost of aging population

- By 2025, the number of people living with an age-related disability is predicted to rise 25%<sup>11</sup>.
- **More complex needs place greater strain on existing services:** e.g., dementia complicates ongoing treatment and recovery and is projected to reach 1 million in the UK by 2027 and 1.75 million by 2050<sup>7</sup>
- **Aging = ↑social isolation = ↑demand for mental health services:** In 2015/16 about 13% of those aged 80 to 89 and 20% of those aged 90+ were in contact with adult mental health services; compared to 3.4% of England's total adult population<sup>19</sup>.

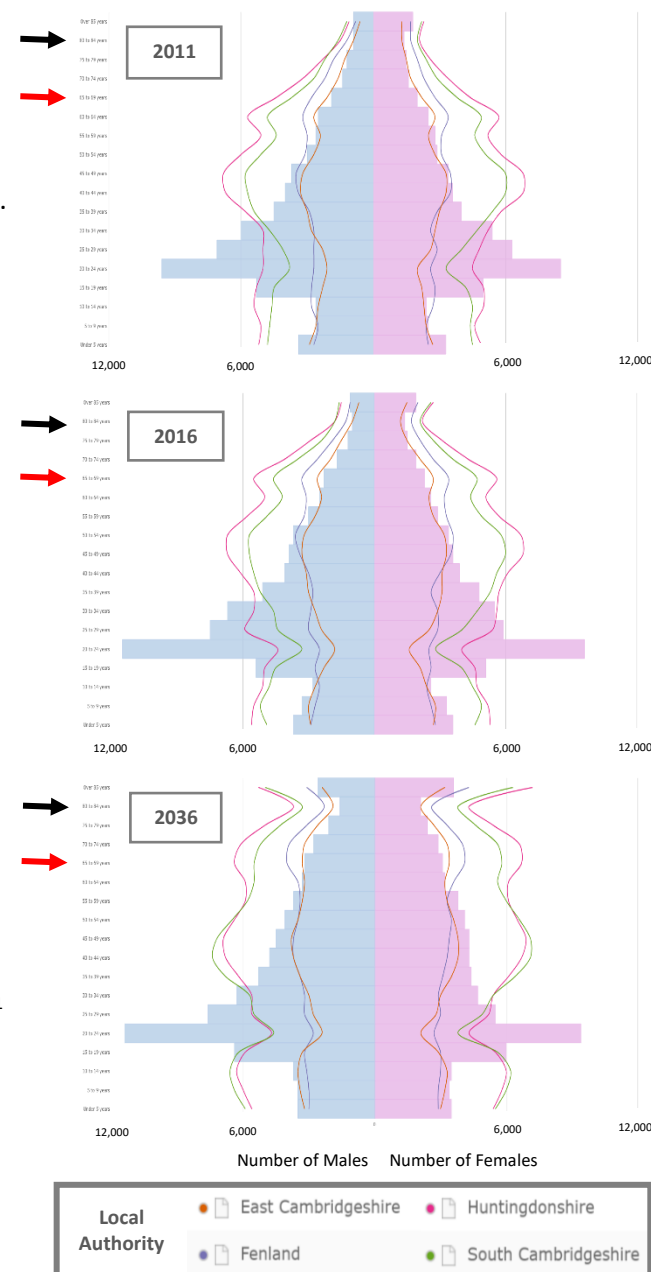
## ❖ Supply of health and social care services<sup>14,26</sup>

- **Between 1977-78 and 2009-10, UK spending on health and social care grew 10x faster than population.**
- This trend quickly changed, however, when Government **cut Local Authority (LA) budgets by nearly 20% between 2010/11 and 2017/18.**
- In light of increasing demand, **the 2020 social care funding gap is estimated to be £2.5 billion<sup>10</sup>.**
- In Cambridgeshire, despite increased spending on adult social care, **spending per client fell 23% between 2011/12 and 2016/17** (see **Table 1**), mainly due to 57% growth in elderly care clients<sup>3</sup>.

**Table 1: Change in adult social care (clients & real spending) between 2011/12 and 2016/17<sup>17,21</sup>**

County/Unitary Authority	Ages	Total Spend per 100,000 residents		Total # of adult clients		Clients per 100,000 residents		Total spend per client	
Cambridgeshire	18-64	21%		27%		21%		-1%	
	65+	-2%	9%	57%	48%	50%	41%	-34%	-23%
Peterborough	18-64	18%		20%		13%		5%	
	65+	-27%	7%	12%	14%	5%	7%	-31%	0%

**Figure 1: Aging population in Cambridgeshire County districts<sup>6</sup>**



## ❖ Main outcomes of recent social service cuts

- **Tightening eligibility criteria:** led to 25% decrease in recipients of local authority-funded domiciliary care in England between 2006 and 2013<sup>13</sup>.
- In Cambridgeshire, the **'applicant rejection rate'** reached 33% in 2016/17, compared to 19% in Peterborough<sup>21</sup>
- **The UK-wide 'social care gap' was estimated at 1.2 million people in 2016/17** (amounting to £4.8 billion of unpaid care), **an 18% increase since 2015-16 and 48% increase since 2010**<sup>8</sup>.

## ❖ The cost of the 'social care gap'

- **Unmet care translates into greater burdens on unpaid carers** who save the economy an estimated £132 billion/year (roughly equivalent to the NHS budget)<sup>8,27</sup>
  - **Healthcare feedback:** Only 16% of unpaid carers receive respite. 40% have gone a year and 25% have gone five years without a single day's break. These burdens translate into poor health outcomes: 73% of unpaid carers going a year without respite report deterioration in mental health; 65% in physical health.

## ○ Cuts to non-essential services result in increased demand in health and social services in later life

- In Cambridgeshire, ¼ of the children's centres budget has been cut since 2013/14<sup>25</sup>; in Peterborough the entire Sure Start budget was cut<sup>9</sup>.
- In addition to providing childcare services, child centres play a critical role in the 'early intervention network', which helps to (i) identify risk (e.g., risk of family breakdown) and (ii) connect children and their families to relevant support services. They are critical in combatting childhood mental ill-health.
- **Life-long implications for inequality:** at least half of adult mental ill-health starts in childhood<sup>23</sup>.
- Early intervention networks found to be cost effective; i.e., ↓ preventative programmes = ↑ future expenditures on services for 'looked after children'

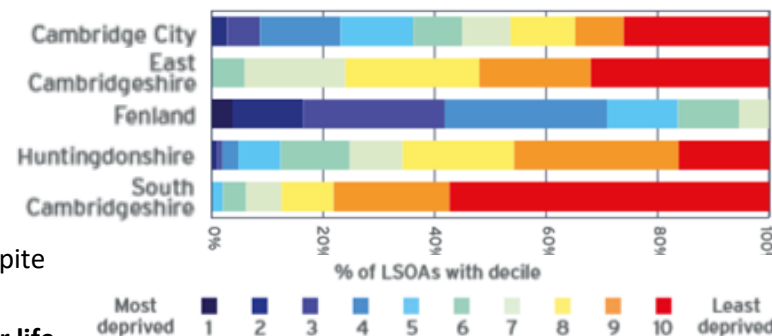
## ○ Direct cost to NHS: UK "bed-day delays" more than tripled between 2014 and 2016<sup>7</sup> due to insufficient supply of adult social care.

- Councils with insufficient funds double hit: 23.2% of LAs report being faced with fines from the NHS for delayed transfer of care.

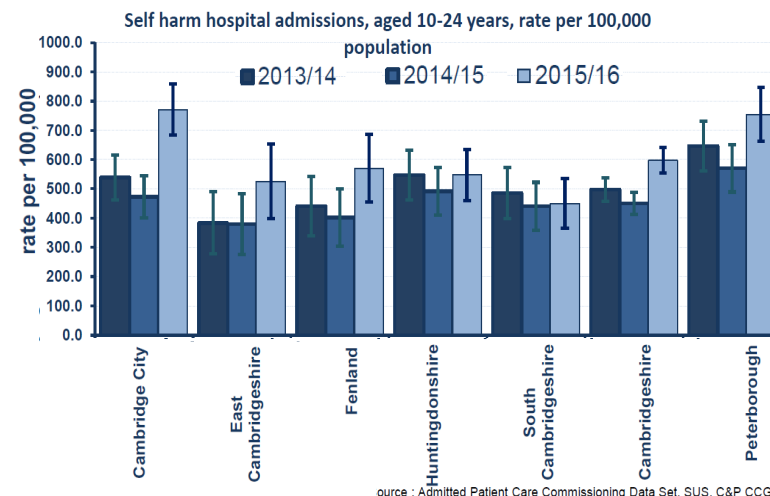
## ○ Indirect cost to NHS: Unmet care translates into more serious need at a future date

- Increased mental health issues: Nationally, there was a 20% increase in detentions under the Mental Health Act between 2014 and 2017.<sup>18</sup> In Cambridgeshire and Peterborough, emergency hospital admissions for youth self-harm have recently increased, providing evidence of unmet need amongst children and youth with poor mental health (see **Figure 3**).
- Increased physical health issues: Between 2011/12, there's been a 20% increase in ambulance calls (nationally)<sup>24</sup> and 12% increase in A&E admissions per capita (in GCGP).

**Figure 2: Health inequalities across Cambridgeshire (2015)<sup>4</sup>**



**Figure 3: Rising rates of self-harm in GCGP region<sup>5</sup>**



Source: Admitted Patient Care Commissioning Data Set, SUS, C&P CCG

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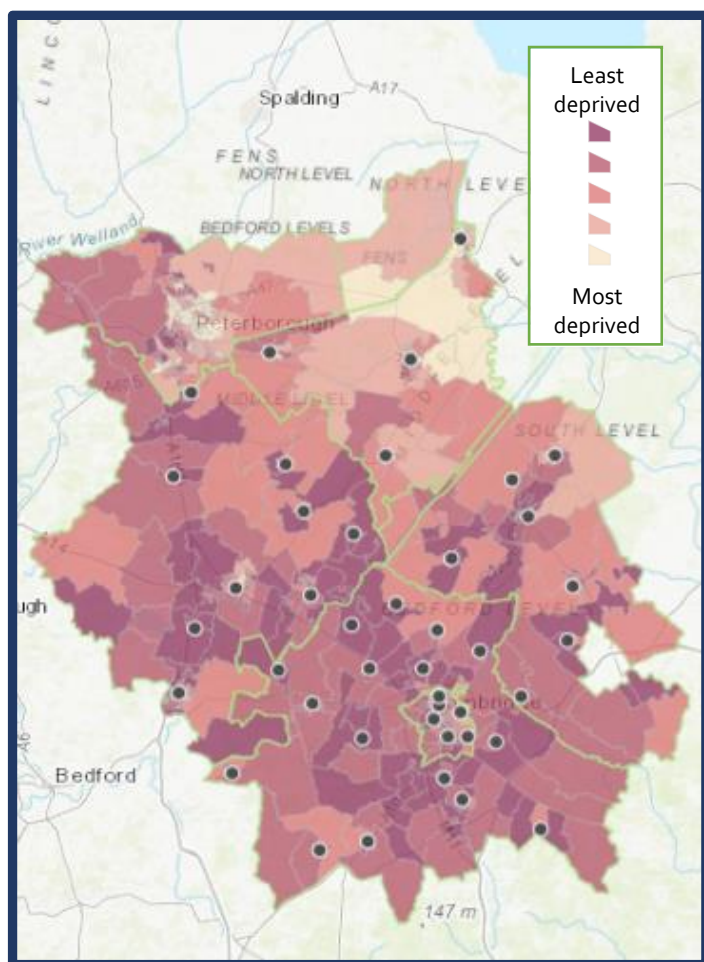
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## Risk Card 6: Inequality across the region

Comparison of deprivation in Cambridgeshire and Peterborough<sup>ii</sup>

**Figure 1: Deprivation across Cambridgeshire and Peterborough<sup>ii</sup>**



- ❖ Peterborough has nearly twice the percentage of children living in low-income households than Cambridgeshire<sup>i</sup>.
- ❖ There is also large disparity within Cambridgeshire: 21% of children in Fenland vs. 8% of children in South Cambridgeshire live in low-income households<sup>i</sup>.
- ❖ Children living in high-income households are more likely to have a positive social and emotional skill set. This is one example of how disparity in income creates other types of disparity.<sup>v</sup>
- ❖ **Figure 1** shows that over 1/5 of Fenland's LSOAs<sup>1</sup> belong to England's most deprived places. South Cambs, by comparison, doesn't have any 'most-deprived' LSOAs. Over half of South Cambs' LSOAs belong to England's 20% *least* deprived places.
- ❖ 70% of Peterborough's LSOAs fall below the national average in education, skills and training, compared to only 40% of Cambridgeshire – most of which are located in Fenland<sup>ii</sup>.
- ❖ The rate of violent crime is over twice as high in Peterborough as in Cambridge.

[Link to Risk Card 5: Health & social care](#)

(1) "39% of people in poverty live in a family where at least one person is disabled".

(2) According to a 2012 study of 11-year olds, 17% of children raised in households in the bottom fifth income bracket had severe mental health conditions compared with only 4% of children in the richest fifth<sup>v</sup>. There are many reason for this. First, children in poverty are at greater risk of experiencing neglect or physical abuse. However, this is still a minority of children in poverty. Second, and of greater importance, is the experience of deprivation itself. Studies have found that the experience of deprivation negatively affects children's mental health to the same extent as being raised by a parent with mental health or substance misuse problems.

### WARD-LEVEL COMPARISON: Percent LSOAs in England's bottom 20%

Ward	Employment	Income	Health	Education, Skill & Training	Living environment	Barriers to housing & services
Abbey, Cambridge	17%	17%	17%	50%	17% (50% in 3 <sup>rd</sup> decile)	83%
East, Peterborough	67%	50%	50%	67%	17%	0% (67% in 3 <sup>rd</sup> decile)
March East, Wisbech	25%	25%	25%	25% (75% in 3 <sup>rd</sup> decile)	0%	0%

<sup>1</sup> LSOA = neighborhood where population > 1,000 people or 400 households and < 3,000 people or 1,200 households (typically smaller than a ward, particularly in high-density areas)<sup>iv</sup>



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# Risk Card 7: Future trade barriers & the local economy



## ADMINISTRATIVE & SUPPORT SERVICES

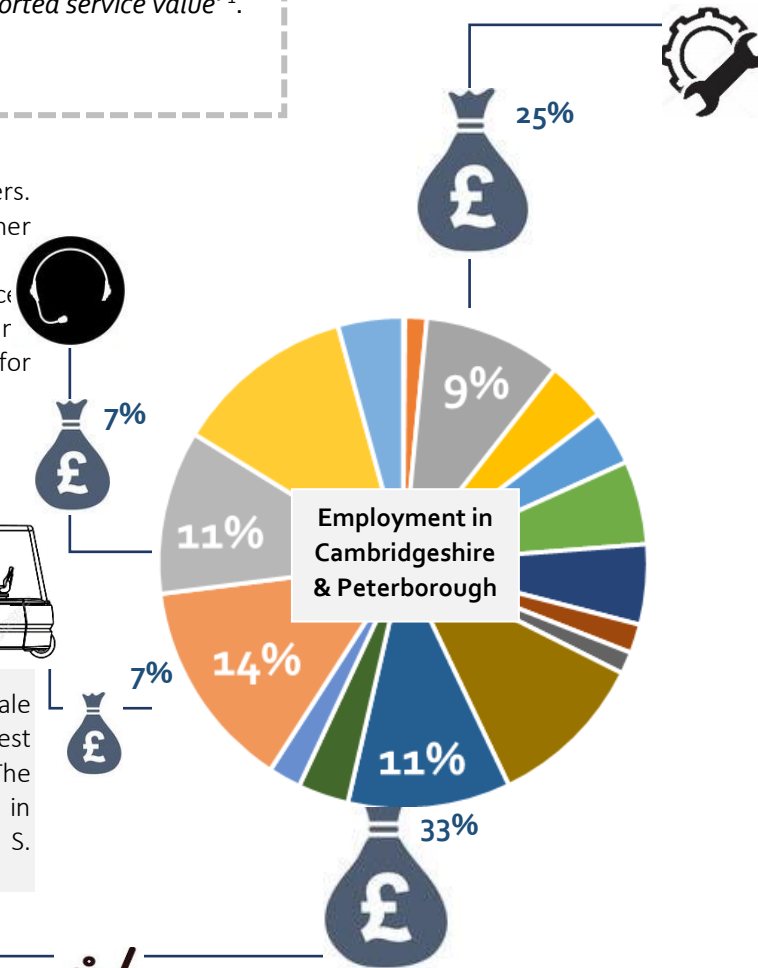
- Trade barriers are costly to UK manufacturers. These costs produce knock-on effects further down the supply chain, including for services.
- In 2015, 40% of administrative & support services underpinning exports from the East of England were supporting goods and services destined for the EU<sup>8</sup>.
- As such, this sector is at high-risk of experiencing indirect losses from future trade barriers with the EU.

## WHOLESALE & RETAIL TRADE

- This sector is highly trade-intensive.
- 55% of wholesale and retail exports from the East of England are destined for the EU<sup>8</sup>.
- In Cambridgeshire and Peterborough, 'Wholesale & Retail Trade' generates the 2<sup>nd</sup> highest revenues from exported goods to the EU<sup>4</sup>. The sector is responsible for 11% of jobs in Peterborough, 6% in Cambridge and 5% in Cambridgeshire, and 7-8% in other districts<sup>1</sup>.

## PROFESSIONAL, SCIENTIFIC & TECHNICAL

- Companies supporting highly regulated, trade-intensive industries – such as Agri-tech, Food & Drink, Pharmaceutical, and Automotive – will likely experience losses from future trade barriers with the EU<sup>2</sup>.
- High-tech manufacturing is 'capital-intensive'. Current levels of investment may decline once trade barriers are introduced. As a result, recent growth in this sector, particularly in the south of the county, may reverse.
- Expected losses would be concentrated in the south of the county. 14% of jobs in South Cambridgeshire belong to this sector, compared to only 3% in the north<sup>1</sup>.
- There are strong links between this sector and Cambridge City's 'knowledge economy'. Future barriers to the research funding and migration of EU researchers could also harm the local economy (1/4 of academics at Cambridge University are non-UK, EU citizens<sup>11</sup>).



## MANUFACTURING

- Food & Drink is the UK's largest manufacturing industry. It employs more people than the automotive & aerospace industries combined and is responsible for 1/5 of all things bought and sold in manufacturing<sup>5</sup>.
- The industry has the most to lose from migration and trade barriers following withdrawal from the EU:
  - Nearly 3/4 of its products are destined for the EU.
  - It imports the largest share of EU goods of any UK industry<sup>13</sup>.
  - Nearly 1/3 of employees in Food & Drink manufacturing are from the EU<sup>5</sup>.
- Food & Drink is an important industry for the region, with a stronghold in Peterborough and Fenland.
- "Greater Peterborough's agri-food industry generates around £4 billion of trade each year. [...] Over 400 food-manufacturing and food-related firms contribute more than 6,000 jobs to Peterborough."<sup>9</sup>
- Jobs in Fenland and Peterborough are more dependent on manufacturing (18% and 7%) than in Cambridge (2%)<sup>1</sup>. The north of the county is therefore at greater risk of future trade barriers for this sector.

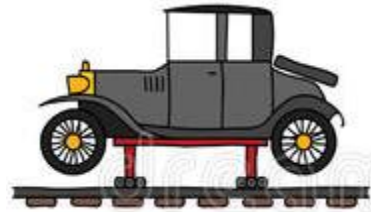
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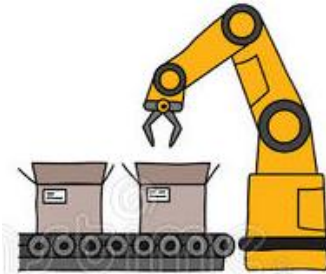
## Risk Card 8: The 4<sup>th</sup> Industrial Revolution



**Industrial revolution**  
(steam & water power)



**Mass production**  
(assembling lines & electricity)



**Automation**  
(IT system & robotics)



**'Smart' Automation**  
(machine learning & Big Data analysis)

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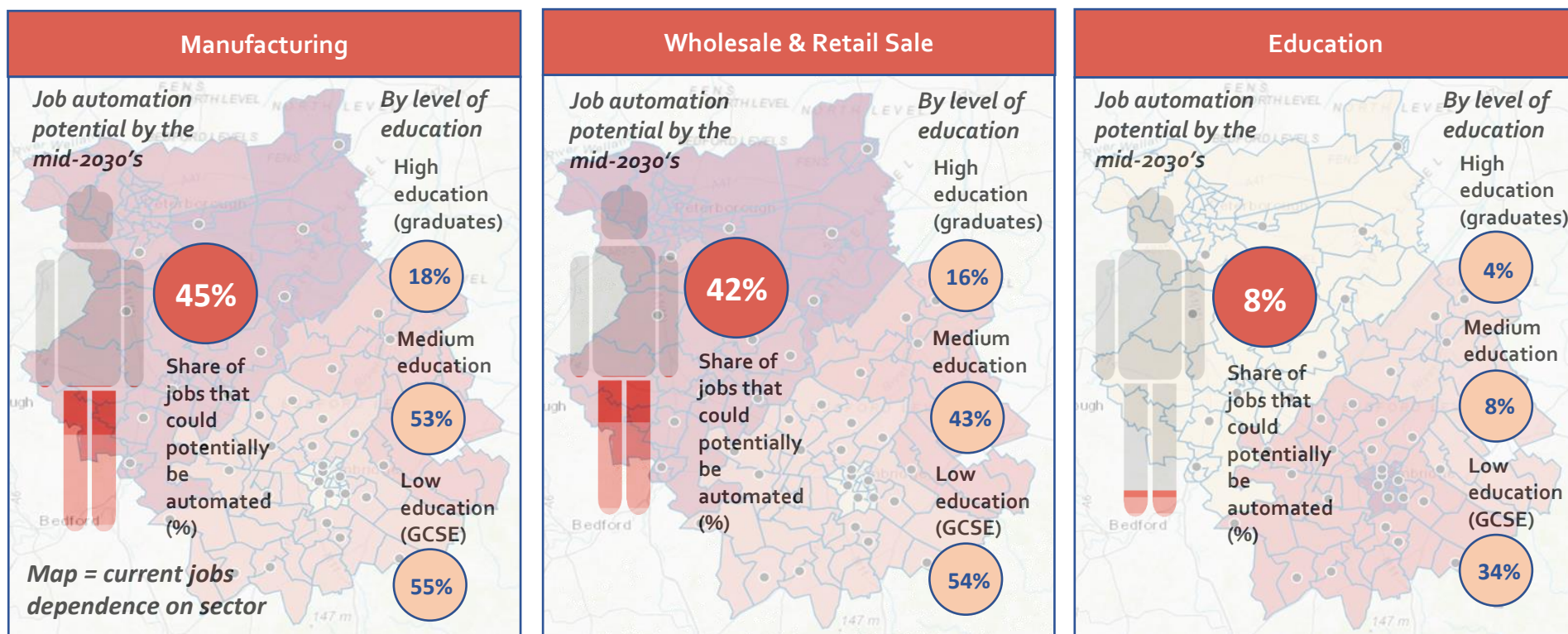
### SUMMARY

The '4<sup>th</sup> Industrial Revolution' is here, from drones to self-driving cars. The revolution is driven by Big Data, and dramatically enhanced computer processing power. The result being: Digital systems that can mine enormous datasets leading to scientific breakthroughs and 'artificial intelligence' that supports new types of business. Yet, 'Industry 4.0' raises a number of concerns from data protection to rising inequality.

### Risks & Opportunities<sup>5</sup>

- i. **Housing & energy:** Industry 4.0 could improve building design and use through 'smart' energy grids' and 'building management systems'.
- ii. **Mobility:** The number of remote workers has risen 34% in the past decade, as many employees are now able to work wherever there is wifi connection. The number of high-skilled remote workers has risen over 50%. In 2017, about 1 in 7 UK workers were full-time freelancers.<sup>3</sup>
- iii. **Consumption & waste:** Big data supports targeted advertising which could increase consumption and waste. On the other hand, real-time information systems could support a transition to a 'circular economy'.
- iv. **Rising unemployment:** By the mid-2030s, about 1/3 of UK jobs are at risk of automation. This risk disproportionately affects medium (-35%) and of low-skilled (-47%) workers<sup>6</sup>. Expected job loss is shown for three sectors in **Figure 1**.
- v. **Rising inequality in employment:** Meanwhile, high-skilled jobs are expected to grow (e.g., in finance, computer science, architecture & engineering). These employment trends will likely increase economic and social divides between low/mid- and high-skilled labour.
  - Cambridge has the highest-skilled labour force in the UK, with 67% of the working age population having a degree<sup>2</sup>. By comparison, Peterborough has the seventh highest share of unskilled workers (14%) with only 27% with a degree.
- vi. **Rising inequality in wealth:** Investors will benefit the most from Industry 4.0, widening the gap between rich & poor<sup>7</sup>.
  - Globally, 42 individuals have more wealth than the poorest 3.7 billion people combined (half the world's population)<sup>4</sup>. With jobs being increasingly automated, including "re-shoring" from developing economies, Industry 4.0 is expected to accelerate rising inequality<sup>7</sup>.

Figure 1: Expected job loss in the UK's 4<sup>th</sup> Industrial Revolution varies across Cambridgeshire and Peterborough<sup>1,6</sup>



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## Risk Card 9: The environmental impact of unsustainable development

### SUMMARY

Through unsustainable levels of consumption, pollution and land-use change, humans have caused the greatest extinction since the dinosaurs. 7 in 10 species having been wiped out in the last 50 years<sup>8</sup>. This mass extinction raises ethical questions (e.g., Is human life more valuable than all these species combined?). The natural environment we destroy to grow food, build cities, etc. not only provides habitat for wildlife, it also supplies us with key services. For example, the environment regulates the climate and provides fresh water (see **Figure 1** for more examples). Globally, we are beginning to surpass so-called 'planetary boundaries', or the limits of environmental change the Earth can withstand before natural systems collapse<sup>5</sup>. Within the housing sector, much can be done to reduce habitat loss. However, research shows that only about 1/6 of new homes have any sort of ecological enhancement<sup>6</sup>.

### What is the state of nature in the UK?

The UK is considered one of the "most nature-depleted countries in the world"<sup>4</sup>. A project pulling together studies from 50 nature conservation and research organizations found that, between 1970 and 2013, over half of UK species were under decline, with 1/3 in stark decline<sup>4</sup>. Much of this loss is due to habitat loss. Since the 1930's, the UK has lost 97% of its wildflower meadows on which pollinators, such as bees and butterflies, rely – a land area equal to 1.5 times the size of Wales<sup>1</sup>. Key drivers of these trends are shown in **Figure 2**.

### What is the UK's global environmental footprint?

If the world consumed as many resources as the average UK resident, we would need 4 Earths to survive<sup>2</sup>. Having exploited much of its own natural capital, the UK is increasingly reliant on foreign resources. For example, the land used to grow food for UK residents and livestock increased 23% between 1986 and 2009, 70% of which was land outside the UK.

Figure 1: Examples of ecosystem services<sup>3</sup>

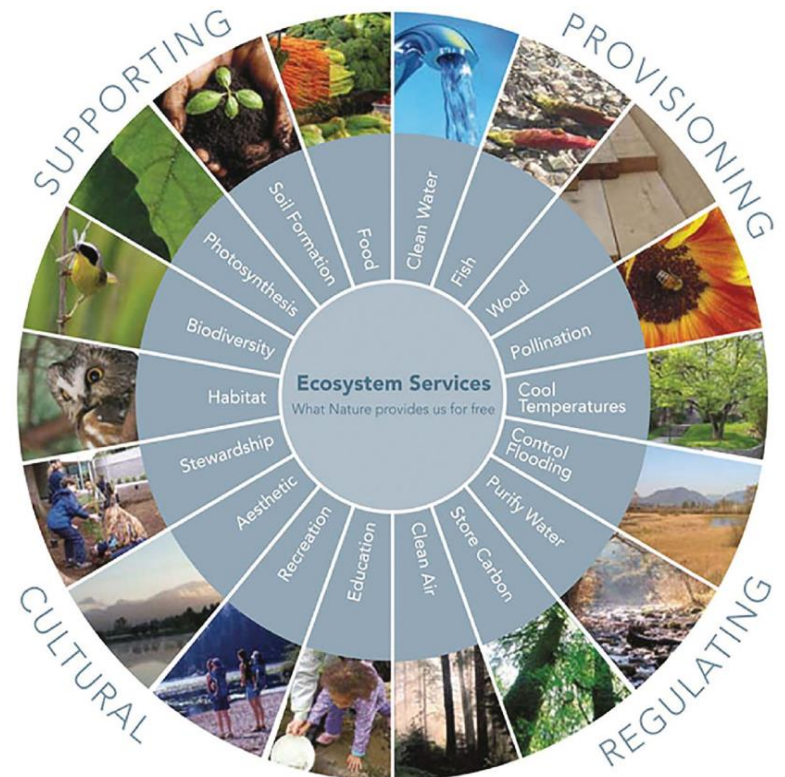
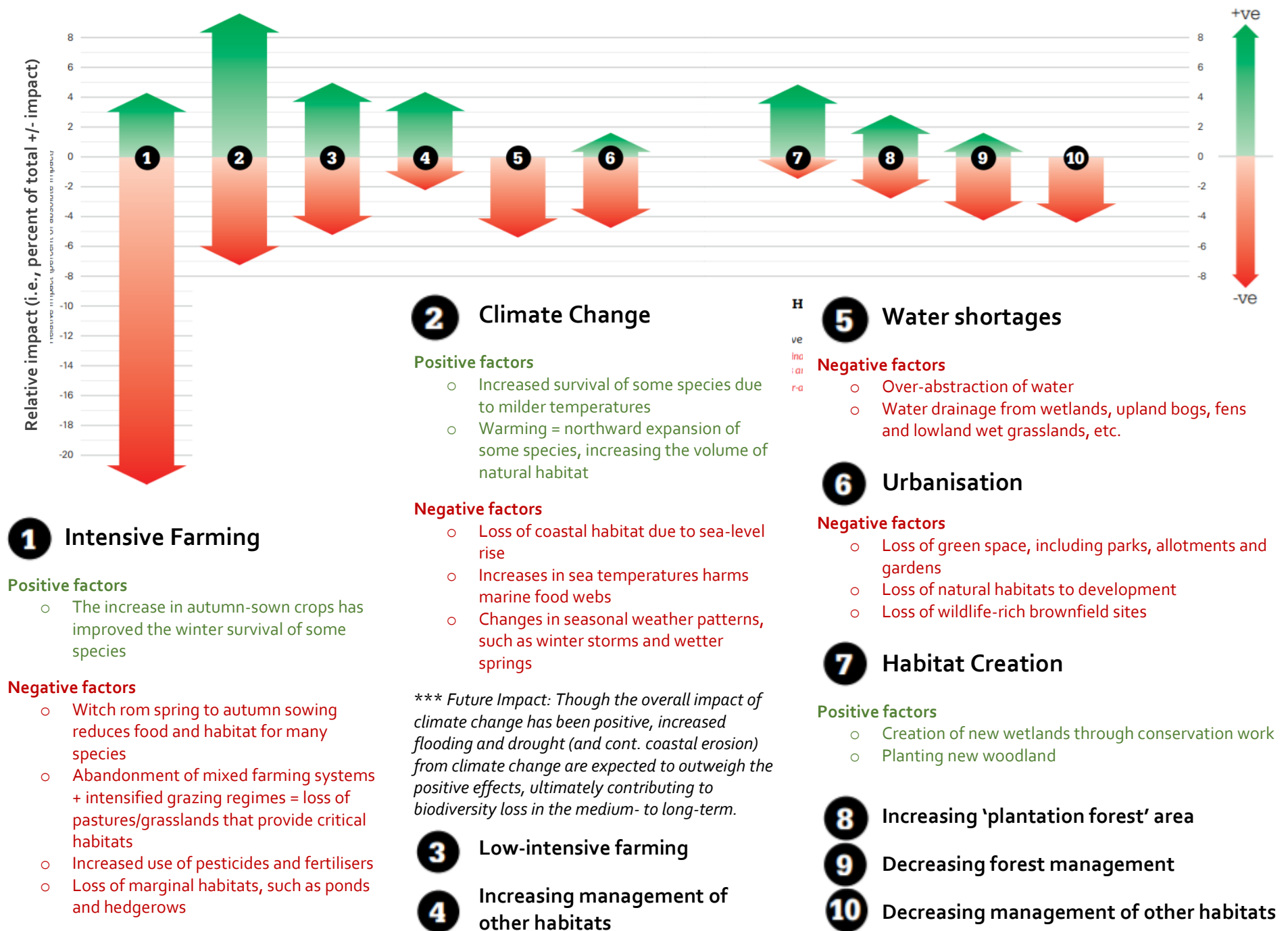


Figure 2: Main drivers of change to UK nature<sup>4</sup>





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# RISK CARD 1: HOUSING AFFORDABILITY

## SUMMARY

With a growing population comes growing demand for housing. When this demand is not met, house prices rise. Where prices rise, so too does demand for housing as an investment – not just shelter. This further inflates house prices. Combined with a shrinking volume of social housing, low-income households are hit hardest by the regional housing crisis. Meanwhile, property owners amass more wealth (see **Figure 1**).

Housing affordability varies across the region (see **Figure 2**). Though housing is still affordable for relatively low income-earners in Peterborough and Fenland, the same cannot be said for the three districts closest to Cambridge. Looking at **Figure 2**, housing has been unaffordable for at least a quarter of Cambridge employees since 2002.

**A shift to more rural housing:** The former East of England's 'Regional Spatial Strategy' purposefully concentrated housing development in **urban** areas, in line with the principles of sustainable development. Since then, however, local authorities have agreed to increase the share of new homes in **rural** districts (i.e., East Cambridgeshire, Huntingdonshire and Fenland) to increase the speed at which affordable homes are built.

## Housing deficits (past & future)

- Between 1991 and 2016, East Cambridgeshire was the only district to have met the council's house building targets.
- In the same period, Cambridge and South Cambridgeshire were 43% and 34% below target.
- If these trends continue, we can expect a 28% *undersupply* of housing across Cambridgeshire and Peterborough by 2045 – a shortfall of nearly 35,000 homes.

## Shifting strategy

- A shift to rural housing development was made to address housing affordability.
- However, job growth will still be concentrated in and around the city centres of Cambridge and Peterborough.
- Without improved public transportation, we can expect increased traffic, air pollution and greenhouse gas emissions.

**Figure 1: Capital accumulation in an increasingly financialised housing sector (Macfarlane, 2018)**

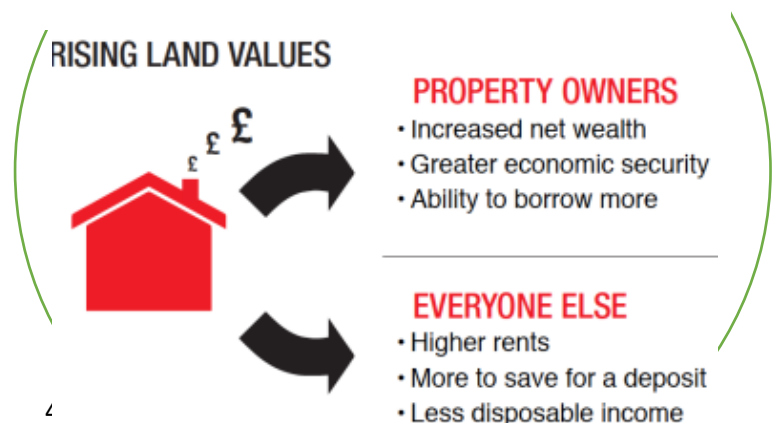
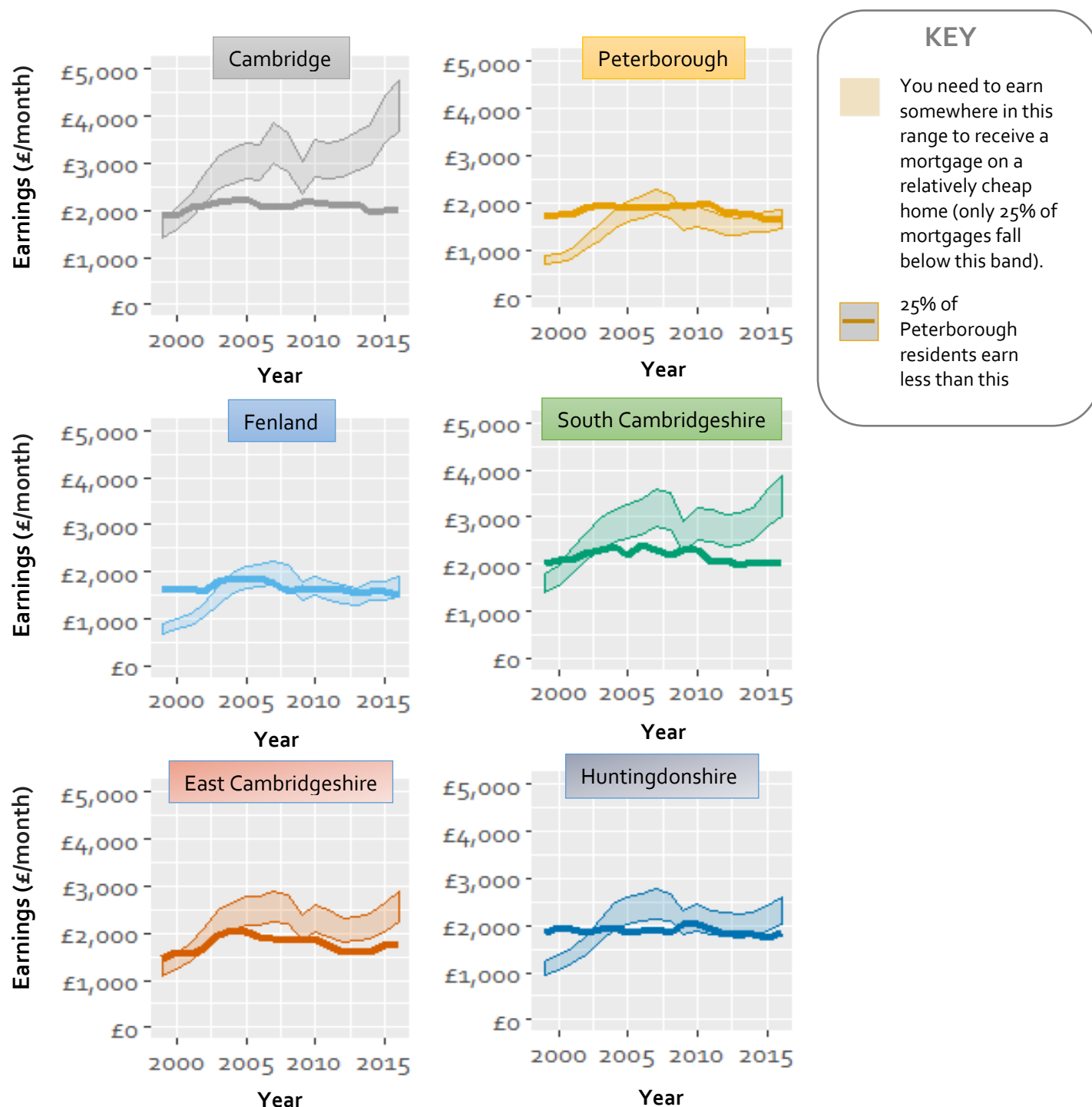


Figure 2: Housing affordability for the bottom 25% income-earners across the GCGP region<sup>2,3</sup>



<sup>2</sup> Earnings data taken from ONS, *Land Registry*; average LQ house prices from ONS dataset 'Ratio of house price to earnings (lower quartile and median) by local authority district, England and Wales, 1997 to 2015'; Monthly mortgage rates estimated using Nationwide's *Our Mortgage Rates* (accessed on January 30, 2018).

<sup>3</sup> 'Affordable earnings' calculated based on the following assumptions: (1) Spending 35% or less of your monthly average earnings on your monthly mortgage bill is 'affordable'; (2) ATV of 85%; (3) 25-year payment term

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# Risk Card 5: Increased demand for health & social care

## SUMMARY

Between 1977-78 and 2009-10, UK spending on health and social care grew 10x faster than population due to increasing costs. This upward trend in social care spending quickly reversed after 2010, when Government cut local authority (LA) budgets. With an increasing demand for care from an aging population, LAs have had to cut spending per person, whilst many non-essential services have gone altogether. These cuts result in unmet need, referred to as the 'social care gap'. This gap disproportionately affects those who cannot afford private care and results in increased costs for the NHS and LAs in the future when problems worsen.

### ❖ HEALTH AND SOCIAL CARE COST OF AN AGING POPULATION

- UK's 65+ population is expected to grow by 20% between 2015 and 2025<sup>11</sup>. Meanwhile, the number of people with an age-related disability is predicted to rise 25%<sup>11</sup>.
- **Aging = ↑ social isolation = ↑ demand for mental health services.**
  - In 2015/16 about 13% of those aged 80 to 89 were in contact with adult mental health services. This is compared to only 3% in England's total adult population<sup>19</sup>.

### ❖ THE HEALTH AND SOCIAL CARE GAP<sup>14,26</sup>

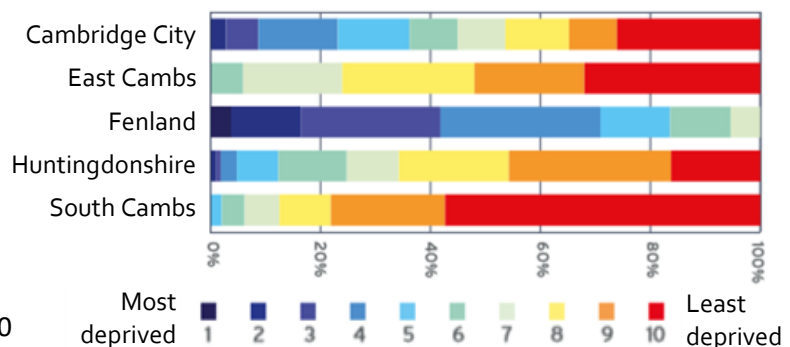
- Across England, Local Authority (LA) budgets were cut 20% between 2010/11 and 2017/18. Still, LAs must provide 'essential services' to those in need.
- As a result, (i) 'eligibility criteria' were tightened<sup>13</sup> and (ii) **spending per client** fell. In Cambridgeshire, **spending per client** fell nearly a quarter since cuts were introduced<sup>3</sup>.
- The resulting '**social care gap**' was estimated at 1.2 million people and £4.8 billion of unpaid care in 2016/17 (UK-wide estimate). This is a 50% increase from 2010<sup>8</sup>.
- The first LA cuts were made to 'non-essential' programmes such as Children's Centres. These centres play a critical role in the 'early intervention network', which helps to identify risk and connect children and their families to relevant support services critical for fighting childhood mental health issues.
- Research shows that cuts in 'non-essential', preventative programmes result in increased Government spending on children's social care in the mid-term<sup>12</sup>. In Cambridgeshire, ¼ of the budget for children's centres has been cut since 2010<sup>25</sup>; in Peterborough the entire Sure Start budget has been cut<sup>9</sup>.

### ❖ THE COST OF THE 'SOCIAL CARE GAP'

- **Those in need of, but not receiving care are more likely to experience preventable injury and illness.**
  - Since the 2011/12 cuts, ambulance calls and A&E admissions have risen 12% (per capita)<sup>24</sup>.
- **The 'social care gap' puts more burden on unpaid carers** who save the economy an estimated £132 billion/year (roughly equivalent to the NHS budget)<sup>8,27</sup>
  - 4 out of 10 unpaid carers have gone an entire year without a single day's break. 1 in 4 have gone five years without a break. Research shows that these burdens result in poorer mental and physical health for unpaid carers.
- **Cuts to non-essential services result in increased demand in health and social services later on.**

- In Cambs and Peterborough, emergency hospital admissions for youth self-harm have recently jumped. This provides evidence of poor prevention and unmet need for children and youth.
- At least half of adult mental ill-health starts in childhood<sup>23</sup>.

**Figure 1: Health inequalities across Cambridgeshire (2015)<sup>4</sup>**



### Link to Risk Card 6: Inequality

Poor physical and mental health has been found to both cause and result from deprivation. In the region, areas with higher income deprivation also have better health outcomes (see Figure 1).<sup>12</sup>

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## Appendix D: Co-modelling appendix

### D1 Participant selection

**TABLE D 1: STAKEHOLDER GROUPS BY THEME**

THEMATIC GROUP	STAKEHOLDERS
HOUSING INEQUALITIES	Social housing rep
	Adult Services, local authorities
	Housing services, local authorities
	Key worker affordable housing programme
	Local charity
	Children and family services, local authorities
	Citizens' Advice
	National and local charities offering support for children and their families
DESIGN AND ARCHITECTURE	Town planning consultancies
	Engineering consultancies
	Heritage consultancy consultancies and heritage conservation groups
	Planning services, local authorities
	Landscape architecture firms
	Accessibility officer, local authorities
	local accessibility charities
	Architectural firms
	Colleges training in construction
COMMUNITY CONNECTION & QUALITY OF NEIGHBORHOODS	Police
	Local authority officers with sustainable communities remit
	Professional community-builders
	Place-making consultancies
	Housing associations
	Residents' associations
	Local authority officers supporting community-led housing development
	Local authority directors of communities
	Community Interest Companies (CICs) enabling community-owned or controlled infrastructure
	Members of 'Community Safety Partnerships'
TRANSPORT	Religious organizations
	National rail company (UK National Rail)
	National transport authority (Highways England)
	Regional transport authority (Cambridgeshire and Peterborough Combined Authority)
	Sub-regional transport authorities
	Dominant bussing company in region (Stagecoach East or Stagecoach in the Fens Ltd)
	SME bussing companies

	Sustainable transport consultancies National sustainable transport charities Local sustainable transport charities Citizens' transport lobby group
<b>HOUSING DEVELOPMENT</b>	Housing development consultancies Rural housing enabler (Cambridgeshire ACRE) Real estate trusts National government agency that funds new affordable housing in England (Homes England) Regional government with housing infrastructure budget (Cambridgeshire and Peterborough Combined Authority) Real estate agency Mortgage financiers Home Builders Federation Building societies Local authority-owned housing company Construction firms SME housing developers Housing Associations National Landlord Association Large land owners Planning services, local authorities Researchers: urban studies Land Economists
<b>NATURE CONSERVATION AND CC ADAPTATION</b>	Local climate change adaptation panel formed under the Department for Environment, Food and Rural Affairs (Defra) Local Nature Partnership formed under the Department for Environment, Food and Rural Affairs (Defra) Environmental consultancies Local Nature Partnership formed under the Department for Environment, Food and Rural Affairs (Defra) National nature conservation trusts Flood risk officers, local authorities Blue and greenspaces management, local authorities Local environmental charities Blue and greenspaces management, local authorities Investment firms with CC adaptation portfolios National membership organisation that promotes the building of quality, sustainable homes Water companies Environment Agency Researchers: Climate change, built environment and land-use change Environment Agency
<b>HOUSING STOCK &amp; ENERGY</b>	Heritage conservation groups Engineering consultancies Regional bodies raising housing design standards National bodies raising housing design standards



	<p>Greentech business incubators</p> <p>Department of Business, Energy and Industrial Strategy</p> <p>Regional government with ability to coordinate actions between local authorities and local businesses (CPCA)</p> <p>Energy Service Company (ESCo) active in the region</p> <p>Research: energy consumption and the built environment</p> <p>Local charities educating citizens and business leaders about ways to reduce energy consumption in buildings</p> <p>National programme supporting local authorities to retrofit public buildings (Re:FIT)</p> <p>Local/sub-regional government delivering energy retrofit scheme</p> <p>Green Deal accredited firms</p> <p>Renewable electricity companies</p> <p>Regional electricity distribution network operators (UK Power Networks)</p> <p>National high-voltage electric power transmission network owner and operator (National Grid)</p> <p>National Landlord Association</p> <p>Local authority officers tackling fuel and water poverty</p> <p>Citizen energy groups</p>
<b>LOCAL ECONOMY</b>	<p>Local Enterprise Partnership (LEP)</p> <p>Cambridgeshire and Peterborough Combined Authority</p> <p>Researchers: local economy and growth trends</p> <p>JobCentre Plus</p> <p>Regional branch of Federation of Small Businesses (FSB)</p> <p>Greater Cambridge business lobby group (Cambridge Ahead)</p> <p>Greentech business incubators</p> <p>Chambers of Commerce</p> <p>Regional colleges</p> <p>Corporate directors and Heads of development, local authorities</p>
<b>HEALTH &amp; WELLBEING</b>	<p>accessibility charities</p> <p>Corporate directors and Heads of development, local authorities</p> <p>social care charities</p> <p>Social care services, local authorities</p> <p>Sub-regional public Health body (Public Health for Cambridgeshire and Peterborough)</p> <p>National public health body (NHS England)</p> <p>Residential care companies</p> <p>Regional Health &amp; Wellbeing Boards</p> <p>Cambridgeshire and Peterborough NHS Trust</p> <p>NHS Sustainable Development Unit</p> <p>Researchers: Impacts of housing inequalities on mental health</p> <p>Researchers: Climate change-related health risks</p> <p>Researchers: Impacts of built environment on public health</p>

**TABLE D 2: TM CRITERIA FOR PARTICIPANT SELECTION**

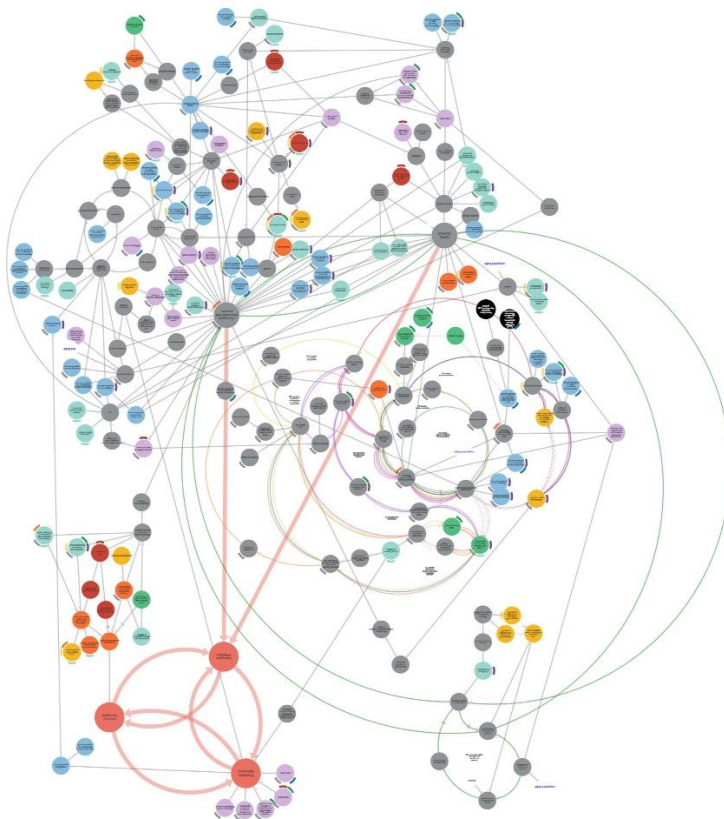
Criterion	Description
Representativeness	<ul style="list-style-type: none"> <li>Each stakeholder group should have at least one representative in attendance</li> <li>Each of the six districts/cities in the city-region should have at least one resident in attendance</li> </ul>
Inclusivity	Traditionally marginalized voices should be represented (e.g., low-income earners, ethnic minorities, people with disabilities, women and the elderly), as the social background of a participant necessarily influences his or her perception of the system and problem situation.
Niche Engagement	Actors who have already adopted new ways of thinking and doing and are already engage in niche activity should take priority
Sources of agency	<ul style="list-style-type: none"> <li>Actors with technical skill/knowledge in public health, social care, and the housing, transportation or finance sectors should take priority to inform concrete solutions and aid in their implementation</li> <li>Actors linked into several social networks (e.g., via membership in various associations or participation in cross-sectoral projects) and preferably demonstrate a position of authority within one or more of those networks should take priority to improve the likelihood of innovation scale-up</li> <li>Actors operating at multiple spatial scales (e.g., in local and national government) should take priority to improve the likelihood of spatial diffusion and alignment with structures operating at higher spatial scales</li> <li>Actors with legislative and financing powers to help realize the projects</li> </ul>
Openness to the transition process	<ul style="list-style-type: none"> <li><b>Creativity</b> to divorce oneself from the current reality and envision a dramatically altered state</li> <li><b>Openness to change</b>, so as to welcome innovative means and ways to deal with complex (persistent) problems</li> <li><b>Value compromise over ‘winner-takes-all’</b> to help produce pareto-efficient outcomes</li> <li><b>Ability to understand and learn from different disciplines</b> so as to improve group learning and receptiveness to solutions lying outside one’s profession</li> <li><b>Analytical skills</b> to reflect upon how existing practices, cultures, and structures relate to complex (persistent) problems</li> <li><b>Communication skills</b> to establish a collective vision within the Transition Network and then effectively communicate that vision within personal and professional networks</li> </ul>

## D2 Presentation of Causal maps belonging to the GCGP Housing & Wellbeing model

This section of the Appendix presents the GCGP model’s remaining subsystem models in the following order with supporting quotes from stakeholder interviews:

1. Housing & Community
2. Housing, Energy & Climate change
3. Housing inequalities
4. Housing market & Land economy
5. Housing design & Spatial planning
- Housing & Transport

Due to its large size and limited number of Causal Loop Diagrams (CLDs) the “Housing & Wellbeing” map into which the other seven maps feed (see Figure D1), is excluded from this thesis. However, its digital version can be accessed online<sup>4</sup>.



**FIGURE D 1: “HOUSING & WELLBEING” CAUSAL MAP**

The first subsystem model, “Housing & Community” (Section D2.1), is presented in full much like the “Housing & the Environment” subsystem model (Section 5.3.3). Theorisations originating from the HEW model are presented, as well as revisions/additional contributions from the GCGP Housing & Wellbeing research project. The second subsystem model, “Housing, Energy and Climate change” (Section D2.2), is also presented in full, albeit, not in the same level of detail as the Housing & Community subsystem, given its size. Rather, only a short, written summary of each CLD is provided. To view figures, the reader is directed to the online Kumu model<sup>5</sup>.

<sup>4</sup> Visit <https://www.kumu.io/Istabler10/housing-wellbeing-model>, or <https://www.kumu.io/Istabler10/housing-wellbeing-model-clds-only> to view CLDs separately.

<sup>5</sup> Visit <https://www.kumu.io/Istabler10/housing-wellbeing-model>, or <https://www.kumu.io/Istabler10/housing-wellbeing-model-clds-only> to view CLDs separately.

Both subsystem models relate closely to their HEW counterparts, with a number of additional variables and relationships. In the case of the “Housing & Community” subsystem, these additions mainly provide greater depth to an otherwise similar conceptualisation. By comparison, the “Housing, Energy and Climate change” subsystem is noteworthy for significantly expanding the boundaries of the HEW model to include supply-side factors and feedback loops responsible for system dynamics having emerged in other countries with the scale-up of competing renewable heat systems.

The remaining four subsystem models are not presented in full. Rather, only select findings are presented – enough to give the reader a clear understanding of the kind of relationships modelled in each subsystem.

## D2.1 The ‘Housing and Community’ subsystem

The “Housing & Community” subsystem model covers reinforcing relationships between the quality of the built environment and “community connection and cohesion” – whereby communities with greater capacity successfully attract investment into their area and places with low capacity struggle to attract investment by developers, local government, and householders. The outcome is a strong differentiation in the quality of built environments, leading, as well, to a differentiation in “<length of tenure>” on which community connection and cohesion relies.

The feedback loops modelled in this subsystem have implications for the societal challenge of decarbonising the housing stock, which requires a certain “<length of tenure>” for significant “<investment of resources into the physical quality of existing [...] dwellings>”. They also have implications for housing inequalities. Because community feedback loops simultaneously drive upward spirals in the quality of certain environments and downward spirals in the quality of others, they contribute to the geographical clustering of households in high deprivation, with numerous implications for wellbeing. As summarised by Macmillan, Davies, and Bobrova (2014, p. 12) “the relationships [in this subsystem] are considered to be currently dominated by reinforcing loops. While some are helpful for improving wellbeing and patterns of energy use, others serve to entrench poverty and poor social wellbeing.”

Feedback loops B1 to B2, R1 to R4 from HEW’s “Community connection and physical quality of neighbourhoods” form the basis of the ‘Housing & Community’ subsystem model with some minor adaptations. The remaining eight feedback loops from HEW’s “Community connection and physical quality of neighbourhoods” – which consider the impact of tenure security on disposable income, education attainment, and employment and income – form the basis of the “Housing inequalities” subsystem model. From the literature review and GCGP interview data, an additional seven CLDs were added to the Housing & Community subsystem model.

### D2.1.1 R1 social trust and length of tenure are self-reinforcing

HEW’s CLDs “R1 physical qualities that make people want to stay” and “R4 housing improvements help people stay” model reinforcing loops between the quality of the built environment, length of tenure and “neighbourhood social connection and sense of security” – whereby households that are able and choose to stick around, thanks in part to a supportive built environment, are more likely to invest in the maintenance and improvement of that environment.

Whilst GCGP interviewees agreed with these feedbacks and the mediating power of the built environment, they tended to emphasise the role of social relationships in fostering “connection to place”:

*“A lot of people like to live in villages because there’s a sense of pulling together. People volunteer to help each other out and there’s something about knowing people and because people are out*

*and about talking to each other. [...] I find, for myself, that knowing a lot of the people around where I live brings me a sense of security but also happiness."* (Interviewee 12)

After reviewing stakeholder interviews, I decided to combine R1 and R4, which focus more on the mediating effects of the built environment, to create "R2 housing improvements help people stay", presented in Figure D3. I then decided to create a new CLD, "R1: social trust and length of tenure are self-reinforcing", that focuses solely on social attributes that account for "pride in place" even when the quality of the built environment is poor (see Figure D2).

In the GCGP model (Figure D2), "Neighbourhood social connection and sense of security", an element in the HEW model, is broken down into three elements, namely "community connection and cohesion"; "<social trust>", and "<sense of safety in neighbourhood>". "Community connection and cohesion" is defined as the number and quality of social relationships between members of the community, which is theorised to improve with "<length of tenure>" and the "[quality of] social interactions with members of [the] community". "Community connection and cohesion" is said to foster "<social trust>", improving people's "<sense of safety [...]>" and "<sense of community and local identity>". It is these social outcomes – social trust, sense of safety, and sense of community – that bolster a sense of "<pride in place [...]>", which is theorised to feed back and reinforce "<length of tenure>".

There are, however, barriers to the number and quality of social interactions between community members. First, large-scale developments, such as fringe developments or newtowns, introduce a large influx of households with little to no community to tap into locally. "Community integration programmes" were considered a key intervention to tackle this issue:

*"I've seen large-scale developments where they have employed, from day one, community coordinators for the first five years of that community's existence, whose role it is to go and meet new people and introduce themselves. So they are actually creating communities from the start rather than just building houses. [...] Or [...] community integration/cohesion programmes. Really, it's happening at Alconbury, and I think it's happening at Northstowe."* (Interviewee 2)

A number of other barriers stemming from other subsystems were also identified:

### **Housing & Transport (red)**

- car-dominant environments hinder impromptu social interactions with neighbours

*"There's a paper by Appleyard in the late 60's? [...] that looked at how well you know your neighbours, and essentially, the busier the road was outside the front of your house, the less likely you were to know your neighbours. Whereas, if you had a quiet road or space that was banned to cars, the number of relationships you had with your community was enormous [...]. I mean, crikey. That's 50+ years of that sort of understanding, and yet we are still building developments that allow lots of motor vehicles to be parked all over the place."* (Interviewee 17)

*"'Jumpers for goal posts'... that's what everyone called it. You'd just put a couple of jumpers down on the street and you'd have a football match. You rarely see that anymore because you get someone saying, 'Don't scratch my car!', or there just isn't space... or you sort of get pushed into these manicured spaces as part of the development. And that sort of 'informal play' has been lost."* (Interviewee 18)

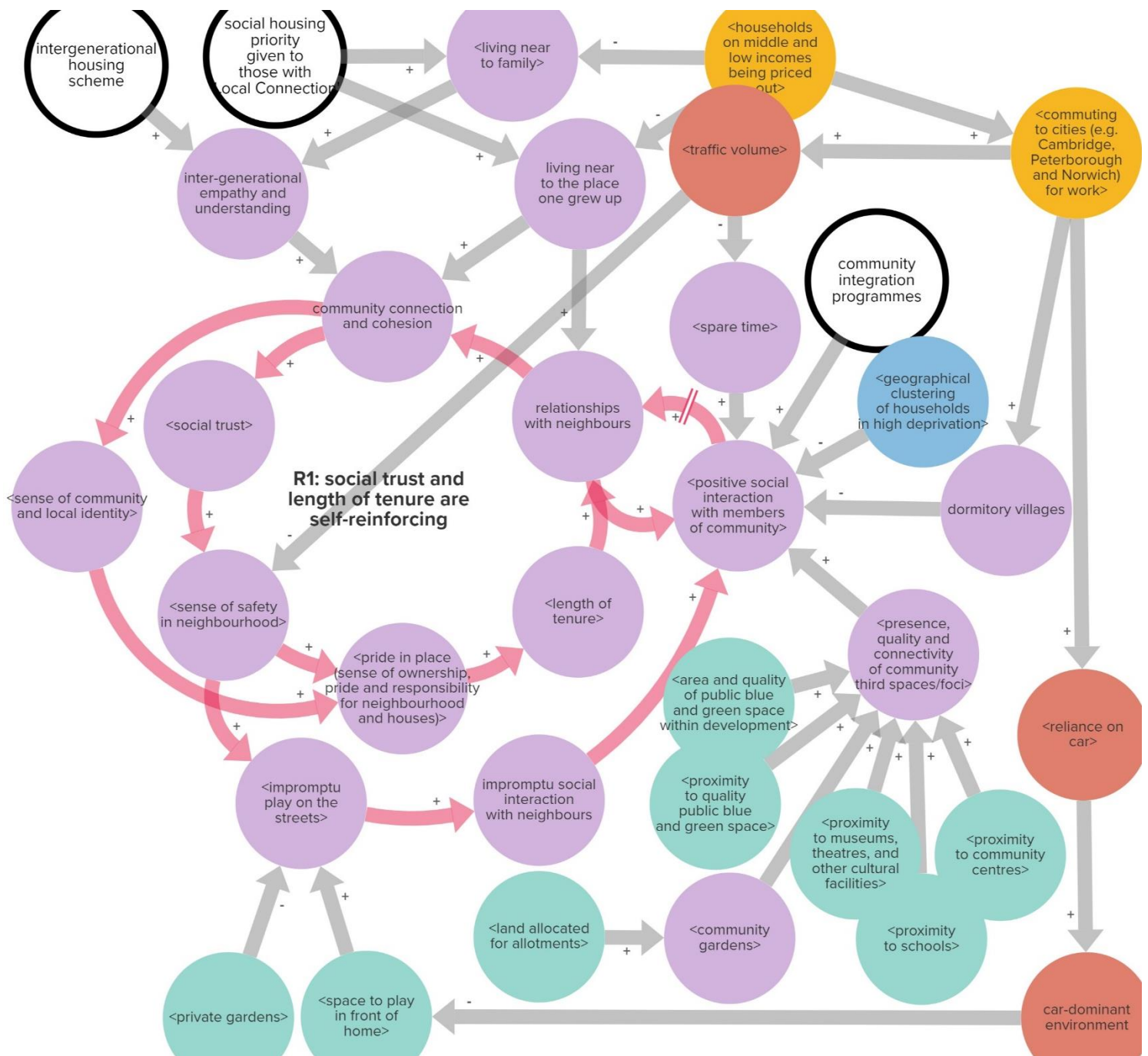


FIGURE D 2: R1 SOCIAL TRUST AND LENGTH OF TENURE ARE SELF-REINFORCING

### Housing & Transport Cont. (red)

- Road congestion and longer travel distances limit one's availability to socialise with neighbours, volunteer and attend community events.

*"If you are having to travel a long distance to do any of those things not only is it taking away from your time, but it is also reducing the community engagement you have locally."*  
(Interviewee 16)

### Housing Inequalities (light blue)

- It was suggested by one interviewee that neighbourhoods with a high density of households in deprivation and struggling with financial stress might experience negative social interactions more often than neighbourhoods without these stresses.

*"I don't necessarily think that having high social housing is a barrier to community spirit. [...] But I do think that there has to be something stable in those communities [such as a] good provision in social welfare or health provision so that people aren't angry and are getting, what I suppose are, their basic human needs met. And then I think you do get good interaction and community spirit."* (Interviewee 12)

Interviewer: *"Are you saying that when too many households lack financial stability and their needs aren't being met, that their quality of interaction changes?"*

*"Yes."* (Interviewee 12)

### Housing design (aqua)

- "*<[...] Community third spaces/foci>*" provide individuals the space for social interaction. LAs can ensure, through the planning system, that households are located near existing third spaces (e.g., schools, community centres and cultural facilities such as museums and theatres).

*"Cambridge is stocked full of [cultural facilities], which is fantastic...it's got access to pubs, access to museums, galleries, public art if you will. I do think it plays an important role, and it's all of those things that engage you with the area that you live in."* (Interviewee 10)

- By designing in quality "*<[...] public blue and green space within developments>*", developers provide households with outdoor space for social interaction.
- Allocating land for allotments provides an additional space for social interaction, particularly when space is guaranteed for community gardens.
- Developments designed with space to play in front of homes (which private gardens detract from) increase the likelihood of "*<impromptu play on the streets>*" and interaction between neighbours.

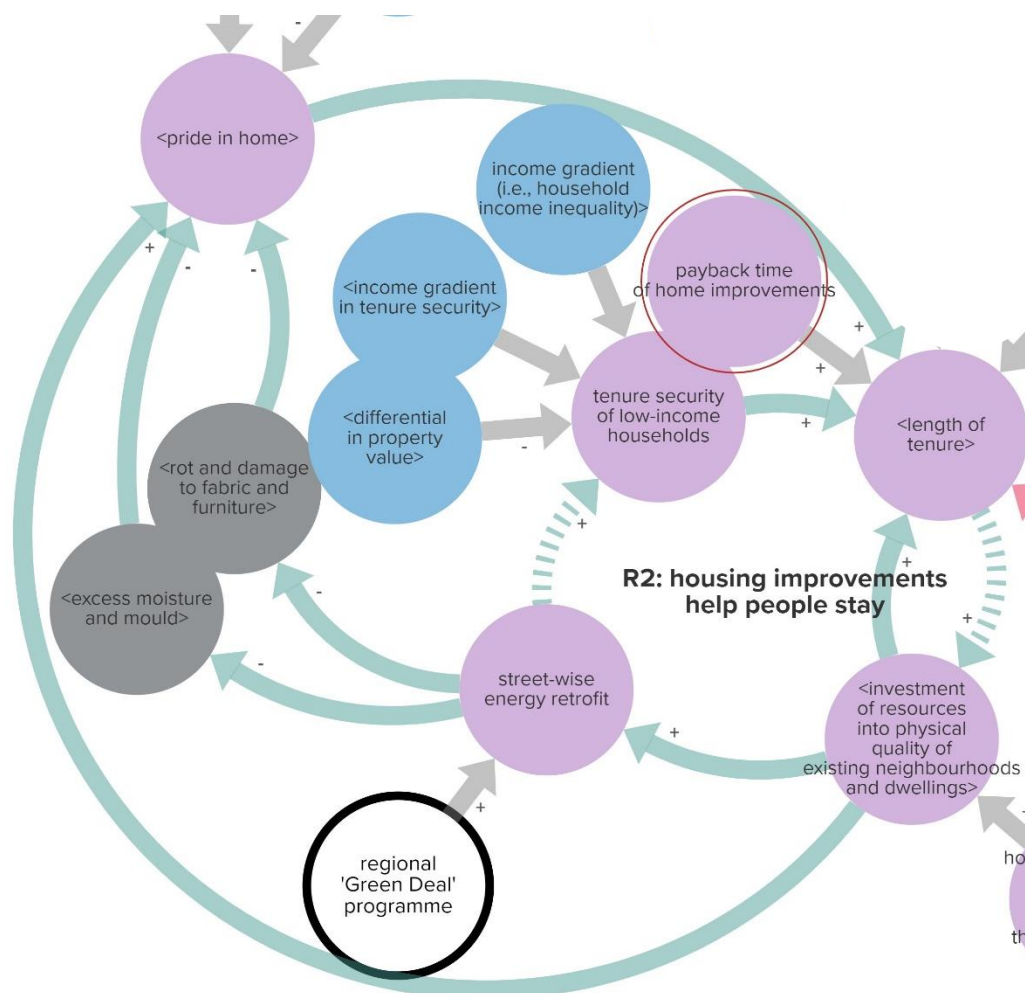
### Housing market & Land economy (yellow)

- As households are priced out from city centres, "*<commuting [...] (e.g., [to] Cambridge, Peterborough and Norwich) for work>*" becomes more prevalent. This creates dormitory villages where households have less time and space (e.g., cafes and community third spaces) to socialise and exacerbates the aforementioned transport effects.
- Rising house prices prevent young households from settling near to their parents and the areas they grew up. This breaks up existing communities and reduces the number of relationships.



### D2.1.2. Adaptations to “R1 physical qualities that make people want to stay” and “R4 housing improvements help people stay”

In the GCGP model, the effect of housing quality on “<length of tenure>” is modelled separately from the effect of “community connection and cohesion” on length of tenure. Reinforcing loops identified between housing quality on length of tenure in HEW’s “Community connection and quality of neighbourhoods” map (R1 and R4) were combined into “R2 housing improvements help people stay” (see Figure D3).



**FIGURE D 3: R2 HOUSING IMPROVEMENTS HELP PEOPLE STAY**

Housing improvements, in the GCGP model, are said to reinforce “<length of tenure>” via four causal chains – all of which feedback to reinforce “investment [...] into [the] physical quality of existing neighbourhoods and dwellings”. First, households are financially incentivised to stick around, so as to earn a return on their investment, dependent on the “payback time of home improvements”. Second, if targeted, energy efficiency retrofits help to improve people’s sense of “<pride in [their] home>” by reducing “<excess moisture and mould>” and by preventing “<rot and damage to fabric and furniture>”. Third, and original to the HEW model, energy efficiency improvements improve the tenure security of low-income



households by reducing energy bills. Fourth, also original to the HEW model, improvements in the built environment instil a sense of ‘pride in home’ and ‘pride in place’, which is said to extend tenure.

GCGP interviewees also identified a number of ways in which economic growth, inequality, and housing design affect tenure security (see Figure D4).

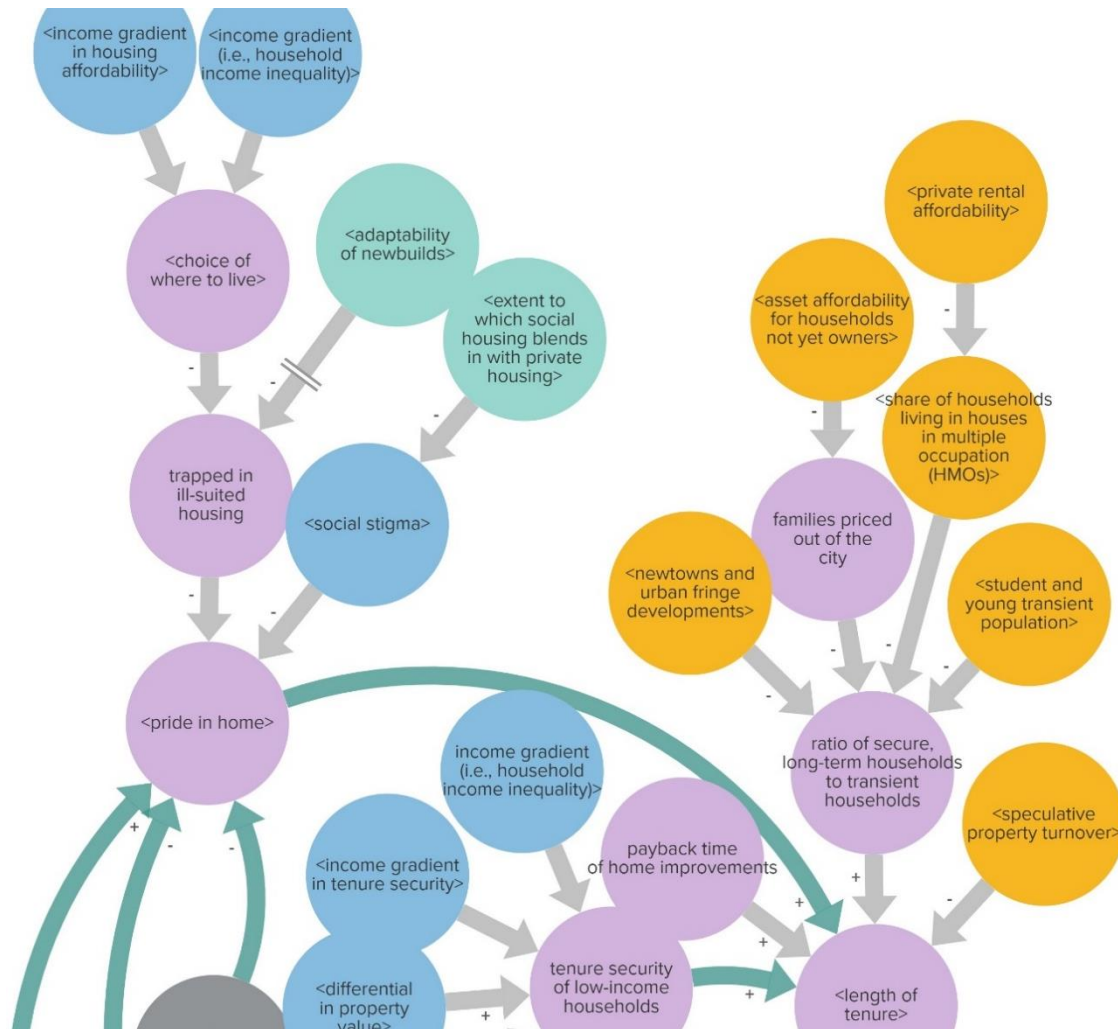


FIGURE D 4: EFFECTS OF ECONOMIC GROWTH, INEQUALITY, AND HOUSING DESIGN ON LENGTH OF TENURE

#### Housing market & Land economy (yellow)

- Households may choose to sell their home and move when it is highly profitable (see “<speculative property turnover>” in Figure D4).
- As urban economies grow, they attract more transient, young professionals, and the “ratio of [...] long-term households to transient households” falls, particularly when urban fringe developments are planned to support of this growth.

*"Increasingly around Cambridge you get more pioneering communities when actually you are effectively probably buying for location and house but there isn't any community. [...] Transiency is definitely something that is upsetting Cambridge quite a lot in terms of the population and communities." (Interviewee 5)*

- Growth in university admissions increases the inward migration of transient households and, in the mid-term, transient young workers.
- Rising demand “[prices] families [...] out of the city” and houses, originally designed for families, are turned into “<[...] houses in multiple occupation (HMOs)>”.  
*“[Because of high housing prices] you’ve got a large percentage of shared housing in new housing developments including new developments which were, in the community sense, aimed at having a higher portion of families or settled couples that might be there for 10 or 30 years.” (Interviewee 1)*
- As the median house price rises, so too does the “<ave. cost of private rent>”. This threatens, in particular, the “tenure security of low-income households”.
- The negative impact of an over-financialised housing market on “<length of tenure>” has an acutely negative impact on rural communities with lower supplies of ‘affordable’ housing.  
*“In urban areas, I think it’s about 20% of housing that is still ‘affordable’, i.e. has some kind of subsidy, whether that’s shared ownership or rented or whatever. In rural areas, that’s down to about 8%. [Excluding] London, rural areas typically have higher house prices. [Made worse by the fact that smaller developments, which are typical of rural areas, are exempt from ‘affordable housing’ quotas]. [...] So [if young households] want to actually get their own home, they’ve got no chance being able to afford something in their [home] village. Some of them probably want to leave, because they want to go see the bright lights of [cities], but some people want to stay and just can’t afford it. And that’s got an impact on communities because, of course, you’re breaking their family links and social links. [...] There’s just less social capital in these communities compared to 30 years ago.” (Interviewee 20)*

### Housing inequalities (light blue)

- “Tenure security of low-income households” is not only affected by housing market dynamics; it’s also affected by the distribution of wealth. Holding other variables constant, a more equal distribution of wealth results in less evictions.
- “<Differential[s] in property value>” (driven by differences in the quality of build, quality of the landscape design, connectivity, and quality of schools) result in fewer eviction rates in the short-term, as households can find housing suited to their income level. During periods of economic growth, however, prices are more greatly determined by the gap in supply than by the gap in quality.
- Poor “<[...] housing affordability>” traps people in ill-suited housing.  
*“[Imagine] you have rented a 1-bed place, you had a couple of kids and now you don’t have enough space, you can’t scale up because of the cost.” (Interviewee 5)*
- Perversely, those who become homeless may end up with greater choice, assuming there is enough social housing stock from which to choose.  
*“Unfortunately, we’ve got policy that has driven people to make themselves homeless in order to get access to this very scarce resource called social housing. So people, not willingly, see the only way to get access to this social housing is to make themselves*

*homeless and go through that terrible process, which is the wrong way to allocate resources.” (Interviewee 4)*

### Housing design (aqua)

- For those living in social housing, their <pride in home> can be negatively impacted by <social stigma> if social housing is not well “<[blended] with private housing>”

*“Because of the restrictions put upon it, [social housing] doesn’t blend in terribly well with the private housing that is built next to it. You can always tell the social housing. Because it hasn’t got a garage. So, you can drive around a housing estate, and it will be all these lovely four-bedroom houses with double garages. And then suddenly you’ll come to a street with no garages and you know that that’s where the social housing is.” (Interviewee 4)*

- The “<adaptability of newbuilds>” is critical for preventing households from being “trapped in ill-suited housing” as they age and/or become disabled.
- The “<adaptability of newbuilds>” gives people the opportunity to customise their home and feel pride in it.

*“I think, actually, personalisation of space is something people feel is important to them. We all do it. You buy [a home] somewhere; you put up a picture on the wall; you change the colour of the walls; you put a blanket on something. [...] I think putting your own touch on something is important, and I think the ability to do that is quite, the ability for people to say I’m living here, I can see myself living here [long-term], can be quite important [for increasing length of tenure]” (Interviewee 5)*

- Not shown in Figure D4: Rising land values negatively affect the “<adaptability of newbuilds>”, as smaller plots leave less space for adaptations.

*“It has kind of happened by default. [...] If you have a bigger plot (take, for example, the 70s where you had quite generous homes on large plots), then you have the ability to add garages, to add another bedroom, extend the downstairs, [etc.].” (Interviewee 5)*

### D2.1.3 R4 Neighbourhood organisations strengthen community

“R2 connection and action” and “R3 community empowerment” from the HEW model illustrate a reinforcing relationship between the “<presence and strength of neighbourhood organisations in the public interest>” and “investment of resources into [the] physical quality of neighbourhood and houses”. Whilst GCGP interviewees agreed with this theory, they also took time to describe how “community organisations” and “community connection and cohesion” are reinforcing, even when built environment remains unchanged. These theorisations form the feedback loop “R4 Neighbourhood organisations strengthen community” (see Figure D5).

Organisations are self-sustaining through their activity (i.e. public events and initiatives), recruitment of “<volunteer[s] [...]>”, and their ability to attract the public to “<[...] events/initiatives>”. Members of the community hear about events/initiatives when they are “publicis[ed]” by community organisations and through word-of-mouth (see link from “<positive social interaction with members of community>” to “learning about community projects and events” in Figure D5). These relationships are self-reinforcing, as “[...] partaking in local community events [and] initiatives>” has been found to increase

peoples' "sense of community and local identity">" and make them more likely to attend or volunteer for future events (see delay in Figure D5). Community organising also fosters relationship-building by providing opportunities for "positive social interactions [...]", particularly between those volunteering their time.

*"[Engaging with your community] enables you to switch off a little bit [...] from your work [and family] life. [You may even] end up with more friends and more connection to a place." (Interviewee 10)*

Local authorities and housing associations can support this reinforcing feedback by devoting a budget and/or staff time to aid community groups (see intervention in Figure D5).

*"Cambridge Housing Society is a good social landlord. It will nurture and support [community spirit]. [...] Most social landlords will have 'best garden of the year' and, you know, it does seem like a bit of a joke. But it's about people feeling confident about the area that they live in. And I think local authorities could extend that to 'best street party' or... you know, there's lots of ideas. But it's one of the areas where both local authorities and social landlords [can make] small amounts of money available to support communities to do what they want to do." (Interviewee 4)*

Community third spaces are said to be a prerequisite of community organising.

*"[In Peterborough] there's a group called the Green Backyard, which is a community garden, right in the middle of lots of housing, and it's a space for people to go and be in green space and make food and host events. And there's quite a strong community feel, not just around the environment or that kind of thing, but there's lots of things going on. You know, artsy stuff. [It's a space for] culture as well. I think that [all] contributes to personal wellbeing [but also, community resilience]." (Interviewee 6)*

One interviewee noted that, for land to be allocated for communal use, particularly in areas with high land values, a certain level of "<communal thinking and living>" is required. Once established, particular spaces, such as "community gardens", were said to foster communal thinking and living amongst those that engage with them.

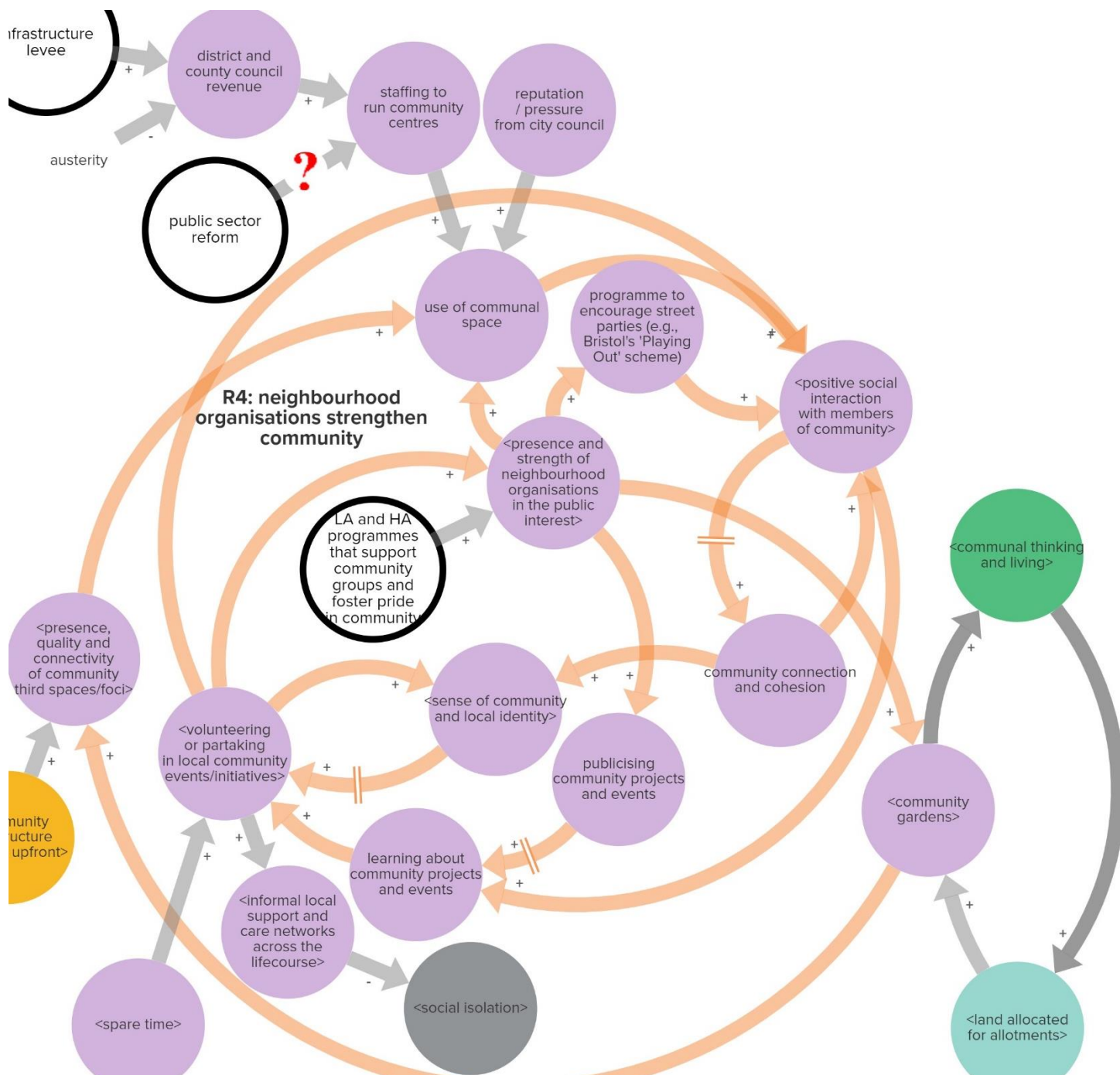
GCGP stakeholders identified a number of ways in which spatial planning, climate change, housing development, and transport impact upon R4 (see Figures D5 and D6).

### **Housing design & Spatial planning (aqua)**

- Land allocated for allotments supports social interaction between allotment holders and between those engaging in community gardening (see Figure D5)

### **Housing, Energy & Climate change (green)**

- "<Pressures from climate change and environmental degradation on human wellbeing>" were said to foster "communal thinking and living" that could, in turn, foster initiatives such as "<community garden[ing]>" (see Figure D5)



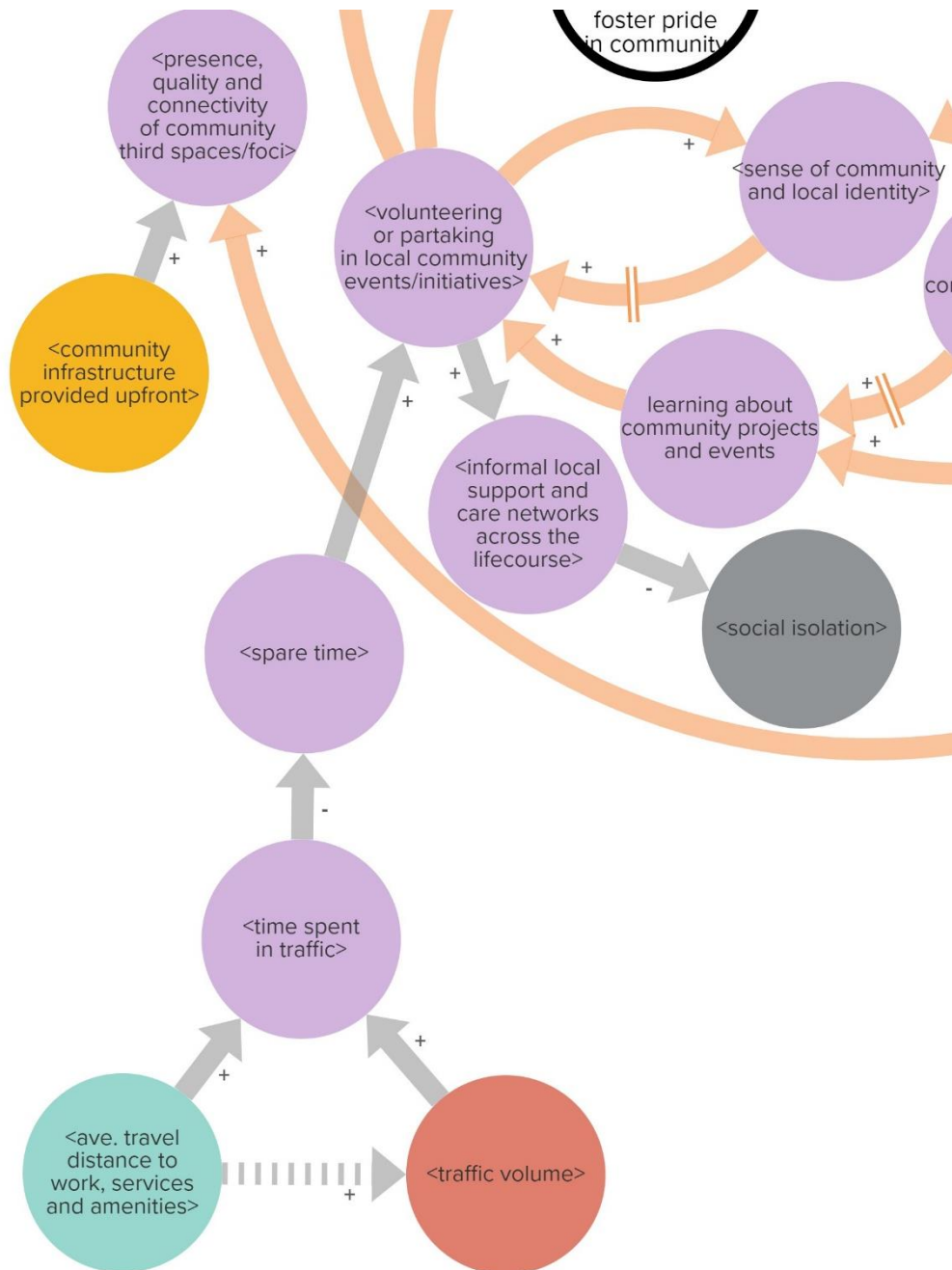
**FIGURE D 5: R4 NEIGHBOURHOOD ORGANISATIONS STRENGTHEN COMMUNITY**

#### Housing market & Land economy (yellow)

- Large-scale developments increase Section 106 or infrastructure levies that support the provision of community infrastructure “upfront”, such as community centres, which provide a space for social interaction and community organising (see Figure D6).

## Housing & Transport (red)

- Time spent travelling on congested roads takes away time to participate in community group and initiatives (see Figure D6).



**FIGURE D 6: INTER-SYSTEM LINKAGES IMPACTING THE FORMATION OF NEIGHBOURHOOD ORGANISATION**

### D2.1.4 R3 social support from neighbours strengthens communities

Those who are more embedded in the community, due in part to a longer tenure, may find that they can rely on neighbours for social support (e.g., childcare, transportation, and conversation). Three

household types were identified as being particularly reliant on informal care: (i) low-income households; (ii) families with young children; (iii) the elderly.

Those who cannot afford private modes of transportation or are unable to operate a vehicle in areas with poor access to reliable, public transportation, may rely on members of the community to access services and amenities. Low-income families may also require more assistance in child- and elderly care. Other forms of assistance (e.g., family conflict mediation, debt management, and maintenance) may also be informally provided by the community. By improving the accessibility of these various forms of care and assistance, families have more resources (time and disposable income) to spend with friends and family and to volunteer or attend community activities (see Figure D7).

Childcare is especially important, as cultural and economic trends have resulted in families living further apart.

*"We both work. If our parents [lived] closer to our home, we would have fewer worries about childcare [...] It would take the pressure off us. Our routine is: we get home already tired, sort the house out, and go to bed. [...] I think people need downtime [to de-stress]." (Interviewee 13)*

Informal social care is also needed to tackle the growing trend of social isolation. This care can tackle social isolation directly (e.g., by neighbours checking in on disabled or elderly households) and indirectly by freeing up "<[...] time>" for households to "<volunteer or partake in local community events/initiatives>". This 'coming together' was considered critical for tackling social isolation.

*"We had an event last week [...], and we had lots of women from the Women's Institute attend. And there was a lady there in her late 80s. And she is a fantastically bright woman, and she has a lot of experience and had a lot to contribute and say. And she's very active in her community. And that's sort of the opposite of isolation. She gets involved in everything. People respect her views. She has a purpose and people can learn from her and her experience. I suppose the opposite of that is feeling like you don't have a purpose and you can't really contribute anymore." (Interviewee 6)*

A number of external factors were said to impact upon the provision of 'informal social care'.

### **Housing market & Land economy (yellow)**

- Prohibitive housing costs that make it difficult for families to live close to one another, negatively impacting social cohesion and informal social care.

*"[Excluding] London, rural areas typically have higher house prices. [...] [If young households] want to actually get their own home, they've got no chance being able to afford something in their [home] village. [...] So, when you get to the point where people need elder care, you haven't got those family links anymore. There's nobody in the local community there to help you." (Interviewee 20)*

*"I live with my partner and we have a child but we both have parents who live in Harlow, and I expect, if things were cheaper in Cambridge, we would move both our parents closer to Cambridge. [...] [My mom's] got friends but it's not really the same as when you have someone from your family. For them both to have more contact with my daughter would be beneficial for both parties but particularly for our parents, [as it would give] them more social contact and contact with children." (Interviewee 13)*







## Housing inequalities (light blue)

- Together, rising house prices and wealth inequality create an “income gradient in [the] ability to live near to family and friends”. This fractures communities and reduces peoples’ “ability to rely on neighbours for social support [...]”. One intervention is used in South Cambridgeshire to limit this trend, namely, “rural exception site[s]”

*“[Cambridgeshire Rural Housing Partnership is a] partnership of [six] housing associations and [all] local authorities [in Cambridgeshire bar Cambridge City] with the focus of delivering affordable homes in rural communities. We do that through things called ‘rural exception sites’, which are small developments, typically 10 or 20 houses, placed in a village where the majority of the housing will be subsidized and there will be conditions on that housing through the planning commission which will control who can live in those houses, [namely those with ‘need’ and a proven ‘local connection’]. [...] So, 60% of people who move into [these] properties actually come from band C or D [i.e., are not those in the ‘greatest need’ categories for social housing]. [The partnership] helps local people to stay in their communities, but it also helps to sustain communities because it’s helping keep families together. [...] [Cambridgeshire ACRE helps deliver] about 50 houses each year [across the county]. [...] It’s only ever going to be small-scale. [It’s] not really about addressing the national shortage of housing. Every home [...] is a life-changing opportunity for a family. And if [the partnership] delivers ten or a dozen houses, it could have an impact on the [social] sustainability of a small, local community.” (Interviewee 20)*

The “income gradient in accessibility” is responsible for an “<income gradient in spare time>”, as low-income households spend more time driving.

*“If I work at Addenbrooke’s hospital, I may have to live several miles away, because the reality is that there are no affordable homes within the right distance, or if there are, they’re limited.” (Interviewee 7)*

*“Plus if you have any family obligations whether its grandparents, parents or children it can mean that your day is very squeezed in terms of what you can achieve and do.” (Interviewee 12)*

- The “<income gradient in accessibility>” contributes to social isolation, particularly for those living in rural areas who either cannot operate a private vehicle or who cannot afford to own and maintain a private car.

*“We can walk out this front door [in the city of Cambridge] and arrive at a leisure facility in five minutes. If you live in any of the ‘travel-to-work’ areas for Cambridge, then they’re not just ‘travel-to-work’ areas, they’re ‘travel-to-leisure’ areas. [Whether it’s the dentist, leisure centre, or pub,] these are key places where social interaction takes place.” (Interviewee 7)*

- Balanced communities can more easily meet social care needs informally. The “<geographical clustering of households in high deprivation>” results in unbalanced communities where need outstrips informal social care.

*“The more vulnerable part of society, if you isolate them by design, that’s a big issue because actually what we want is community to help manage the problems itself rather than relying on*

*intervention from outside. [...] Some of those things can be done within the community with no cost to the public because people are nice and want to be friendly and are more than willing to help support others in their community. But they can only do that if that community exists.”*  
(Interviewee 16)

### **Housing & Transport (red)**

- More road traffic = less “[...] time” to provide care for neighbours or build relationships with neighbours that could otherwise provide you with some form of care.
- Public transport can improve accessibility for rural communities (the link between public transport and “<accessibility>” is modelled in the “Housing Design” subsystem)

### **Housing design (aqua)**

- Locating housing near existing services and amenities (i.e. densification) and ensuring a mix of land uses (residential, commercial, etc.) can improve “<accessibility>” and reduce the “<ave. travel distance to work, services and amenities>”.

### **Housing, Energy & Climate change (green)**

- A cultural transition to more “<communal thinking and living>” may increase the provision of informal social care in communities.

#### **D2.1.5 Adaptations to “R2 connection and action” and “R3 community empowerment”**

The “R2 connection and action” and “R3 community empowerment” CLDs from HEW’s “Community connection and quality of neighbourhoods” map model a reinforcing relationship between the “<presence and strength of neighbourhood organisations in the public interest>” and “investment of resources into [the] physical quality of neighbourhood and houses” – both private household investment (R2) and external investment (R3). These theorisations form the basis of “R7 supported communities improve their environments and attract further investment” of the GCGP model (see Figure D8).

In the GCGP model, improvements to individual households are considered separately from improvements to community third spaces (see Figure D3: R2 housing improvements help people stay). As such, R7 only models a reinforcing loop between the “<presence and strength of neighbourhood organisations in the public interest>” and the “<presence, quality and connectivity of community third spaces/foci>”.

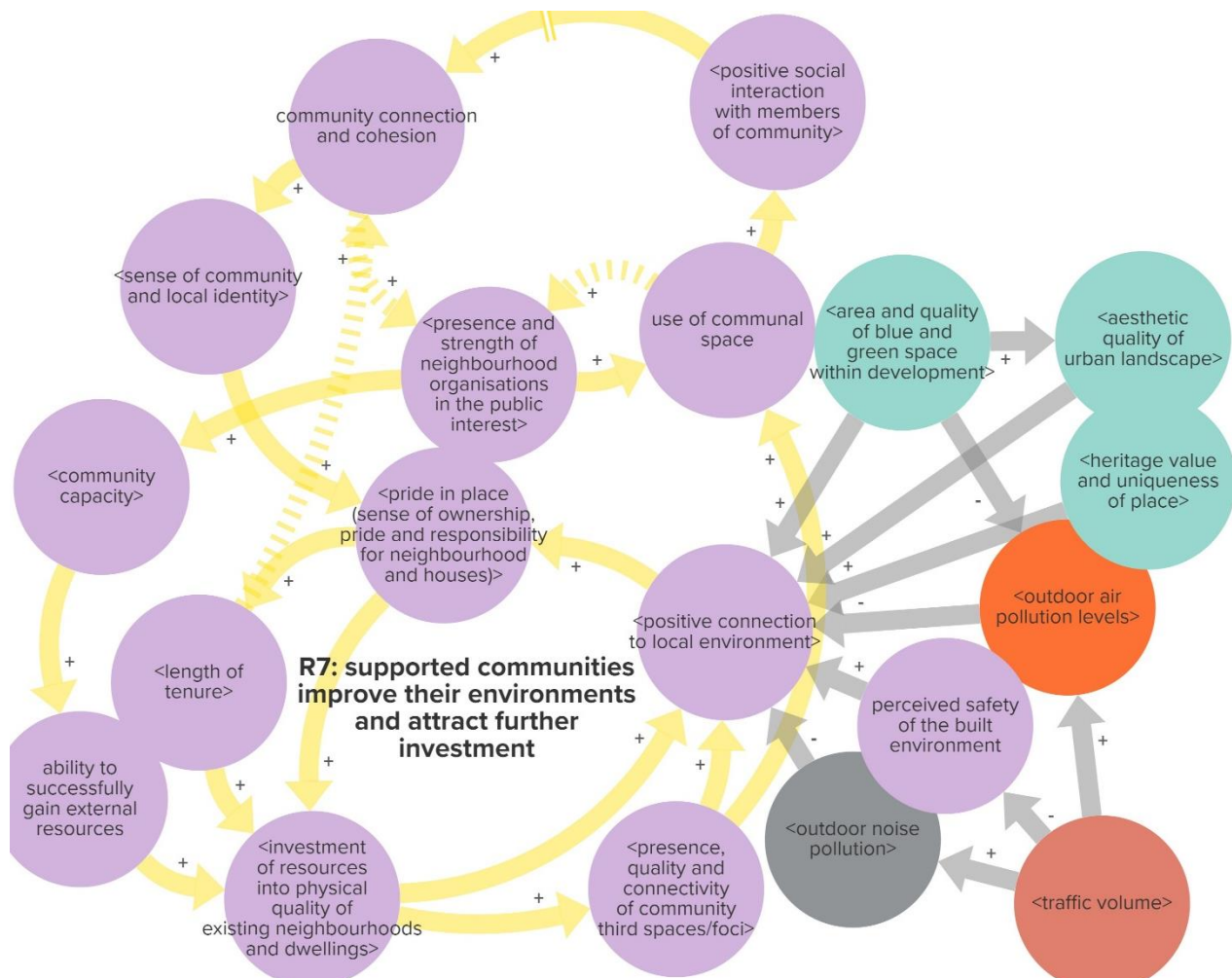
This reinforcing loop R7 (Figure D8) is made up of six causal assumptions. The first assumption is that “community connection and cohesion” and “[strong] neighbourhood organisations in the public interest” are positively reinforcing (see Figure D5: R4 neighbourhood organisations strengthen community). Second, these organisations improve the community’s “ability to successfully gain external resources” and, thereby, “investment of resources [...]” to improve the “<presence, quality and connectivity of community third spaces/foci>”. Third, quality third spaces foster a “<positive connection to [the] local environment>” and “pride in place [...]”. Fourth, pride in place extends tenure and encourages households to contribute their own resources to neighbourhood improvements and maintenance.

*“I think as well, if you live in a well-designed neighbourhood, people tend to treat it better. They take a sense of pride in place and then I think that has a positive impact as well.”* (Interviewee 10)

*“I think if you live in a quality environment, you value it more, you take more pride in it, and you’re probably more likely to look after it. [...] If you live in a shoddy environment then you think, ‘well if*

*nobody else cares, why should I?’ I think that’s true in terms of the quality of build. If the quality is poor, if the quality of design is poor as well, and if things just don’t work... you know, if the lights don’t work or the paths don’t take you to the right place and we haven’t linked up the community with employment and housing... then I think that absence of quality immediately leads to lack of pride in the place. And lack of pride in place can lead to fractured communities.” (Interviewer 2)*

Fifth, it is assumed that these spaces feed back and reinforce the “presence and strength of neighbourhood organisations in the public interest in two ways. First, “<[...] community third spaces/foci>” provide indoor and outdoor space to assemble, plan, and organise events and initiatives. Second, by fostering “<pride in place [...]>” and extending tenure, these spaces indirectly support “community connection and cohesion”, which positively reinforces “<pride in place [...]>”. Finally, healthy communities with a strong sense of “<social trust>” and “ability to rely on neighbours for social support” have greater “<[...] capacity>” to work together to “[...] successfully gain external resources”.



**FIGURE D 8: R7 SUPPORTED COMMUNITIES IMPROVE THEIR ENVIRONMENTS AND ATTRACT FURTHER INVESTMENT**

GCGP interviewees also identified ways in which transport, housing design, and the natural environment impact upon residents’ “<[...] connection to [the] local environment>” and “<pride in place [...]>”.

## Housing & Transport (red)

- “<Traffic volume>” worsens sound and air pollution and increases road accidents.

## Housing & the Environment (orange)

- Blue and green spaces filter air pollutants and improve the “<aesthetic quality of the urban landscape>”.
- There is a well-researched, positive impact of the natural environment on mental health.

## Housing design (aqua)

- Quality urban design can improve the “<aesthetic quality of [one’s] environment>”

*“It’s an interesting question on the role of beauty and high-quality design and whether that matters. And I suspect it does, [and] if you live somewhere that doesn’t look very good and doesn’t feel very good, you probably take less pride in it than something that looks nice and is well designed, well-built and well planned.” (Interviewee 2)*

*“A space can be [designed in a way that is] threatening to you, [or it can be designed in a way to yield a positive] emotional response.” (Interviewee 19)*

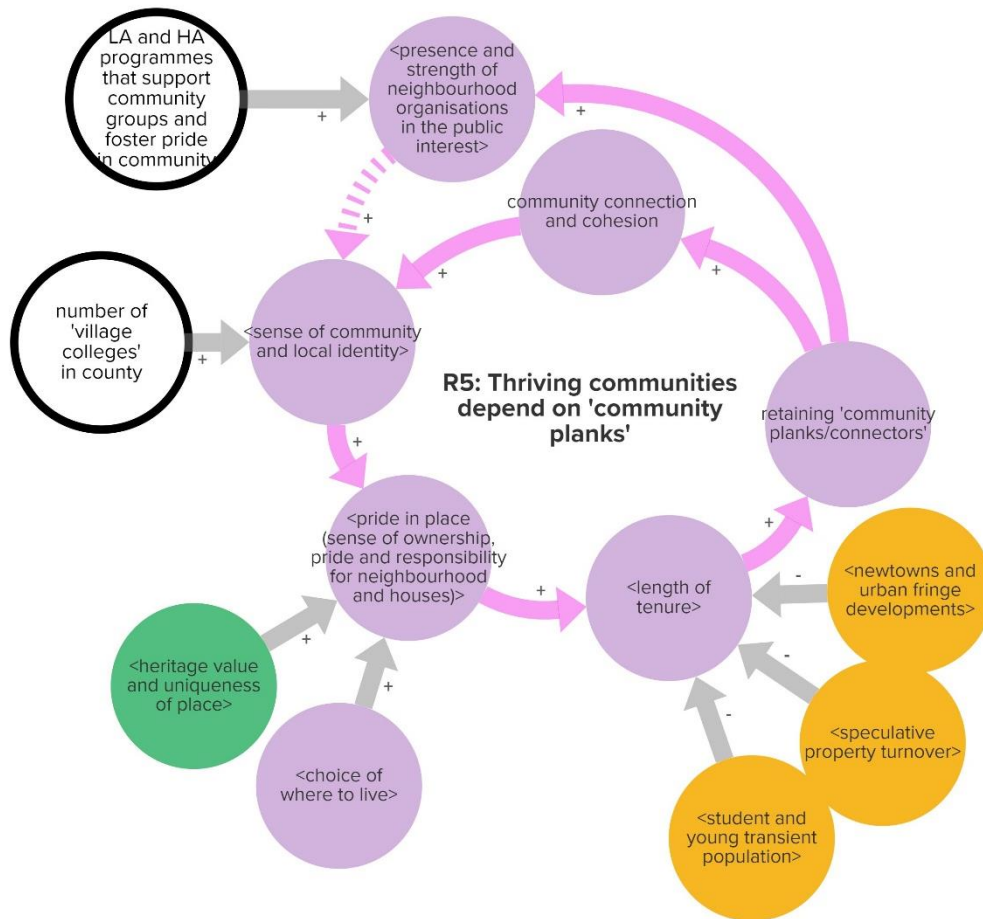
- The <heritage value and uniqueness of place> improves one’s connection to their local environment.

*“There’s someone I work with at the moment who lives in a new estate right outside of Peterborough and he will say he just doesn’t like looking out his window, looking at a whole load of houses that look exactly like his. [...] Perhaps it’s an identity thing. [...] The house I live in [...] every time I walk around the corner, it kind of always takes my breath away, because I just love to see it. I find it quite inspiring. It’s had a life before and it’s got a history attached to it, which I find interesting. Lots of people have come and gone in that space.” (Interviewee 6)*

*“I think [Cambridge] is quite an inspiring place to be - the culture and the historic buildings, the heritage of the place as well. [...] It’s telling that people will travel from the other side of the world to come and look at Cambridge and come and see the historic buildings. And they’re interested in them from a historical perspective, but they’re also pleasing to look at. [...] You don’t get people coming to look at new buildings in the same way. They’re more functional. And they can be beautiful. [But,] I don’t think you’d get tourists coming to see them.” (Interviewee 6)*

### D2.1.6 R5 thriving communities depend on ‘community planks’

Two GCGP interviewees posited that the function of community organisations in building “community connection and cohesion” is dependent on “community planks” or “connectors” – individuals who lead local initiatives and who have a relatively large social network. Improving the “<length of tenure>” was said to lead to a greater number and “[retention of] community planks/connectors” (see Figure D9).



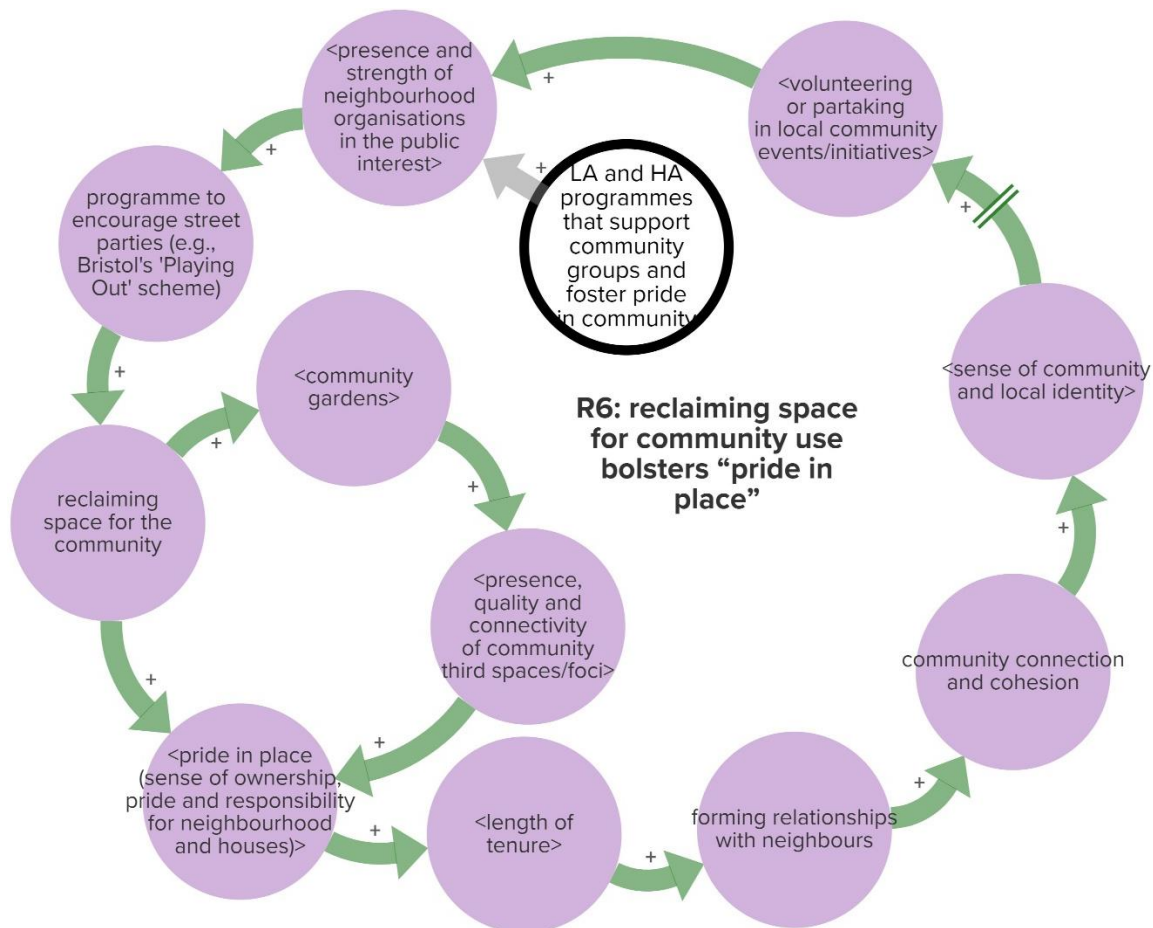
**FIGURE D 9: R5 THRIVING COMMUNITY DEPEND ON 'COMMUNITY PLANKS'**

#### D2.1.7 R6 reclaiming space for community use bolsters "pride in place"

It was also noted by four GCGP interviewees that reclaiming space for community use (e.g., community gardens or parklets) can bolster "<pride in place [...]>" and, thereby, "<length of tenure>" (see Figure D10). The permanent or temporary reclaiming of space can be supported by LA-led programmes, such as the 'Playing Out' scheme and by existing community groups.

*"[In Peterborough] there's a group called the Green Backyard, which is a community garden, which is right in the middle of lots of housing, and it's a space for people to go and be in green space and make food and things there, and host events. And there's quite a strong community feel, not just around the environment or that kind of thing, but there's lots of things going on. You know, artsy stuff, culture and I think that contributes to wellbeing." (Interviewee 6)*

*"There's an initiative [in Bristol] called 'Playing Out'. [...] And people are kicking balls around and having fun and sort of remembering that it's their place. I think that does make quite a big difference to how people feel." (Interviewee 6)*



**FIGURE D 10: R6 RECLAIMING SPACE FOR COMMUNITY USE BOLSTERS “PRIDE IN PLACE”**

#### D2.1.8 R11 dormitory towns cause economic leakage (downward spiral)

Several interviewees noted the problem of “economic leakage”, whereby commuting into cities such as Cambridge and Peterborough, produce dormitory towns and villages.

*“Leakage [...] is about where [people] take their money. Because if people are moving elsewhere, first of all they’re funding transport... they’re not spending that money in the local economy. They’re funding ‘exit strategies’ every day. They buy lunch, they buy their coffees, sometimes after work they’ll [engage in] a paid leisure activity – all in the town they work in.” Economic leakage then feeds back, because as the “[...] village high street [shrinks]”, people are forced to “[...] travel [further] distance[s]...” to access services and leisure.” (Interviewee 19)*

The reinforcing feedback between economic leakage from rural towns and villages and the distance travelled for work, services and amenities has implications for the social, environmental, and economic sustainability of rural areas. Commuting rates were said to be co-determined by the “<quality [and coverage] of public transport>” (red), as well as land economy dynamics (see Figure D11).

#### Housing & Transport (red)

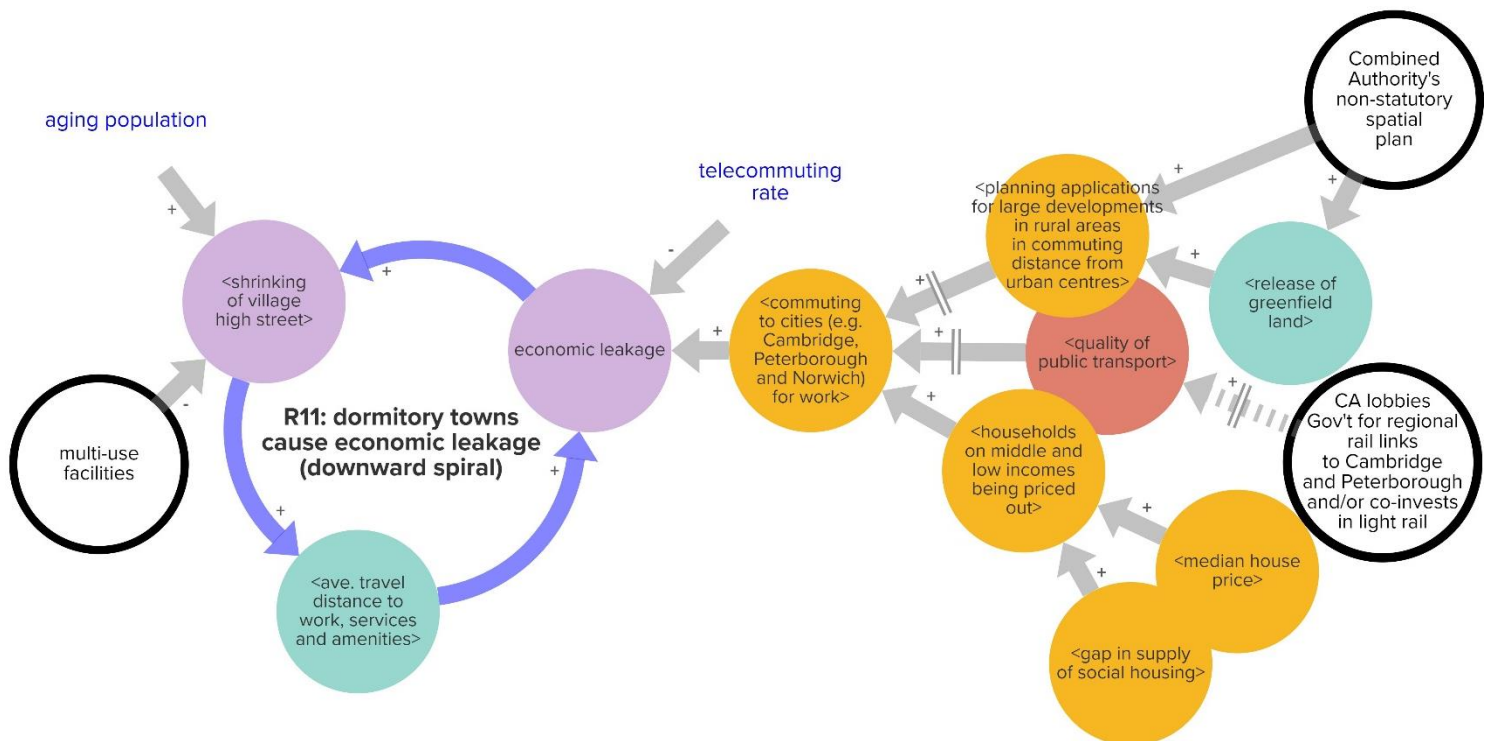
- Improvements in “<[...] public transport>” encourage commuting, particularly in areas experiencing inward migration. As such, public transport interventions by the Combined Authority (e.g.,



investment in light rail) could significantly impact settlement patterns that contribute to this reinforcing loop.

### Housing design (aqua)

- Housing affordability affects the number of “<households on middle and low incomes being priced out>” of the city and needing to commute
- The Combined Authority’s non-statutory spatial plan is meant to support the selection of greenfield development sites for new towns along transport corridors to facilitate regional economic growth.



**FIGURE D 11: R11 DORMITORY TOWNS CAUSE ECONOMIC LEAKAGE (DOWNWARD SPIRAL)**

The effect of commuting on “<[...] the village high street>” is additional to the effect of demographic changes. An aging population reduces rural communities’ overall level of disposable income to spend on the village high street. By contrast, young populations in urban areas improve the “viability of local businesses, [particularly the ] leisure market”.

*"Students make sure that there are bars open late, that there is café culture. All that stuff they help provide is a huge asset to the city. I do think it provides the attraction to younger workers, no one wants to be in a dead location and I don't think that it should be knocked. [Having a young, transient populace] provides things that other places don't have."* (Interviewee 5)

The same interviewee proposed the introduction of “multi-use facilities” to tackle shrinking village high streets:

*"I do think we are embracing new technology and this is the way forward. [What if] village pubs became like drop box locations? I think facilities have just got to work harder to become new sort of assets of villages to make living life there different"* (Interviewee 5)

### D2.1.9 R8 tidy neighbourhoods build social trust, sense of safety, and pride in place

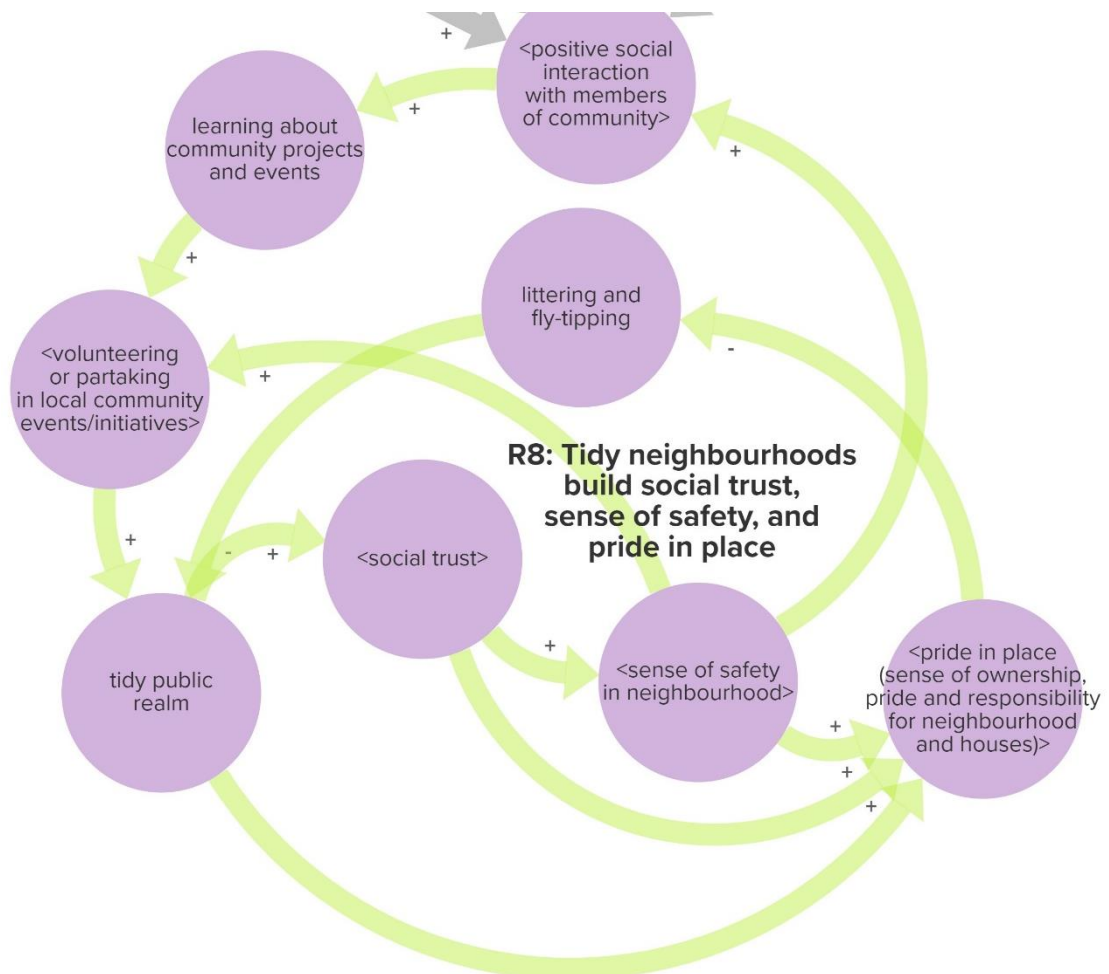
As one interviewee put it, a “<[sense of] pride in place...>” also “comes from the little things” like maintaining a “tidy public realm”. A tidy public realm directly provides a sense of ‘pride in place’, but it also acts indirectly, by contributing to a sense of “<social trust>”.

*“If there’s not lots of litter everywhere, you have the feeling that people look out for one another. [...] It’s just those little things that make you think people care about this place. [...] And when you think people care about the place, that then helps you think this is a safe place.”*

This further relationship between “<social trust>” and “<sense of safety in neighbourhood>” is modelled in Figure D12. More social interactions are said to take place in environments where people feel safe:

*“You are then, through positive reinforcement, more likely to engage in the community, and you will go out and you will use public spaces because you think yep, they’re safe to use”.*

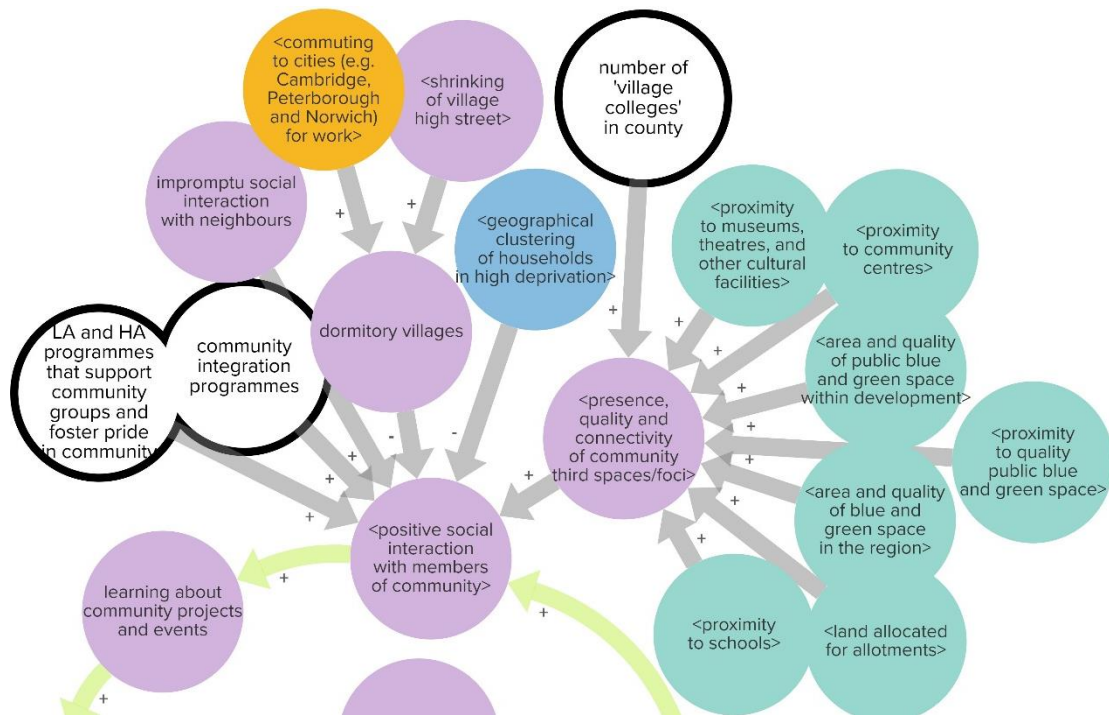
See link between “<sense of safety in neighbourhood>” and “<positive social interaction with members of community>” in Figure D12.



**FIGURE D 12: R8 TIDY NEIGHBOURHOODS BUILD SOCIAL TRUST, SENSE OF SAFETY, AND PRIDE IN PLACE**

A number of elements from other subsystem models were identified for their impact on “<positive social interactions between members of [the] community>” (see Figure D13).





**FIGURE D 13: IMPACTS ON “<POSITIVE SOCIAL INTERACTION BETWEEN MEMBERS OF [THE] COMMUNITY>”**

#### **Housing market & Land economy (yellow)**

- Housing (in)affordability prices households out of city centres and increases the rate of “<commuting [...]>”. If this leads to economic leakage (as theorised in R11) and dormitory villages, commuters will split their socialising between the city they work in and their village. In theory, this reduces the amount of “<[...] social interaction [between] members of [village] communities>”.

#### **Housing & Transport (red)**

- As described in R4, car-dominant environments suppress “impromptu social interaction with neighbours”.

#### **Housing design (aqua)**

- As described in R4, the design of housing developments can support and hinder “impromptu social interaction with neighbours”
- “<Positive social interaction with members of community>” relies on the “<presence, quality and connectivity of community third spaces/foci>”. The latter can be improved by developing housing near existing third spaces (see elements starting with “proximity to...”). As well, “<land allocated for allotments>” and the “<area and quality of public blue and green space [planned] within development[s]>” were considered critical for community wellbeing in their support of positive social interaction.

#### **Housing inequalities (light blue)**

- The “<geographic clustering of households in high deprivation>” is theorised to reduce the *quality* of social interaction between neighbours, as deprivation is known to increase levels of stress and negatively impact upon social behaviour.

*"I don't necessarily think that having high social housing is a barrier to community spirit. [...] But I do think that there has to be something stable in those communities [such as a] good provision in social welfare or health provision so that people aren't angry and are getting, what I suppose are, their basic human needs met. And then I think you do get good interaction and community spirit."* (Interviewee 12)

Interviewer: "Are you saying that when too many households lack financial stability and their needs aren't being met, that their quality of interaction changes?"

Interviewee: "Yes." (Interviewee 12)

#### D2.1.10 R9 place-based crime is self-reinforcing

Two feedback loops were identified to describe the reinforcing nature of place-based crime. First, it was proposed that "community connection and cohesion", which fosters a "<sense of belonging>", helps prevent crime.

*"People are less likely to commit crimes against people they know and that they feel part of as a community. And so, if people are made to feel welcome and integrated, then potentially there's less likelihood that then those same people would commit crimes against other people in the same community."* (Interviewee 6)

Second, it was proposed that "civilian policing", which helps deter crime, is more likely to take place in communities with a greater "<[...] sense of ownership, pride and responsibility for [the] neighbourhood [...]". However, it was acknowledged that other issues, such as deprivation and "cuts to policing" are greater determinants of crime.

*"The reduced number of police officers means the amount of intelligence we get is less. [...] Also, going back ten years now, the ['crime disorder reduction partnerships'] CDRPs were responsible for community safety in [each district]. So we [in the crime research team at Cambridgeshire Constabulary] would [...] be using a mixture of partnership and crime data to try and form a bigger picture. The recommendations we made, maybe involved social services. If we felt there was a high level of vulnerability for any reason, we might put a recommendation to social services to engage with homeless people, or schools or whatever. [...] And if it was a housing issue, we would put that recommendation out as well. So, it was much more about things from a community perspective. Then five years ago, austerity kicked in, you've presumably heard of the public sector spending cuts. [...] Our team, we were originally 35 [...] working across the whole force [...] and that suddenly cut down to eight full time equivalents [...] trying to do the same job. So that's why now our engagement [with] the council [...] is pretty much non-existent."* (Interviewee 14)

#### Housing inequalities (light blue)

- The "Housing inequalities" map models a number of housing-related poverty traps, as well as links between "<homelessness>" (or housing insecurity), "<financial poverty>", deprivation and crime.

*"Looking at burglary in the main towns, it tends to be committed by local offenders who need it in order to fund, for example, a drug habit [and/or] housing. It's looking at what's the motivation for these people who are going on to steal, or to commit crime and what's driving that. Do they have a basic need which could be addressed and might help to curtail or limit that behaviour? Have they got a drugs problem, housing need, have they got a mental health issue? That sort of thing."* (Interviewee 14)

*"We did some work around violence in....that was Peterborough actually. [We looked at the] link between [deprivation] and domestic violence and that sort of whole cycle... [...]. Oh, it was ages ago; [I'll have to look up the findings again]. But there tends to be a representation along the more deprived areas, that's to say it's not exclusively there but there is a link between crime and deprivation." (Interviewee 14)*

- The "<geographical clustering of households in high deprivation>" increases crime rates in these communities directly by increasing the number of residents with a higher propensity to commit crime (due to deprivation) and the "cuckoo'ing" phenomenon.

*"[There's also the phenomenon of] county lines, which is an interesting housing issue. Drug gangs from London come out and set up [...] a base in satellite towns [...]. So the drugs will come up from London, they'll send runners to come and do the drug dealing, but they've already set up a base for cuckoo'ing. If they come across a vulnerable person who is perhaps renting a small flat, they'll move in and they'll use that property. But they'll supply that vulnerable person with drugs in return for using their property. [They do this] so nobody knows they're there. And they quickly set up a network of drug dealing and then when they've saturated a town, they'll move on to another one." (Interviewee 14)*

The "<geographical clustering of households in high deprivation>" may also inflate the crime rate indirectly by negatively impacting people's "[...] sense of ownership, pride and responsibility for [their] neighbourhood".

- In the literature reviewed, "<[...] alcohol and drug misuse in adolescence>" was found to increase the propensity to commit crime in adulthood (hens the time delay in Figure D14). Tackling inequality and deprivation could potentially reduce alcohol and drug misuse in adolescence and thereby, future crime levels.
- Inequality [e.g., in access to public transportation and adult education] also impacts negatively upon the "<ability to fulfil one's aspirations>", which may increase one's propensity to commit crime. The element is coloured grey, as it originates from the "Health and Wellbeing" map where housing-related mental health issues surrounding 'aspiration' are modelled.

*If you haven't got something to aim for, and you aren't working towards something positive then obviously your... the way you think about yourself and your mental health is not going to be functioning as well as it could. I mean lack of aspiration [...] does lead to crime. It does lead to anti-social behaviour because what have you got to aim for, to live for, and to be there for. Why spend time engaging with people in a positive way if everything seems negative?" (Interviewee 16)*

- In addition to deprivation, inequality creates a "<sense of social [in]justice>". One interviewee considered whether this sense of injustice contributes to crime.

*"[There is a] perception [that there] is of a large number of people living in huge homes with accumulated wealth, lots of empty bedrooms, compared to a large number of people who can't even afford to pay rent. [...] I haven't got the homelessness figures, but I think number of homeless people in Cambridge should be really high." (Interviewee 14)*

"It might just be my views on it, but I'd like to think, actually, that if people feel things are fair, then there's less to be upset about, or angry about. [...] It's important that housing is mixed, so you don't have all the rich people living somewhere and all the poor people living someone else, [...] so that people don't feel segregated. Then I think, potentially, you've got the makings of a more harmonious society. But that is a bit of a utopian vision. I don't necessarily think that's always true. [...] I think [people commit crimes] when they are desperate for whatever reason. So, I think if you've got provision for people, you know things like making sure there's affordable housing. [...] I think it's policy and it's housing's role to try and make sure that everything is in place to give the best possible set of circumstances." (Interviewee 6)

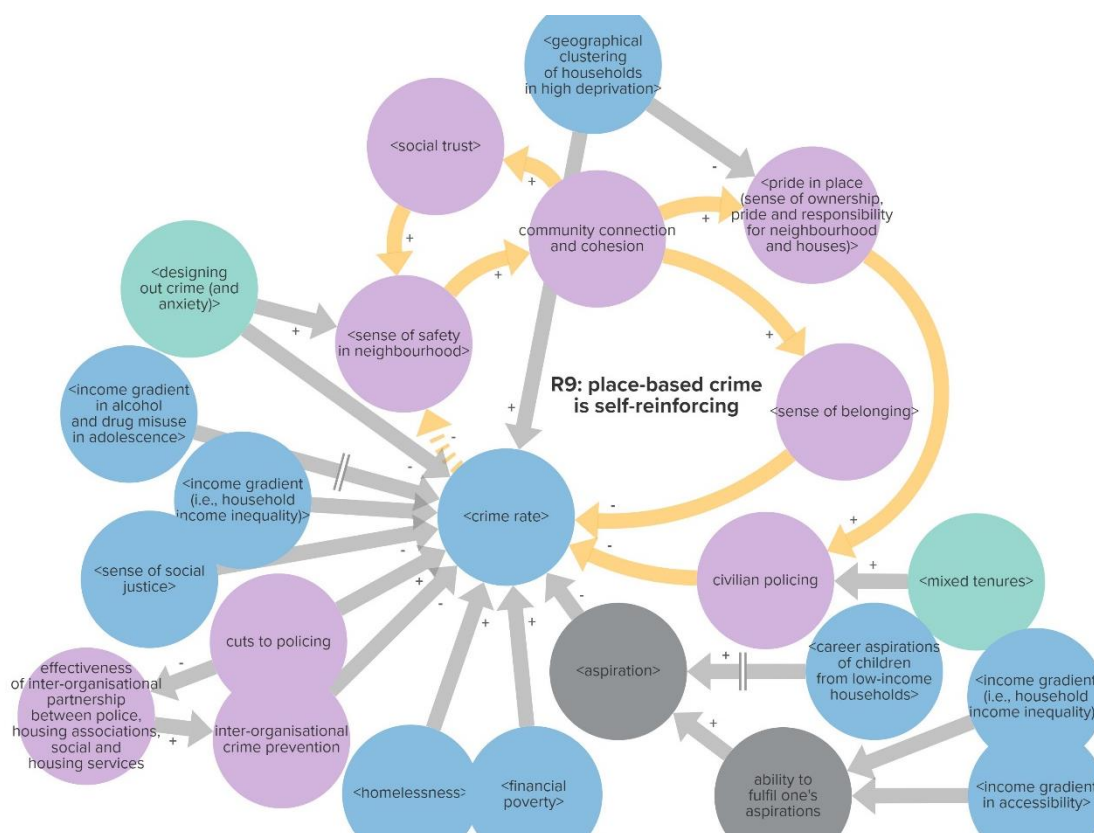


FIGURE D 14: R9 PLACE-BASED CRIME IS SELF-REINFORCING

#### Housing market & Land economy (yellow – not shown in Figure D14)

- As house prices rise, so too does “<homelessness>” and “<financial poverty>” – two drivers of crime, according to interviewees. The impact of rising house prices is greater, however, in more unequal societies.

#### Housing design (aqua)

- Cambridgeshire Constabulary employs experts that consult local authorities on “<designing out crime>”. Design that tackles actual crime (e.g., choosing tree varieties that do not obstruct lines of vision in communal spaces) often tend to provide local residents with a greater “<sense of safety

[...]>”, contributing indirectly to a lower “<crime rate>” via improved “community connection and cohesion.”

- Similarly, “<mixed tenures>” can indirectly reduce the local “<crime rate>”.

*"The more people that are around and watchful... Have you ever heard of Jane Jacobs, she wrote the "Death and Life of American Cities"? So, there's this idea of the unofficial watchman, the unofficial eyes on the street. When you have a certain density and diversity of ages and stages of life, there are people around. Eddington, for example, part of me is like, "Well... it's great for the university people, but what kind of community are you building when everyone's pretty much the same?" (Interviewee 15)*

#### D2.1.11 R10 diversity strengthens communities

Diversity strengthens community in a number of ways. One, quite obvious, link is the provision of “[...] cultural events” and community organisations (see bottom-right feedback of Figure D15). Such groups and events provide opportunities for “<positive social interaction [between] members of [the] community>” and positively contributes to a “<sense of community and local identity>”, as discussed in Section D2.1.3.

*"One of the things I really like about Peterborough is that it's really diverse. [...] I think it's about 80% white British and then a real mix of other nationalities living in Peterborough or people from other backgrounds. And those cultures are quite celebrated. [For example,] there was a big influx of Italians in Peterborough in, I think, the 70s. There's quite an Italian culture within the city because of that I think that makes for a really vibrant place in lots of ways. So, for example, there's an Italian festival every year. [...] [These events] give people a shared interest; or, it enables people to find things they're interested in personally and meet like-minded people. There's quite a lot of activity [in Peterborough]. I think you could be doing something every night of the week, easily. And it would all be quite interesting." (Interviewee 6)*

*"So, it has two benefits for wellbeing? One of increasing social interaction and getting out and meeting others. But as well, for your own personal, mental wellbeing, to be able to have exposure to the arts?" (Interviewer)*

*"Yeah." (Interviewee 6)*

The other ways in which diversity was said to strengthen community are more complex. I begin by placing them within the context of the larger subsystem model.

R1 through R8 in the “Housing & Community” model illustrate the self-sustaining nature of communities and how they inherently strengthen over time. The CLDs also reveal external factors (e.g., the design of the built environment, the provision of indoor and outdoor community spaces, and LA programmes to support community development) that feed into these reinforcing feedbacks. The CLDs, including R9, also model pressures on communities (e.g., crime, commuting, screen-based activities, and car-dominant environments) that can trigger exponential declines in “community connection and cohesion”. Promisingly, however, actions can be taken to reduce these pressures and improve elements of the reinforcing loop (e.g., energy efficiency improvements can increase lengths of tenures).

A greater social mix was said to provide a number of benefits to communities. First, communities with age, occupational, and ethnic diversity host a mix of skills, knowledge, and experiences that foster mutual support and community resilience (see “ability to rely on support from neighbours” and



“community capacity” in Figure D15). Second, “<living in a culturally diverse community>” forces community members to “<engage[...] in conflict, negotiation and collaboration [...]>”.

*“I can think of a diverse community that I’d love to be a part of, but it can’t be without some level of investment in trying to develop social cohesion [amongst diverse households]. [Imagine I] live next door to [...] a house with screaming children. [...] If you don’t ever live next to neighbours that are ‘difficult’ for you, you’ll never [gain the skills you need] to express when something is bothering you or to find solutions together. [...] Constructive conflict is a really important part of developing resilience and negotiating change and transformation through your life. [...] That’s true on the individual and community level.” (Interviewee 15)*

In addition to gaining negotiation and conflict-resolution skills, neighbours become more aware of the impacts of their actions on others, helping them to develop more “<communal [ways of] thinking and living>”. It was suggested that this development could lead to “[mutual] support [between] neighbours” and encourage an active welcoming and inclusion of outsiders or newcomers (see “culture of inclusivity” in Figure D14).

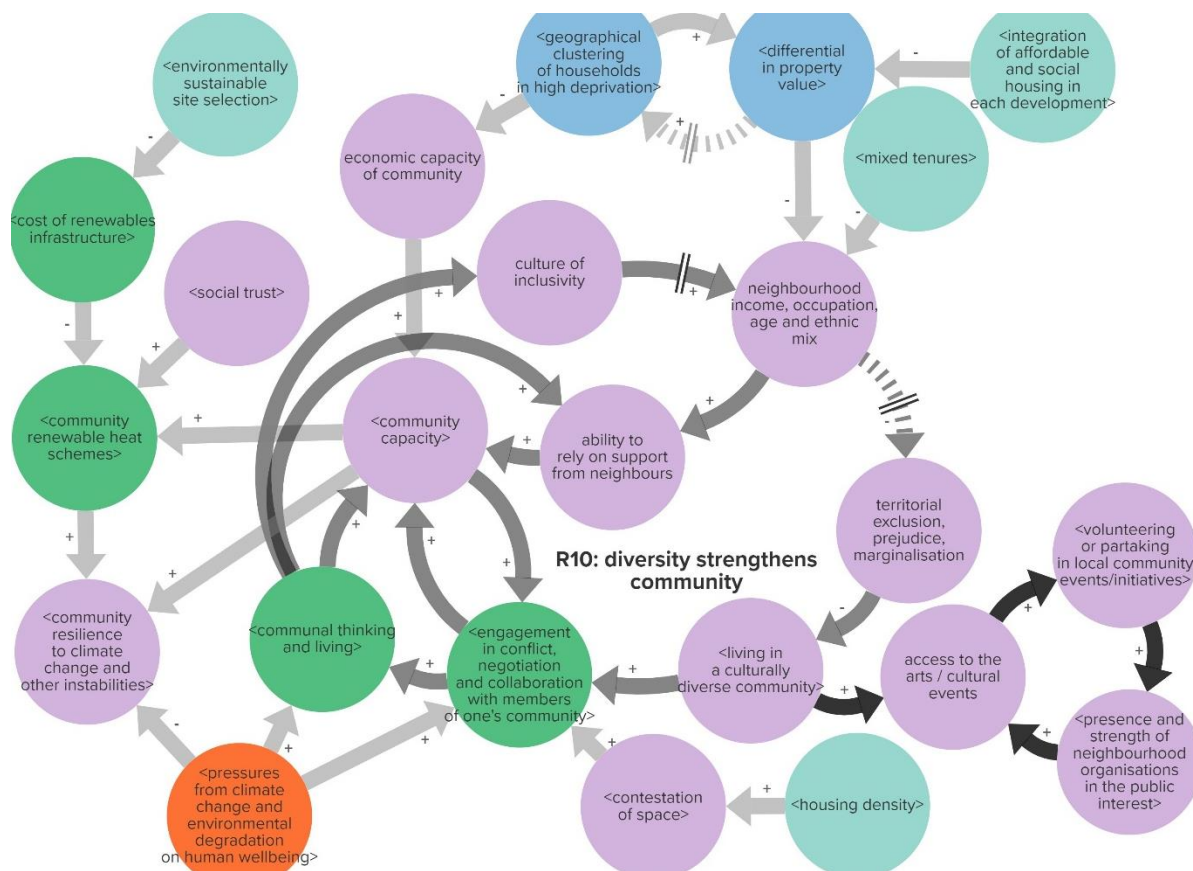


FIGURE D 15: R10 DIVERSITY STRENGTHENS COMMUNITY

### Housing design (aqua)

- A planning requirement of “<mixed tenures>” can support social mix.

*“People often talk about the problems of areas where there are populations in transition - and obviously students are a very transitory population - but what seems to happen [in] a*

*very accepting community, [is that students will] partake in that community [before] mov[ing] on. I suppose the reason being is that it's not exclusively students... it's balanced. [Romsey Cambridge], is a good example of a diverse community. [There] you'll find fairly high value homes next to housing which is student housing, which is next to some social housing. And there is a real sense of community agency there, which is generated by probably a range of people. So, I think that's quite a good example of a well-balanced community." (Interviewee 4)*

- “<Housing density>” creates conflict via the “<contestation of space>”.

*"[CB1 in Cambridge] is much more of a high-pressure environment [compared to when I was a kid living in Cambridge] because there are so many people in one small area, [but also] because people are much less getting out of their houses and wondering and much more getting from A to B. And it's very much about getting to the station or to the shops and back from the shops. And every year, the number of people using the station is getting higher and higher. [Tells story of conflict between taxi drivers and local residents over the use of space not designated for taxi drivers]. You get to that point... to that pressure, like a kettle. You get to that point where you say, "No, this is not just commuter space, this is also where I live. And you're starting to seriously mess with my serenity at home. Just popping to the shop leads to [a conflict with strangers]. It's a much more high-pressure environment." (Interviewee 17)*

Although this conflict causes tension, it should, in theory, support “<engagement in conflict [resolution] [...]>”.

*"We're [less] practiced in living with people and sharing space [than we used to be]. [...] As countries become wealthier, you can afford to live separately from your parents [and escape conflict]. None of this conflict is easy. But again, conflict was a regular part of life. Though, conflict is present even if you move away, because suddenly you're in an environment where you have only five metres between you and your neighbour." (Interviewee 15)*

### Housing inequalities (light blue)

- “<Geographic clustering of households in high deprivation>” and “<differential in property value>” is self-reinforcing. Together, these two variables reduce communities’ social mix (particularly their mix of incomes). This trend has a disproportionately negative effect on communities with higher levels of need, as it reduces neighbours “ability to rely on [mutual] support [...]”.

*"The opposite [of diversity] leaves you with whole areas in which you find concentrations of people who maybe don't have the same number of choices. I think there are studies of housing, you know in [...] the late 1980's, early 90's, where we can see in housing areas, even villages, a concentration of people with less economic power, less choices, [leading] to high levels of need. Whereas actually, if you have a more mixed community, there will always be vulnerable people within the community or people with levels of need, but that's balanced out by other people. In the ideal society... those people that are more able will support those that are less able. If you've only got one person in your street with, maybe who needs help with shopping or has a child who has special needs, the community can help that person. Whereas if you're all living together and have those needs, then it's quite*

*difficult to do that. So that's the sort of one issue in terms of balanced societies."*  
(Interviewee 4)

## Housing & the Environment (orange)

- "Pressures from climate change and environmental degradation [...]" may directly and indirectly foster "<communal thinking and living>". Environmental pressures threatening global supply chains are expected to highlight our interdependence, force a shift to 'the local' (e.g., local food, local energy, and local economy), and break with certain neoliberal values, such of individualism. In this way, environmental pressures may directly foster "<communal thinking and living>" Environmental pressures may *indirectly* foster "<communal thinking and living>" by forcing communities into "<[...] conflict, negotiation and collaboration>".

*"It's interesting [what you said about resource constraints and the cultural effects of switching to a decentralized energy system]... To think that could have further implications on how social the community becomes... socially-minded, I mean."* (Interviewer)

*"Yeah absolutely. I do think our problem in the UK is that we all want our own boiler, our own house and our own garden. We're people who like to sort of be in charge of our own system and we find it quite difficult to become communal and dependent. We used to be communal and dependent before, and then we moved into this space where we've become individualistic rather than communal. [...] I do also believe [decentralised energy] has its own merits because I think it will help communities collaborate and I think that is important for wellbeing."* (Interviewee 12)

*"So, [to summarise your previous comments,] communities become more aware of resource limitations and their own individual impact, and, if that awareness [foster communal thinking and behaviour], it could give way to better communities."* (Interviewer)

*"That's exactly right."* (Interviewee 12)

### D2.1.12 R12 prejudice undermines community

Inequality and housing market dynamics were said to create "<differential[s] in property value>" and "<[inequalities] in housing affordability>", resulting in poor "neighbourhood income, occupation, age and ethnic mix", resulting in homogenous neighbourhoods.

*"[Rising house prices threatens diversity.] Even in terms of balance of age as well."* (Interviewee 12)

*"Eddington, for example, part of me is like, 'Well... it's great for the university people, but what kind of community are you building when everyone's pretty much the same?' [...] Personally, I wouldn't want to live there. I would like to live somewhere where there's a mix of people... of ages, of work types, income types... just because then you're sort of passively learning and being prompted to expand your experience and your understanding of the world."* (Interviewee 15)

In areas with poor "<[...] social mix by income and ethnicity>", "bonding [happens] between people who are alike". "Bonding between people who are alike" was said to strengthen community groups, but reinforce "territorial exclusion, prejudice [and] marginalisation" (see Figure D16).

Territorial exclusion, prejudice, and marginalisation were said to undermine community wellbeing in three significant ways. First, they lower the mix of "[...] income, occupation, age and ethnic[ity]" in



neighbourhoods (see the inner-most reinforcing loop in Figure D16) which is critical for community resilience, e.g., by providing a range of skills for mutual aid.

Second, territorial exclusion, prejudice and marginalisation reinforce the differentiation in property values, resulting in both neighbourhoods with a high density of households in deprivation and neighbourhoods with a high density of high-income households (see remaining two reinforcing loops in Figure D16). The reinforcing loop between territorial exclusion and land value differentials is further reinforced by “R7 supported communities improve their environments and attract further investment” (Section D2.1.5). In other words, wealthy neighbourhoods can collectively raise their relative property values by investing in the physical quality of their immediate environment and dwellings. In doing so, young and low-income households are further excluded from these neighbourhoods, reinforcing prejudice, and marginalisation.

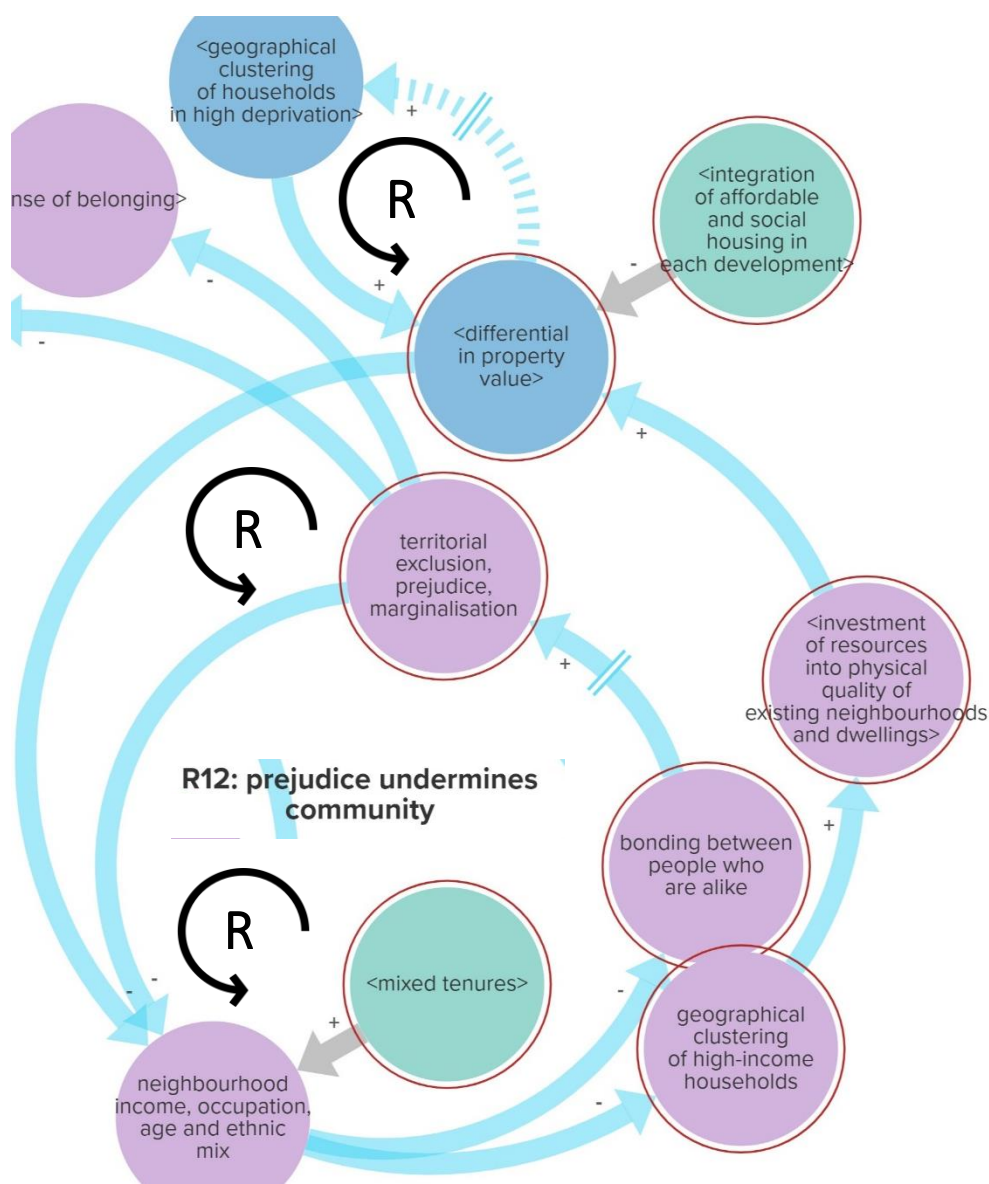


FIGURE D 16: R12 PART I: TERRITORIAL EXCLUSION, PREJUDICE AND MARGINALISATION ARE SELF-REINFORCING

Third, “territorial exclusion, prejudice, [and] marginalisation”, along with the <geographical clustering of households in high deprivation> were said to exacerbate “<crime [...]>” by creating unmet need, social ‘outcasts’ with a poor “sense of belonging”, and a “sense of social [in]justice” (see Figure D17). Moreover, poor “income, occupation, age and ethnic mix” negatively impact “civilian policing”, as described in R9 (see Figure D14). The three reinforcing loops presented in Figure D16 thus feed into upward and downward spirals in peoples’ local “<sense of safety [...]>” depending on where they live.

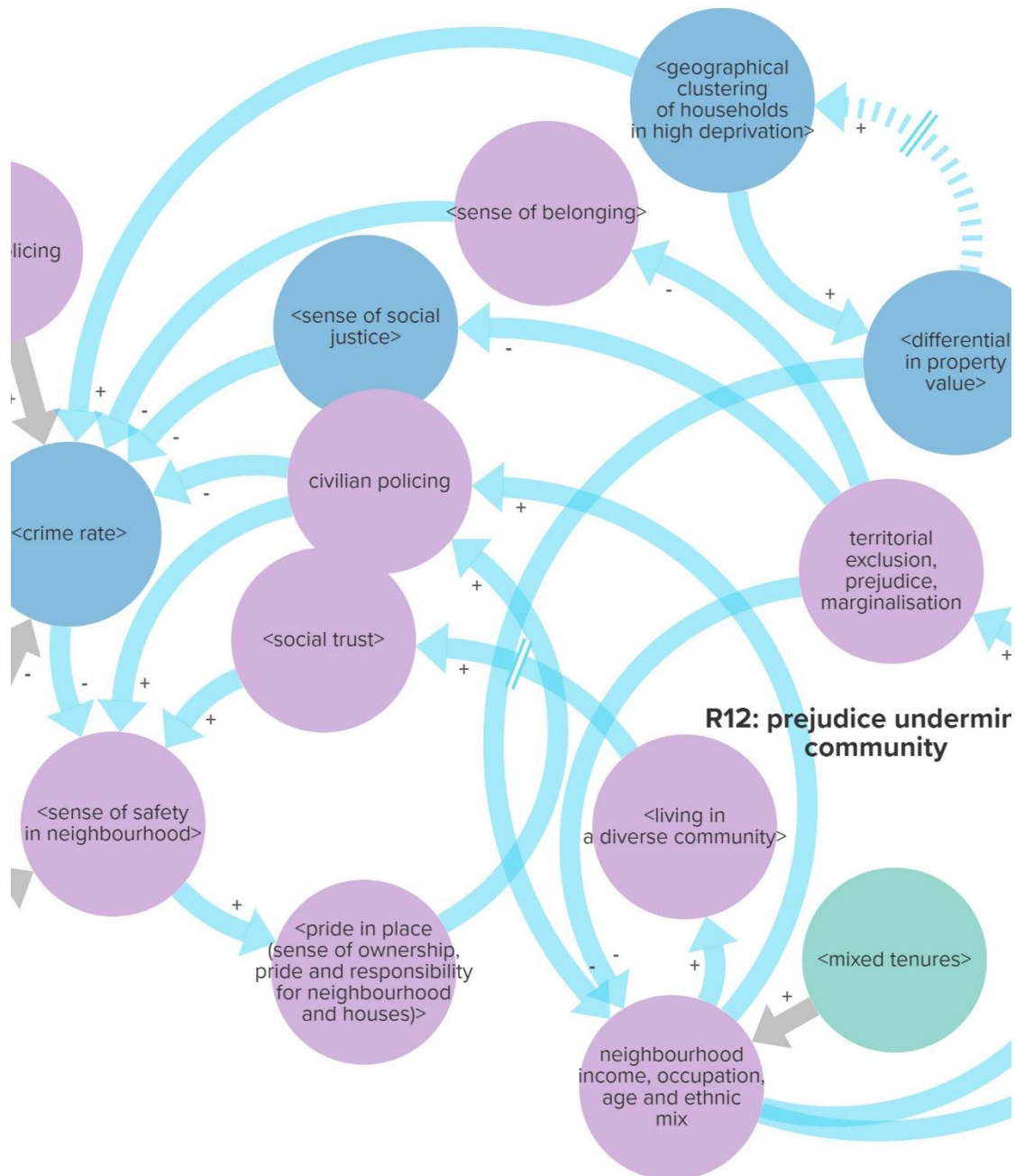


FIGURE D 17: PART II: TERRITORIAL EXCLUSION, PREJUDICE AND MARGINALISATION ENGENDER CRIME

### Housing inequalities (light blue)

- Housing inequalities affect community outcomes (diversity and resilience) which feedback to affect housing inequalities (“<differential in property value[s]>”).

### Housing design (aqua)

- The “<integration of affordable and social housing in each development>” was said to help tackle the rising differential in property value[s]>”
- “<Mixed tenures>” are said to support “neighbourhood income, occupation, age and ethnic mix”.

### Housing market & Land economy (not shown in Figures X and X)

- Differentials in housing values are less significant in highly saturated housing markets where the demand for housing inflates the value of poor-quality housing.

## D2.2 The ‘Housing, Energy and Climate change’ subsystem

Three HEW causal maps formed the basis of the “Housing, Energy & Climate change” subsystem model, namely “Influences on energy efficiency of the housing stock”; “Adaptation of housing stock to expected climate change effects”; and “Fuel poverty and indoor temperature”.

#### Retained

- **R1 climate change and need for summer cooling** – retitled “R1 CC increases energy demand in summer months” in GCGP model
- **B1 climate change and winter heating** – retitled “B1 CC reduces energy demand in winter months”
- **R8 societal expectation of number of rooms used and warm** – retitled “R5 Shifting societal expectations re: proportion of rooms heated”
- **R9 societal expectations of thermal comfort (behavioural adaptation)** – retitled “R4 Shifting societal expectations re: thermal comfort”

#### Omitted

- **R4 temperature and physiological adaptation**
- **B2 urban heat and need for winter heating** – considered irrelevant in Cambridgeshire and Peterborough
- **B3 disruption to household energy supply**

#### Additions

- **R3 climate change increases the need for energy-intensive pumping of water from reservoirs or water-rich regions** – increasing “<water-related energy consumption>” and reinforcing climate change.
- **B2 Costs limit rising consumption** – Heat consumption is a function of physiological need, cultural expectations regarding thermal comfort and the proportion of rooms to be heated, as well as affordability. R4 and R5 are constrained by the costs of rising heat consumption.

## The “Influences on energy efficiency of the housing stock” theme in HEW’s “Energy efficiency and climate change” causal map

The “Influences on energy efficiency of the housing stock” theme presents reinforcing and balancing loops that accelerate or dampen energy efficiency improvements in a particular geography. These include (i) “R1 experience and salience of cost-savings [from energy efficiency improvements]”, whereby positive (or negative) experiences spread via word-of-mouth to increase or decrease the attractiveness of energy efficiency improvements; (ii) “B1 limits to investment in energy retrofits”, whereby the return on investment in improvements diminishes with each intervention deterring investment beyond a certain point; and (iii) “R2 local aggregation of environmental awareness”, whereby environmentally-minded communities create a local culture that attracts like-minded individuals, thus reinforcing the level of concern amongst residents. This reinforcing feedback is relevant, as levels of environmental concern are said to impact decisions around investment in energy efficiency measures.

All three feedback loops modelled in the “Energy efficiency and Climate Change” map (B1, R1, and R2) were retained in the GCGP model (B3, R6, R16) with adaptations, and four additional feedbacks were identified.

### Adaptations

- **Connections between “population environmental awareness” and investment in energy efficiency measures**

In both the GCGP the HEW model, environmental awareness is theorised to increase the demand for energy efficiency interventions and national regulation *when* housing is affordable.

*"The 'invest to save' approach has almost entirely been forgotten by us as a nation. [...] I think people have felt they have had to make certain priorities because of cost of living not matching wages. So there's a socio-economic part to that." (Interviewee 16)*

*"I think it's not necessarily a lack of demand [for energy-efficient housing]. I think there's a lack of supply of housing, so you basically are presented with quite a limited range of options. You kind of have to go with what's on the market." (Interviewee 10)*

The GCGP model identifies an additional barrier, namely “<materialist and consumerist culture>”:

*"You might say that you take a smaller house, but you have it more efficient because that's what you can afford. But then that comes up with material choices and aspirations and peoples own world view of what success looks like. Someone's world view will be that success is a 4 bedroomed house detached, whereas someone else's view will be actually a 3-bed semi but highly efficient and no operational costs for energy is the aspiration. So, [...] our personal sense of ['success'] is wrapped up in housing choices." (Interviewee 12)*

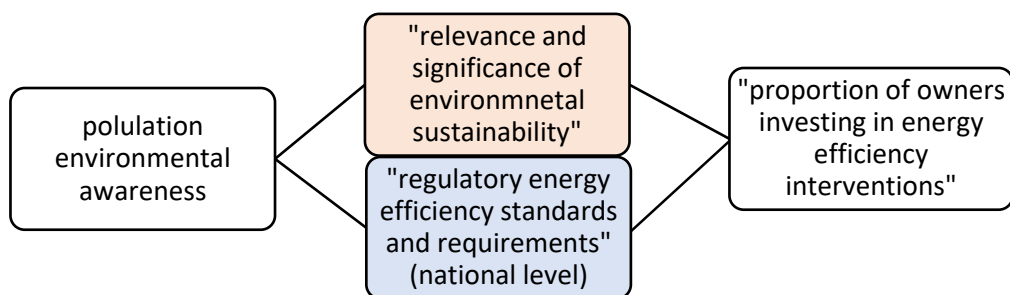
Regarding pressures on Government, the GCGP model additionally assumes that the Combined Authority will be under pressure to use its infrastructure budget and borrowing powers to finance innovations, such as a regional ‘Green Deal’ programme (see Figure D18).

## Additions

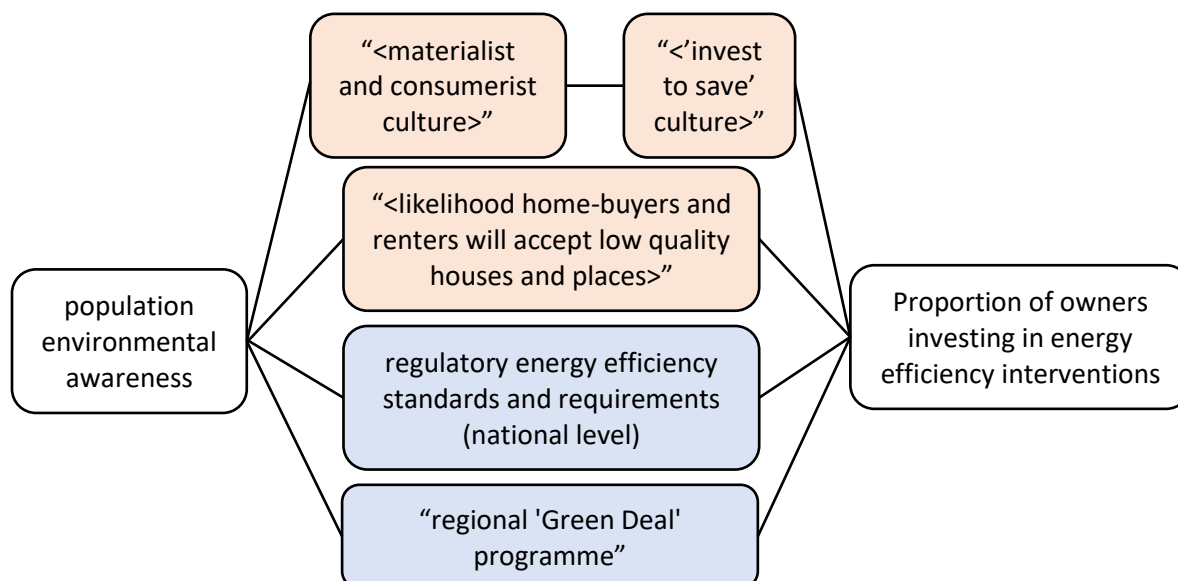
- **R7 Mortgage lenders value energy efficiency** – reinforcing loop between demand for energy efficiency interventions>” and “<preferential mortgage lending rate for buyers investing in energy efficiency improvements>” via “changes to methods of home valuation”

*"There needs to be different financial models. Some of the mortgage options at the moment [...] affect the refurb or refit side of things, in so far as, people might buy a house and go, 'You know, I think I could do a lot with that.' [...] So, some people [buy] houses knowing they have 20-30 grand they can spend to make something completely different. There's no value in that for mortgage companies, apart from Ecology and Coop, who are a bit more switched on to this. [...] If I was running a bank and offering mortgages, I would tell my surveyors, 'If you find a house with a south-facing roof, perfect for pv! If you find a house that's off-gas, and they're on lpg or oil, perfect opportunity for air-source heat pumps. You tell the house buyers, we'll give you a preferential rate if you do this, and this and this, [...] so that the cost of running it is not going to be 2,000 pound/year in energy bills, but 500. [...] But while preferential rates would increase demand [for energy efficiency interventions], financial institutions first need to see that the demand is there before they include it in their valuation formula. It's almost as if you've got to find something to kick-start that reinforcing feed-back loop, because once people start demanding energy efficient homes, the banks start to notice, 'Oh, there's value in this.'"* (Interviewee 16).

### HEW model



### GCGP model



**FIGURE D 18: HEW AND GCGP LINKS BETWEEN “POPULATION ENVIRONMENTAL AWARENESS” AND INVESTMENT IN ENERGY EFFICIENCY INTERVENTIONS**

### Additions Continued

- **R8 Estate agents could reinforce demand for energy efficient housing** – Estate agents can help stimulate demand for energy-efficient properties, and thereby help ‘kick-start’ R9, by informing buyers about potential energy savings.

*"With the greatest respect to estate agents, [...] they don't understand this dimension to wellbeing, coming from fuel poverty and financial poverty [resulting from poor quality] properties. So, a house comes up for sale, it's got pv, it's got an air-source heat pump, it's got triple glazing. They should say, 'This is more valuable than your labour'. That was the whole basis of the Green Deal, really. It's the same thing with the EPC; the whole point was that if you've got the option between three houses and one is A rated and the others are C and E, they should go for the A. But nobody reinforces that."* (Interviewee 16)

- **R9 energy efficiency demand drives improvements in private, rental sector** – “<private landlord spend on improvements>” may increase if preferential mortgages are available.

- **R10 Critical level of perceived demand needed to kick-start (self-reinforcing) regional 'Green Deal' programme** – by making available affordable retrofit finance, the Combined Authority could stimulate the demand and supply of energy efficiency measures. Political will for a regional 'Green Deal' programme, however, relies on the “perception of energy retrofit demand by local policy-makers”.

*"In the long term all these houses need [improvements], and I think there is an argument to look at it as a CA/LEP-wide infrastructure investment. We spend an awful lot of money looking at roads, and rail, and transport in order to increase economic growth and improve people's lives [why not retrofit?]. [...] When you start looking at the economics of that and what that saves our economy, then I think there has to be justification for doing this. We potentially could use government borrowing to start funding this with some private money from the energy companies. And we deliver it using nationally recognised firms who have the training and skills to deliver it well. [Such a scheme would stimulate demand, but a certain level of demand is needed from the outset to de-risk investment]." (Interviewee 16)*

### The “Adaptation of housing stock to expected climate change effects” theme in HEW’s “Energy efficiency and climate change” causal map

The “Adaptation of housing stock to expected climate change effects” theme handles the implications of housing adaptations on the lifecycle energy use of domestic buildings. As conceptualised in the HEW model, ‘adaptations in response to climate change’ include energy efficiency improvements, changes to accommodate hotter summers, and the demolition and reconstruction of homes in flood zones. In addition to energy consumed by householders, lifecycle energy use refers to the energy consumed by resource extraction, the manufacturing and transportation of materials, and construction/installation of newbuilds and retrofits. In the UK, the built environment accounted for 42% of UK emissions in 2014; 16% of which was carbon embodied in the building materials, transportation, and construction process (UK Green Building Council, 2017). The reinforcing loops modelled imply that homes that are energy *inefficient* accelerate climate change, whose impacts feedback to require further carbon-intensive adaptations to dwellings. “The map is dominated by problematic reinforcing loops that tend to undermine efforts to reduce energy [...] by intervening in housing” (Macmillan et al., 2014, p. 16).

Six of these reinforcing feedback loops were retained, three of which were merged into one, and additional two were added. Unlike the HEW model, a number of additional balancing loops were also identified, theorising society’s response to climate change, albeit with long delays.

#### Retained

- **R5 energy costs of relocation (R11 in GCGP model)**
- **R7 pressure on green space (renamed “R12 Relocations from flooding puts development pressure on urban greenspace with implications for permeability” in GCGP model)**

#### Omitted

- **B1 severe energy discontinuities**
- **R6 relocation and housing pressure**
- **R8 sea level rise and pressure on land for housing**
- **R9 climate immigration requires new housing**



## Adaptations

- **R2 CC increases energy demand from infrastructure failures:** R2 energy costs of extreme temperature”, “R3 flooding, energy cost and climate change; and “R4 inundation, energy cost and climate change” were merged into “R2 CC increases energy demand from infrastructure failures”. It was unclear from the HEW report which “energy costs” were considered. GCGP interviewees only mentioned energy costs associated with infrastructure failures, such as railway disruptions and sewage back-ups, leaks and floods, such as the energy required by decontamination, construction/repairs, and heating the homes of employees on days they are unable to commute to work.
- **R13 energy costs of pre-emptive adaptation of stock (R1 in HEW model)** – includes energy embodied in energy efficiency improvements (for climate change mitigation) as well as cooling interventions (for climate change adaptation). The HEW map only models carbon embodied in cooling interventions.

## Additions

- **R14 rebound effect of energy savings**  
*"There has been a lot of research on this [e.g. from Cambridge Architectural Research Ltd.] and so some people like to live in very hot homes and when you insulate the home you don't make a saving because they're sitting there in shorts and t-shirts in the middle of winter at 75 degrees." (Interviewee 16)*
- **B4 society responds to CC by reducing energy consumption** – As the impacts of climate change worsen, levels of concern are expected to increase demand for energy efficiency interventions and energy-efficient newbuilds and encourage “energy-efficient behaviour/choices”. The balancing relationship with “demand for energy efficiency interventions” was considered to be the most significant of the three for emissions reduction. “At least 70% of the housing stock likely to exist in the England in 2050 has already been built and around 75% of these houses were constructed before 1975” (Historic England, 2017, p. 5).  
*"Well I think that should be our primary focus in energy efficiency. I think that the modern homes naturally even with accepting that we are not going as far the zero-carbon home standard that they are pretty good compared to the existing buildings we have from the 19th century. I think there are many more opportunities to reduce carbon emissions by addressing the existing buildings than the new stock." (Interviewee 13)*
- **B5 Society responds to CC via 'Regional Green Deal'** – The “local aggregation of environmental awareness” (R16) increased concern over climate change is expected to raise “political will for regional 'Green Deal' programme”, led by the Combined Authority, that would provide “innovative finance with [an] interest rate 1% below [the] market rate”.
- **B6 Society responds to CC with ambitious national energy efficiency standards** – for newbuilds (such as the national building regulations for zero-carbon homes) and mandated efficiency improvements for rented or sold properties.  
*"Government had a previous programme for reasonably dramatic improvements over a period of time that would help develop the technologies and make them more affordable [to construct] zero carbon homes. That has all been scratched so we are back down to a base level that is acceptable but not really pushing us that much more forward." (Interviewee 16)*



- **B7 Extreme weather events to shift lenders' valuation of durable, low-carbon housing stock** – increasing finance for the development of low-carbon housing.

*"If we end up going down carbon emissions-type metrics or dimensions for financial models... and there are a couple of finance houses that have said, 'If you build to Code 6, or passivhaus or A, B, C or silver standards, as a finance house, we know that the building physics and the quality is there, that the house will stay standing for a long enough period of time, and if the cost of electricity doubles, or we have extremes of weather and the cost of running a house is a lot more, then they are fit for purpose.'" (Interviewee 16)f*

- **B8 energy efficiency reduces need for fossil fuels** – by reducing variability in energy demand profiles
- **B9 society responds to CC by reducing consumption of imported goods**  
Although slightly tangential to the housing system, it was suggested that environmental community groups help to reduce the consumption of imported goods by organising initiatives like 'repair cafes' and community gardens, reducing Scope 3 emissions. The housing system was very much seen as a determinant of the formation, strength and longevity of these community groups.

#### Identifying a new theme: "Interactions between decentralised, low-carbon heat systems and the incumbent heat regime"

All theoretical relationships modelled under this theme are additional to the HEW model and based mainly on a review of transitions literature on European renewable heat transitions.

- **B10 society responds to CC via investment in renewable energy**  
Heightened concern of climate change could increase households' "willingness to pay for renewable energy" and thereby the "rate of heat pump installations" and "connection to renewable heat network[s]".

The development of district heating (DH), a community-level alternative to individual heat solutions, may also require a willingness from "residents [...] to sacrifice [public] space for [the development of a] heat centre", which can be difficult to find in urban areas. In Cambridge City, for example, the heat centre recommended for a network to supply low-carbon heat to Parkside Pool and Anglia Ruskin University would require the conversion of an LA-owned carpark – permission for which would undergo public scrutiny in a formal public consultation.

Heat networks also require political buy-in from local authorities and significant public investment. Heightened concern over climate change may support this by creating political pressure for LAs and the Combined Authority to lead the transition to renewable heat, e.g., by making spatial accommodations for heat networks in Local Plans and pump-priming renewable energy infrastructure to attract further funding under central Government's 'Heat Networks Investment Project'.

The more households that switch from a fossil-fuel based heating system to individual or community-level, renewable heat systems, the lower the "greenhouse gas intensity of the [local] heat supply".

- **B11 DH and heat pumps reduce the installation rate of air conditioning systems**

As ambient outdoor temperatures rise, DH and heat pumps (HP) that also provide a cooling function may become more attractive. The greater the adoption rate of these low-carbon technologies, the lower the adoption rate of central air conditioning units. Assuming the lifecycle emissions of DH and HP are both lower than the life cycle emissions of central air conditioning units, this feedback loop could dampen the negative impacts of “R2 CC increases energy demand from infrastructure failures.”

- **R15 high housing and utility costs prevent investment in energy-efficiency retrofits and renewable heat**

Investments in energy efficiency improvements can produce significant cost-savings, resulting in more disposable income in the mid-term and ability to invest in further retrofits or renewable heat solutions. Although, in theory, this reinforcing feedback supports investment in energy efficiency improvements, a lack of disposable income, upfront, acts as an initial barrier. The ‘Housing market & Land value’ subsystem impacts upon this feedback, as investment in energy efficiency improvements is expected to come from “<disposable income after housing and utilities>”. The same is true for investment in renewable heat.

- **R17 competition between renewable and natural gas heating systems**

Currently, natural gas is a relatively cheap fuel source. Although renewable heating systems, such as DH and HP, are price-competitive, the upfront cost of connection or installation and, in some cases, retrofit deter households from adopting new, renewable heat systems. Government subsidy helps to reduce this barrier for early adopters, e.g., households, local authorities, and housing associations, who have additional motivations for switching heat systems, such as their concern over climate change.

Once a critical mass of households switch, a new dynamic forms in the competition between natural gas heating and renewable heating systems. As households reduce consumption and, in some cases, disconnect from the grid, the per capita service and maintenance costs rise. With these rising costs come rising service fees, making natural gas heating less competitive and thus reinforcing the transition to renewable heat.

A Government survey found heat network customers paid, on average, £100 a year less for their heating and hot water, compared to those not on networks; however, prices varied hugely across the country (Kaminski, 2019).

- **B12 EScO maintains economic viability of DH network by raising awareness of over-consumption**

The technical optimisation of heat networks depends, in part, on maintaining an assumed level of heat demand. If demand rises beyond the initial level on which the system was developed, e.g., via new building connections, the network owner will need to expand system’s capacity to maintain good performance. If demand rises only slightly, e.g., due to a particularly cold winter, the heat provider could instead choose to invest in a “campaign to educate customers on sustainable consumption”, increasing “[...] customer[s] awareness of resource limitations” and encouraging “energy-efficient behaviour of households connected to [the] DH network”.

*"[With decentralised renewable energy systems,] local communities can have an understanding about how much energy they use relative to how much they are producing. So they can become more aware of the cost of energy and how they can manage it better and become less wasteful as a society. [...] We have to change our psyche from just*

*assuming that our energy is coming from a huge centralised power station [...] and that it doesn't matter that we have all our lights on or that we choose not to switch off our plugs, [...] There's a lot of culture wrapped up [in energy consumption] [...] [A decentralized, local energy system would provide] a direct [educational] link into where energy comes from and what it takes to get that energy. If you [are wasteful with energy], potentially the next-door neighbour doesn't have energy because what we are really coming to is local supply and demand where this is how much supply you've got which is finite right and this is how much your demands are. If you, as an individual, want to run your heating at 23 degrees and wear kami tops it means that someone has to have their heating on at 17 degrees to balance out your desire. And I think to become cognisant of that balance [and understanding resource limitations] is something we should be moving towards [...]. We will have even more [resource limitations] in the future if our population continues to grow as it does. [...] I think that countries that are colder than ours, like Sweden, have already got on to having some of those debates because it's a more critical issue." (Interviewee 12)*

- **Link between “R6 experience and salience of cost savings from energy efficiency improvements” and “R20 consumer preference for heat pumps [...]”**  
Energy efficiency interventions improve customer “experience with cost-savings from switching to [a] heat pump” which, in turn, increases the “social popularity of heat pumps” and “rate of heat pump installations”. In other words, R6 further reinforces R20.
- **R18 pressures from energy retrofits and fuel prices could push DH into a downward spiral**  
Provided sufficient housing density, an economically viable heat network gains efficiencies of scale as it expands, lowering costs and attracting more investment and customers. The reinforcing loops responsible for this self-sustaining growth can also result in a downward spiral. One trigger for this could be a sudden, dramatic increase in renewable fuel prices if the DH network is reliant on one fuel source (e.g., climate change-induced spikes in biofuel prices). Another pressure that could trigger a downward spiral is energy efficiency. Measures that lower the “energy use of households on [the] renewable heat network” negatively affect revenue on which the economic viability of the network relies.
- **B13 threats to the economic viability of local heat networks can trigger LAs to lower energy efficiency standards of newbuilds**  
As economic viability falls, prices rise. Although most DH networks in the UK are price-competitive, there are also examples of low-income households being locked into ever-increasing energy bills and fuel poverty. To prevent this unintended consequence and safeguard the economic viability of their business, network owners lobby local government to lower energy efficiency standards and require all zoned newbuilds to connect to the network. A successful lobbying effort was carried out in the award-winning Vauban district of Freiburg, where local legislation has significantly curtailed the uptake of Passivhaus design against the will of local residents. Residents opposed this legislation, as DH is costlier, in terms of the economy and the environment, than Passivhaus design.
- **R19 consumer preference for DH network grows via rise in property values**  
As more households connect to the DH network, the popularity of this alternative heat system grows, so long as experiences with the network are positive. This reinforcing loop has a strong delay, as the social processes that reshape consumer preferences take time, and a critical proportion of homes need to be connected before positive experiences can have a society-

wide effect on consumer preference. Negative experiences with the DH network will drive a reinforcing decline in connections.

- **R20 consumer preference for heat pumps grows via rise in property values**

As more households install heat pumps, the popularity of this alternative heat system grows. This reinforcing loop has a strong delay, as the social processes that reshape consumer preferences take time, and a critical proportion of homes need to have heat pumps installed before positive experiences can have a society-wide effect on consumer preferences. Negative experiences with heat pumps will drive a reinforcing decline in installations. This could be caused, for example, by insufficiently insulated homes and rising electricity prices. In contrast, rising electricity prices increases the relative popularity of CHP-DH systems, as local electricity generation and distribution is significantly more efficient than pulling electricity from the grid, and the DH system may be owned and operated by a public body (e.g., Local Authority) or not-for-profit.

- **R21 competition between DH and HP can push DH into downward spiral**

Competition between DH and HP largely comes down to their price differential (“HP:DH ratio of cost-savings”). Some municipalities have responded to this threat by using the planning system to create zones in which newbuilds must connect to the DH network. In Sweden, where there is an emerging “preference for HP in DH zone[s]”, householders have begun disconnecting from the network and subsequently installing heat pumps.

## D2.3 The ‘Housing inequalities’ subsystem

This section presents a selection of findings from the HEW project that were adopted into the GCGP model under the “Housing inequalities” theme or subsystem, as well as a selection of changes (adaptations or additions) that were made. This section diverges from the previous three, as the presentation of findings is not exhaustive – albeit, comprehensive enough to give the reader a very clear understanding of the kind of relationships modelled in this subsystem.

The “Housing inequalities” subsystem models sixteen housing-related poverty traps, i.e., causal loops that reinforce poverty through housing-related factors. Four HEW causal maps form its basis, namely “Community connection and physical quality of neighbourhoods”, “Energy cost inequities”, “Fuel poverty and indoor temperature”, and “Household crowding”. Subsequent subsections present causal loop diagrams from the GCGP stakeholder interviews and literature review that do not fall under one of the aforementioned themes and therefore expanded the boundaries of the “Housing inequalities” subsystem.

### The “Tenure security” theme in HEW’s “Community connection and physical quality of neighbourhoods” causal map

The “Tenure Security” theme in the HEW model considers the impact of disposable income on tenure security, which feeds back to further entrench households in poverty and reinforcing housing insecurity, particularly as frequent moves are costly. These feedbacks are captured in R1 and R3 of the GCGP model, adapted from R6 and R7 in the “Community connection and quality of neighbourhoods” map of the HEW model.

What is not shown in the HEW model is the amplifying effect of a <gap in supply of social housing> on tenure security.

*"A new consideration is that an awful lot of families have to move regularly in order to find houses to rent that they can afford, and that is because of the nature of the contract. Short help tenure. Whereas before, families used to rent a council house and properties, and many spent the rest of their lives there." (Interviewee 11)*

Another addition from GCGP interviewees were the reinforcing feedback loops responsible for ever-increasing tenure security for high-income households. Surplus income, invested in rental properties, provides an additional source of income for high-income households, reinforcing their wealth and security (R12 and R13 in the GCGP model),

*"Because there's a shortage of property, the price of buying is far too high, and the price of renting is far too high. Renting isn't any cheaper. And it does massively create further social inequalities. There's a real danger of having a property-owning class that's doing very well for itself and can actually probably live off of its properties, and a rental class that can't buy into that asset-based economy." (Interviewee 2)*

This reinforcing loop is intergenerational:

*"For most young people, even those with good incomes, getting a deposit and paying mortgage on a house is beyond their reach. [...] For those who don't have inherited wealth, buying a house is not an option." (Interviewee 11)*

There are also intergenerational reinforcing loops present in the HEW and GCGP models between tenure (in)security, frequent moves/disruption to education, access to quality schools, and children's future income and job prospects.

Whilst retaining all of the HEW relationships modelled under this theme, reinforcing relationships between tenure security and mental health were added. According to the United Nations Department of Economic and Social Affairs (UN DESA), depression is the leading cause of years lost due to disability worldwide. Fitness for work can be severely affected by mental health problems and associated issues such as alcohol and drug misuse. Indeed, mental ill health is "among the ten leading causes of disability in both developed and developing countries", and "depression is ranked third in the global burden of disease, and is projected to rank first in 2030" (UN DESA, 2020, p. no pagination).

Prolonged stress associated with financial and housing insecurity may also contribute to domestic abuse and family breakdown which, in turn, reinforces housing insecurity. This reinforcing relationship was also added under the 'housing security' theme (see "R14 reinforcing loop between housing affordability and household breakdown" in the online GCGP model).

*"It would be interesting to look at the statistics, but when I worked at [East Cambridgeshire District Council] [about a decade] ago, one in ten houses that were rehoused were due to domestic abuse, and it's probably higher now." (Interviewee 4)*

Housing insecurity also has a significant impact on children's mental health and social wellbeing, impacting their current and future wellbeing. These relationships are only found in the GCGP model.

Frequent moves, experienced during childhood, impacts upon child behaviour (e.g. aggression hyperactivity and impulsivity), their mental health (e.g. anxiety and depression), and their social

development (e.g., one's ability to develop and maintain positive relations) – all of which impact their future employment and career prospects (LGA, 2018; Shelter, 2006).

*"If it's a family that is homeless, the impact on the children is far worse, I would argue. You know, having to move schools, know where to do your homework, the stigma attached to being homeless as a young person..." (Interviewee 4)*

### The "Energy cost inequities" theme in HEW's "Energy efficiency and climate change" causal map

The "Energy cost inequities" theme identified by the HEW project covers the unequal cost of heating homes, whereby low-income households pay more to heat their homes (per square metre) than middle- and high-income households (see "R2: health and employment impacts of housing in disrepair compounded by 'benefit vulnerability'" in the GCGP model which combines and slightly modifies R1 and R2 from the HEW model's "Energy cost inequities" map). Findings from the GCGP interviews repeated those from the HEW project, concluding three reasons for energy cost inequities.

First, energy (per unit) is cheaper for households with financial security who can switch to "direct debit" utility payments.

*"I work on some people who need to have energy meters [paying through coins]. It is a far more expensive tariff than [those families that] own a 7-bedroom house and can negotiate direct debits and credit effectively." (Interviewee 12)*

Second, households on higher incomes have greater <[...] access to energy efficient housing> that are cheaper to run.

*"Energy efficient [homes] are cheaper to run. There's a cost-saving element. [...] On the other end of the spectrum, you have people in fuel poverty. [...] This means they're spending more on energy than they can afford to." (Interviewee 6)*

*"There's still an awful lot of poor-quality housing in the UK, particularly now in the private rented sector occupied by families. That housing, without sometimes proper standards of insulation, warmth and so on and so forth, is still a significant problem. [...] [These homes] can provide a series of stresses for people." (Interviewee 9)*

Third, households on housing benefit, who typically live in poorer quality dwellings in the private rental sector and suffer greater housing insecurity, are less likely to complain to their landlords compared to those with housing security.

*"In Cambridgeshire we have a lot of [poor quality houses and] houses of multiple occupation where a landlord is exploiting [...] vulnerable people. They're vulnerable because their choices are limited. As a student or young person, you're limited by income and life experience. Although most of those, I hope, at least will have parents who can [intervene]. But vulnerable people [on housing benefit], or have been trafficked in, or lured in with false promises to organized crime, [they are vulnerable to housing in disrepair]. [...] And it's driven by [housing] demand. If demand's high, the prices go up [and vulnerable people have less choice and less security]." (Interviewee 14)*

Missing from the HEW model is the reinforcing feedback between energy cost inequities and utility debt.

*"Ensuring that people have systems in their houses to make their home as efficient as it can be can contribute to mental wellbeing in particular. We've seen lots of cases of people where they've got into debt and it's made them really unwell. Of course, people aren't ever just fuel poor and there's nothing else going on. It's obviously part of a range of things. But it can directly be a contributor to poor mental health. [...] I think [fuel poverty] also contributes to people feeling out of control. Their bills are piling up and they don't know what to do about it." (Interviewee 6)*

*"I think we are in an economic climate still at the moment where things are tight for an awful lot of people. There will be people who find paying a utility bill very difficult. [...] So that's increasing the pressure on those who can't pay the bill. [...] The one thing that is different between water and any other utility is you can't have your water cut off. So, if you don't pay your phone bill or electricity bills, someone will eventually cut it off. You can't do that with water. But you will have a debt that hangs over you." (Interviewee 8)*

Because the GCGP model goes beyond discussions about energy, it can consider, as well, the impact of water efficiency in metred homes on household debt, which falls into the same reinforcing feedback loop as energy efficiency ("R4 poverty trap from poor access to energy and water efficient housing" in the GCGP model). In fact, household debt from unpaid water bills is nearly double that of household debt from unpaid energy (heat and electricity) bills (Citizens Advice, 2018). This is especially concerning given the impacts of climate change and environmental degradation on the local water environment. "Annual water bill[s]" in the East of England are expected to rise over time as water companies adapt to these changes (see "Housing & Environment" subsystem interlinkages in Kumu).

One last feedback loop (R6) was added to the theme "energy cost inequities" based on findings from the GCGP project. This feedback links the upscale of renewable heat technologies and housing inequalities. As explained in the "Housing, Energy & Climate change" subsystem (R17), the gas grid grows decreasingly efficient and per capita service and maintenance costs rise as more households adopt decentralised, renewable heat solutions and consumption from the gas grid significantly reduces. Because low-income households are unable to invest in low-carbon technologies, they are more likely to remain on the gas grid and experience hikes in their energy bills. In other words, without intervention, the competition between gas and renewable heating will reinforce energy cost inequities that, in turn, subjects households to fuel poverty.

#### HEW's "Fuel poverty and indoor temperature" theme and causal map

The "Fuel poverty and indoor temperature" theme describes reinforcing relationships between the "[...] affordability of temperature optimisation", "[...] fitness for work (or school)" and the "<[...] ability to hold a job or be promoted>" (R5 in the HEW model) – whereby those with little disposable income and high energy costs underheat or undercool their homes, resulting in "morbidity and mortality from heat and cold". Those who are unwell or out of work are forced to spend even more time at home, exposing them further to temperature extremes in poor quality housing. These latter reinforcing feedbacks were modelled separately in the HEW model (R6 and R7). The GCGP model combines R5, R6, and R7 into one feedback loop ("R5: reinforcing loop between fuel poverty and income inequality").

*"If somebody's house is damp and they can't afford to heat it. There's lots of instances of respiratory problems coming from damp houses. Also, slips and falls are more prevalent for people living in colder conditions, particularly elderly people." (Interviewee 6)*

R5 in the GCGP model also considers implications of demographic trends, specifically an “<aging population>”, on fuel poverty.

*"[The price of energy] becomes a much bigger deal when you get to our age when you become a pensioner when the fraction of your income that you are spending on housing costs particularly fuel costs is significant." (Interviewee 13)*

The GCGP model goes beyond “morbidity and mortality from heat and cold” when modelling impacts of indoor temperature extremes on health and wellbeing. For example, “<[...] sleep deprivation>”, “[...] children’s educational attainment”, “<[...] in-home comfort>”, “[...] ability to host visitors”, “[...] pride in home”, and even “[...] positive family relations” and “<domestic violence>” were found to be impacted by fuel poverty.

*"I suppose there are mental health impacts, living within a home, if it's not a comfortable place to be." (Interviewee 10)*

*"We've seen people where they're just living in one room and they've got a little heater plugged in next to them. And their quality of life is really diminished because they can't or don't think they can afford to heat their home." (Interviewee 6)*

Like all poverty traps, fuel poverty feeds into other reinforcing loops, e.g. by affecting household debt, tenure security, and household crowding. These relationships are all modelled in R5 on Kumu.

#### HEW’s “Household crowding” theme and causal map

HEW’s “Household crowding” causal map, much like the others, is “composed of mostly reinforcing loops, “potentially trapping generations of families in crowded houses” (Macmillan et al., 2014, p. 29). These reinforcing loops show the cyclical relationship between crowding and poor respiratory health from excessive moisture and mould growth; unemployment (which itself worsens crowding, as adults stay home); family breakdown from conflict and stress; “[...] children’s educational attainment” and social wellbeing (which itself worsens crowding if young people are unable to leave home). Whilst family break-ups would reduce crowding (at least in the short-term), separations often exacerbate other poverty traps associated with financial stress and housing insecurity.

In the GCGP model, these relationships are covered in “R7 reinforcing loop between household crowding and income inequality”, which combines R1, R2, R3 from HEW’s “Household crowding” theme, and “R9 intergenerational vicious cycle from poor housing-related health outcomes”, which combines R4, R5, R6, and R7. The GCGP model adds very little detail to this theme beyond touching on inequities in “[...] space for solitude” and “[...] ability to relax / find tranquillity>”.

#### Expanding the boundaries of the “Housing inequalities” theme and creation of a new causal map

The boundaries of the GCGP “Housing inequalities” causal map go beyond the four themes found in the HEW model. to include reinforcing loops between income inequality and inequality in accessibility (R8), family wellbeing and household breakdown (R14); and propensity to commit crimes (R16), and propensity to experience repeat homelessness.



## D2.4 The 'Housing market and Land economy' subsystem

The "Housing market & Land economy" subsystem models balancing and reinforcing loops responsible for the dynamic behaviour of the region's housing market with implications for housing quality, density, affordability, and environmental footprint. Three causal maps from the HEW model form its basis, namely "Land ownership, value and development patterns" and "National Property Market" and "Regional housing affordability" falling under the "Housing affordability" theme.

With 15 reinforcing feedbacks and 11 balancing feedbacks in the "Housing Market & Land Economy" subsystem, this section presents only a selection of findings from the HEW project that were adopted into the "Housing market & Land economy" subsystem model, as well as a selection of additional contributions from the GCGP project. The CLDs selected for presentation should give the reader a clear understanding of key feedbacks and contributions made from the GCGP research project.

### HEW's "Housing affordability" theme and causal map

HEW's "Housing affordability" map models causal loops responsible for the housing market dynamics that emerge during periods of economic growth. When developing the GCGP model, all HEW CLDs were retained from this map; however, CLDs related to gentrification or being 'priced out' of Cambridge were moved to the "Housing Inequalities" subsystem and CLDs related to the quality of the housing stock were moved to the "Housing design" and "Housing, Energy & Climate change" subsystems. The remaining key feedbacks from this theme are presented below alongside new contributions from the GCGP project.

As the regional economy grows, so too does inward migration, housing demand and property sales. The growth in sales, however, is limited by a number of balancing loops (e.g., "B5 limits to growth through housing affordability"). Nonetheless, a number of reinforcing loops are said to dominate, overriding this balancing affect in the short-term (e.g., "R10 expanding demand through easier mortgages", "R12 property speculation", and "R13 price rises [improve asset affordability for current home-owners to invest in rental properties or second homes]"). As long as these reinforcing loops dominate, low-income households are 'priced-out' of urban areas, with implications social equity, road congestion, emissions, and public health.

In the mid-term, this trend is social, environmentally, and economically unsustainable. It is economically unsustainable, as the economy relies on key workers (e.g. teachers, nurses and carers) accessing the city.

*"When the local economy is doing well, house prices go up on average. Then there's phenomena called 'price-out' of the city, unique to urban areas. Then you have the issue of certain jobs not being sufficiently filled, which negatively impacts the local economy."* (Interviewee 9)

Interviewer: *"Then you'd expect it to balance itself out, right? As the local economy starts to suffer, the cost of housing should drop. So, theoretically, there is a balancing effect."*

*"Depends on how you think it's working. If there's a market economy working and you're a classic economist that believes in an adjustment to market equilibrium, then it should sort itself out eventually."* (Interviewee 9)

It was also noted in the GCGP interviews that road congestion weakens the regional economy directly (through inefficiencies) and indirectly by reducing the "<attractiveness of [the] area to businesses

and employees>”. As such, a new balancing loop was added to the model, namely “B4 limits to growth through road traffic”. This mid-term balancing is, however, postponed through several reinforcing feedbacks, such as the development of social or ‘affordable’ housing (“R5 affordable proximity to jobs stimulates the economy (and [nearby, greenfield] land development)” and infill development (“R7: Density stimulates economic growth via improved accessibility”).

The HEW model also theorises that density stimulates growth by making places more walkable, increasing foot traffic and support of local businesses on the high street (R10). A few GCGP interviewees argued that density also reinforces growth by improved IT infrastructure (R8) and public transportation (R6) that attract businesses and employees to the area.

This regional growth, which is self-sustaining and even reinforcing in the mid-term interacts with the region’s land economy, creating dynamic behaviour. A selection of these feedback loops is presented in the following subsection – some of which were original contributions from the GCGP project.

### Land ownership, value and development patterns

As land is developed to meet housing demand, the stock of land with planning permission declines and its financial value rises. This increases the “land profit margin” for developers, stimulating the submission of further planning applications (“R1 [land] scarcity stimulates demand”). There is, however, a finite stock of land on which to develop that, in the long-term, limits the growth in land development”. Because this limit to infinite growth was not captured in the HEW model, the feedback “B3 limits to land development” was added to the GCGP model.

Currently, in the GCGP subregion, the lack of greenfield land with planning permission is perceived, by many, as being a significant barrier to housing market growth. The former East of England’s ‘Regional Spatial Strategy’ purposefully concentrated housing development in urban areas, in line with the principles of sustainable development. Since then, however, local authorities have agreed to increase the share of housing delivery in rural districts (i.e., East Cambridgeshire, Huntingdonshire and Fenland) and decrease the share in South Cambridgeshire and Cambridge City to improve housing affordability. (Cambridgeshire Insight, 2018)

*“The big push to raise housing density in the early 2000’s seems to have gone away now and lots of plans for building as a consequence, and I think that is good in some respects and not so good in other aspects. I think [the push for densification] was really good on sustainability and environmental terms. For instance, travelling distances came down in some settlements”*  
(Interviewee 13).

Interviewees were divided on whether this pivot to greenfield development represented a positive shift in policy. Regardless of one’s opinion on the change in planning policy, there was a relatively strong consensus among interviewees on the barriers to and enablers of greenfield development.

First, land-banking, which was also identified in the HEW model, was considered to be a significant barrier to greenfield development. Land is purposely withheld by landowners to inflate the average land price (“B1 speculative land market”). The second barrier, specific to the GCGP model, is opposition from rural residents.

*“If you’re in a village of 300 houses, you probably don’t want 150 houses being built because it’s going to change the character of the village.”* (Interviewee 20)

*"Every housing development I get involved in, there's a massive opposition to it. You think, how could that be when housing is so fundamental? You know... [in terms of] hierarchy of needs, you'd think housing would be a good decision. [...] [Problematically,] many [of the] stakeholders [consulted] tend to be of an age and profession, where they've already bought their house."* (Interviewee 2)

Interestingly, a reinforcing loop with land price was identified ("R2 opposition of rural residents slows development and drives up land price"). As the average land price rises, only large developers can afford to invest in property – reinforcing "opposition from rural residents" given the high level of distrust between the UK public and bulk housebuilders.

*"Essentially, we have a housing market that is driven by distrust between communities and house builders."* (Interviewee 2)

A number of policy interventions were proposed to help address opposition from existing residents. These can be found in the Kumu model, along with interview quotes.

The third cited barrier to greenfield development is the preservation of the Cambridge Green Belt established in the mid-1950s. However, pressures from growth (e.g., rising homelessness), were said to chip away at the "<political will to preserve [the] greenbelt>". Here, another reinforcing loop was identified: "R3 pressure from growth degrades political will to preserve greenfield land, reinforcing development and growth". This 'urban sprawl' reinforcing loop, however, triggers a balancing loop: "B3: Release of greenbelt land for development raises political will to preserve it".

Taken together, these barriers to greenfield development, during a period of significant economic growth and regional inward migration, are said to contribute to the gap in supply of social housing.

*"There's a [...] lack of available land for housing. [...] And [land] values are so high; it's been very difficult to get the number of social houses built. So, there's a whole drain on social housing. Numbers in the Cambridge subregion have gone down enormously."* (Interviewee 4)

That said, other factors outside of land economy, such as Government's 'Right to Buy' policy, have also contributed significantly to the gap in supply of social housing.

*"Young people with families and older people, in previous times, would have rented council houses [...] because the market rents around here are so high. [...] That option is largely gone because those houses were [...] sold and are traded privately."* (Interviewee 11)

*"The 'right to buy' was introduced in 1980 or 1981 which meant that tenants had the opportunity to buy their own home. Basically, what it's done is diminish the [social] housing stock. If you looked at somewhere like South Cambridgeshire, probably the most desirable social homes have been bought and are no longer available for people. And they haven't been replenished. Although the intention was always to build homes to replace the 'Right to Buy', that hasn't happened, and in fact [...] councils were restricted from using what was called the 'Right to Buy Receipts'. [They] could only use a certain percentage of those. So, the equation never stacked up for local authorities. Since the 1980's, local council were discouraged, and in fact prevented, from building them themselves."* (Interviewee 4)

Rather than ease the restrictions on local authorities, Government shifted the responsibility to not-for-profit Housing Associations and, more recently, commercial developers, which has largely backfired ("R15 'economic viability' defined by investors' expected returns").

*"We went through a phase where [Government shifted to the private sector to deliver affordable housing]. "[Commercial developers] are going to maximize their profit within the policy environment that exists, and the policy environment was relaxed to allow them to make more profit, because the government's view, I would imagine, was that that would sponsor and promote house building. But it had the opposite effect. [...] [The] new national planning policy that came out and basically said, 'If you can prove that it's not economically viable for the commerciality of the site to provide affordable homes, then you don't have to do it'." (Interviewee 7)*

*"If you rely on the mass-market builders, the 'big 15' if you want to call them that, they have a set financial model which gives their shareholders a specific return. And I've spoken to people like the technical director of Taylor Wimpey... they won't deviate from that, because it'll upset the shareholders." (Interviewee 3)*

With housing affordability remaining a significant challenge, particularly in the South of England, Government improved access to the housing market via 'Help to Buy'.

*"'Help to Buy' is a government scheme where they provide 20% of the deposit per new house purchaser, and the house purchase provides 5%. Which means, the lenders see it as a much better proposition. It would be sensible to understand the proportion of new homes that are being bought with 'Help to Buy'. It's very high, [allowing people] earlier access to the market." (Interviewee 7)*

Interviewer: *"In combination with relaxed criteria around [affordability quotas] for commercial builders, in that environment, isn't Government just paying for people to be able to afford unaffordable housing?"*

*"Agreed. So that's the point I'm making. The point is that affordable homes have not been produced, and therefore Government has come in with a different solution [providing 20% of the equity]. [...] There's a real problem here. Private sector house builders have been allowed to move to a 20%, 30% margin. That's the new norm [the benchmark for their shareholders], and Government is supporting that with policy." (Interviewee 7)*

#### Proposed interventions targeted at the region's land economy included a "cap on land price"

*"The conservative Mayor believes in land-value capture, which I also believe in. He believes in capping the land of price of land to 10x of agricultural land, in simple terms." (Interviewee 1)*

*"[A cap on land price] is one of many components that will unlock development. [...] Right now, we're working on a site that has 22 landowners because the scale of the development is enormous, and, of course, it only takes one of [the land owners] to say, 'That deal isn't good enough for me. I'm not pressing ahead until the deal gets better.' [a fixed land price would remove this barrier and viability could be determined sooner]" (Interviewee 19)*

These measures (artificially reducing the price of land or increasing households' access the housing market), however, only alleviate symptoms rather than addressing the underlying cause: land availability. In fact, these measures exacerbate the problem in the mid-term as the stock of land for development continues

to diminish in areas of economic growth (“B11 limits to affordable housing delivery”). The economic, environmental, and social implications eventually catch up:

*“Unfortunately, we’ve got [a situation] that has driven people to make themselves homeless in order to get access to this very scarce resource called social housing. People, not willingly, see the only way to get access to this social housing is to make themselves homeless and go through that terrible process.”* (Interviewee 4)

## D2.5 The ‘Housing design’ subsystem

The “Housing design” subsystem models interactions between land economy, housing design and place-making with implications for social equity, community, energy consumption, travel patterns, and health. The subsystem model is based on CLDs from HEW’s “Land ownership, value and development patterns” causal map but expanded to include issues such as accessibility. Rather than being a comprehensive review of the five reinforcing feedbacks and six balancing feedback loops, this section presents only a selection of findings from in the GCGP “Housing design” subsystem. The CLDs selected for presentation should give the reader a clear understanding of key feedbacks and any contributions made from the GCGP research project.

### The impact of land value on quality development

“<Developer commitment to, and ability to deliver, quality [homes] and place-making> is said to have an inverse relationship with market land values in three ways (B4). First, a rise in land price “increases the ratio of developer profits that are derived from the land compared with from houses, creating a disincentive for investment in quality” (Macmillan et al., 2014, p. 40). Second, as previously mentioned, high land prices make it difficult for local authorities and Housing Associations to deliver social housing. Because these stakeholders retain ownership, they have a “longevity of interest in [their developments]” and, thereby, an interest in quality.

*“Developers don’t have a long-term interest I suppose, and we’ve seen that in recent years with a number of complaints that developers are getting about new builds. [...] The model is short-term. They go in, they build, they leave. They hand over to the new owner, that’s it. You get a period of after-care and then they’re gone and I think we need to perhaps change that view a little bit, and have a longer-term view of what it is we’re building and how is it going to be performing in 10, 15, 20 years. You know, these buildings are going to be around for a long time. There’s a bit of a disconnect there [with long-term sustainability targets].”* (Interviewee 10)

Third, prohibitively high land prices create an <advantage for large developers> who have (in theory) significantly less interest in delivering quality developments.

*“Most house builders are public limited companies. The big volume ones are all FTSE 100-250 companies, so they really are focused on the bottom-line and the profit, rather than being focused on wellbeing.”* (Interviewee 2)

*“If you rely on the mass-market builders, the ‘big 15’ [...], they have a set financial model which gives their shareholders a specific return, [and] they won’t deviate from that [...]. They know they can make a better-quality house for less money. They can use off-site construction. They can use*

*modern methods of construction. They can use more natural materials. [But they won't.]"* (Interviewee 3)

*"Another thing that would help is just a little bit more diversity in [actors involved in] the housing market. [...] Quite often what you find with [small to medium size house builders] is they want to differentiate themselves from the bigger house builders, so they are [trying] to market themselves on certain aspects, be that sustainable construction or healthy homes."* (Interviewee 10)

In theory, developers should incur costs when they deliver poor-quality housing. Whilst some specification problems or design, material, or workmanship defects do trigger complaints and calls for remedial works to be carried out, they are often disputed, and it may be challenging for councils to successfully claim damages past the defects liability period. In theory, developers should also incur reputational costs when delivering low quality housing, preventing them from winning future bids (B1: reputational harm could prevent low-quality development in the mid-term). In practice, there a number of counterfactuals disproving this theory. For example, the developer Brookgate was publicly chastised for its "rubbish", "unfit" and "soulless" CB1 development in Cambridge (Wainwright, 2017), then subsequently awarded two major developments in the city – the Cambridge North station and the conversion of the County Council's Shire Hall into a luxury hotel and prime office location (Brown, 2019).

Participants of the HEW and GCGP projects contended that the B1 feedback is only active when housing is more affordable. When there is a "<gap between [the] supply and demand of [housing]>", there's a greater "likelihood [that] authorities will accept low quality houses and places" as they are required, by law, to facilitate housing delivery at pace to meet previously assessed housing need. Legal battles – whether initiated over proposed, underway, or completed developments – require a tremendous amount of time and resource from local authorities whose budgets have already been hit by austerity.

*"I think in some places there is this desperate need for new housing to come to market, [so you get growth at any cost]. [...] Getting the project going is more important than the type of impact it might have. I mean... that sounds terrible, but I can think of a couple of new development sites that have just been ramrodded through, and without consideration of what the impact is going to be in 10, 15 years."* (Interviewee 18)

*"My understanding is that [the current planning system] favours developers more than the creation of forward-thinking local policy. [...] [There is tremendous pressure on] local government to deliver planning application approvals rather than improve the quality through local policy. And I see this in terms of decision-making locally on a regular basis. The planning authority is very, very focused on making sure the application is approved sometimes [and are less] concerned than I think they should be about quality or sustainability. And they're potentially being starved of resources to make good decisions."* (Interviewee 16)

*"[The urban regeneration of South Bank in Peterborough was planned to happen over a decade ago] and it's only just come to fruition, [...] and it is completely dominated by the car. [...] I think in some of the smaller local authorities, and I think Peterborough as a unitary authority comes into that, are a bit scared of taking that step. They're not quite brave enough to say, 'actually, this is going to be our premier, river-side development, and we're going to be really bold, and we're not going to put any carparking in there. [...] So, you've got this amazing river-side development... it's going to have 350 apartments, it's going to have a hotel there, an arts centre there... but it's also going to have a*

*multi-story carpark. [...] They are within walking distances of the city centre, walking distance of the train station, bus station. [...] There needs to be a foot/cycle bridge from the development to the other side of the river. But they said they can't afford that. [...] It's a £160 million development site. [...] My impression is that we've been so desperate to develop that site as a city, that we've probably let the developer get away with quite a lot in terms of their contribution."* (Interviewee 18)

HEW and GCGP stakeholders also pointed out the role of home buyers, and how the gap in supply affects their decision to accept low quality

*"I think it's not necessarily a lack of demand [for energy-efficient housing], it's that people aren't necessarily...I think there's a lack of supply of housing, so you basically are presented with quite a limited range of options. So, you kind of have to go with what's on the market."* (Interviewee 10)

According to the HEW model, the acceptance of low quality by local authorities and home buyers is theorised to backfire in the long-term, as poorly designed and constructed homes and public spaces reduce the "<attractiveness of area to businesses and employees>" (B2 and B3). The assumption here is that places have a 'quality' tipping point. This could apply, as well, to the (over-)density of the built environment (B6), which increases with land price and detracts from blue and green spaces within and between built-up environments.

*"There's a place in Nuneaton called Camp Hill... quite a large-scale development, about 500 units, [where the developer tried to] get as many units on the site as possible [...]. So, there was a lack of open space but also [a lack of space] within the units. [...] If you make the homes slightly smaller, and you make the open space provision only the minimum you need to meet planning criteria, [you get a higher return]. [...] In terms of wellbeing, that was a very unsuccessful development in one sense. From a sales perspective, it was successful because just about every home was sold within weeks of it being completed. [...] But therein lies the conundrum we personally have to deal with, because if the need is great enough [...] and you will always have a good return, you can almost demand your price."* (Interviewee 19)

This theorised balancing loop (i.e., the theory that poor quality eventually backfires) did not emerge in the GCGP interviews, likely because the economy is seen by stakeholders as having a substantially larger impact on inward migration. In fact, the expert reviewer from the Greater Cambridge Shared Planning Service suggested that it would be very difficult to find evidence for these balancing loops from the HEW model. Rather, they argued that the causal arrow from quality to inward migration is likely negative, as the process of ensuring quality slows housing supply and raises the cost of housing – negatively impacting the "<attractiveness of area to businesses and employees>". This opposing theory was added to the GCGP model ("B7 poor quality reinforces growth").

### The impact of new towns on quality development

It was proposed by GCGP interviewees that new towns offer a better opportunity for quality development in two ways. First, they provide an opportunity for a significant uplift in land value – a significant portion of which could be invested in the delivery of green infrastructure, quality landscape design, higher specification housing, sustainable transport infrastructure, community infrastructure, etc.

*"This goes back to the garden village concept. Part of the concept there, and I'm not sure it works, but part of the concept is that if you build on land... I don't know... 10 miles out of Cambridge, it*

*won't currently be land that anybody has thought of for housing, so you get to buy it at an agricultural value rather than housing value. And if you can do that, then, with the difference in price, you can invest in your community infrastructure. So, you can go the whole hog on this kind of planning. This guy called Matthew Taylor has done a lot of work on thinking about this."* (Interviewee 2)

Second, 'starting from scratch' offers an opportunity for masterplanning which is said to improve land use mix and the overall quality of developments.

*"If you are a master planner or master developer like the Urban and Civics or the O&H at Hampton, Peterborough, you're going to have a longer-term perspective. Interestingly, they're all very small companies that are usually owned by one or two individuals who have a very strong personal vision and are very invested in what they're doing. [You need a magical solution] whereby all these big sites have got that sense of legacy, sense of long-termism, sense of responsibility to drive wellbeing. I mean, they still make an awful lot of money, these guys. So, we're not talking about them being philanthropists at all. If you look at O&H in Peterborough, they're going to deliver in the region, 8... 9,000 houses over a 30 to 40-year period, and they will make a significant amount of money. But they are constantly thinking about the long-term from the start. They knew they were going to be there for 30 to 40 years. And the same is true of Urban&Civic at Alconbury and Waterbeach. [...] I think if you could get that right... if you could create a model that means if everybody involved in delivering a project is invested its long-term future... potentially, invested in its long-term management, then you could look at community land-owning, community stewardship management companies. I think it could change a lot."* (Interviewee 2)

New towns reinforce regional growth (R3 and R4), however, leading to prohibitively high land prices for quality developers and increasing the aforementioned pressure on local authorities and homeowners to accept poor quality.

## D2.6 The 'Housing and Transport' subsystem

Much like the GCGP's "Housing & the Environment" subsystem, the GCGP's "Housing & Transport" subsystem goes beyond the system boundaries of the HEW model to consider interlinkages between housing and transport. It takes as its basis the "Traffic Congestion and Policy Resistance" model in (Armah, Yawson, & Pappoe, 2010), the key theories from which are presented in the first subsection. The subsequent subsections provide select examples of how the transport system is closely interconnected with the other subsystems of the GCGP model, meaning that interventions in transport impact upon housing design and vice versa, along with community, the environment and other subsystems not presented in this dissertation.

### Traffic, road building, and competition between private and public transport

This subsection presents balancing and reinforcing feedback loops responsible for rigid car-ownership rates, ever-increasing congestion, and the dismal public transport options in the GCGP subregion. Interestingly, the CLDs are borrowed from a system dynamics model of transportation in the city of Accra, Ghana (Armah et al., 2010). That said, the feedback loops integrated into the GCGP model are universal and explain why cities in developing countries may adopt similar road-building/-expansion



projects to those pursued by 'advanced' economies in the post-war period and that continue to be pursued today.

During periods of economic growth and inward migration, traffic volumes increase, resulting in slower "<road travel times (km/hr)>". This puts political "pressure [on Government and local councillors] to be seen reducing congestion". Despite all the evidence that roadbuilding induces traffic, politicians approve and budget for expensive schemes to increase "<road capacity>", making themselves part of the problem ("B1 expanding road capacity").

"Roads are still seen as the answer to everything. We're still scratching around for millions of pounds [for active travel infrastructure], whereas down the road, the A14 is getting a 1.5-billion-pound extension/widening programme that will just lead to more traffic, more congestion. If we meet in 14-years-time, the A14 is going to be just as congested as it is now. That theory of induced demand will come to fruition." (Interviewee 18)

Road-building increases traffic in the mid-term through two balancing loops. First, alleviation of traffic in the short term makes short-distance, discretionary trips (i.e. trips that could be made without the private motor vehicle) more attractive (B2). Second, increasing road capacity enables longer trips (e.g., to a supermarket that is further away) and encourages inward migrating households to rent/buy in a location further from work (B3). B2 and B3 explaining how roadbuilding actually *increase* congestion in the mid-term.

When the attractiveness of private transportation increases in the short-term due to roadbuilding, so too does car ownership (B4). Problematically, the dependence on cars is reinforced by the fact that "car-dominant environment[s]" worsen the "perceived safety of walking and cycling". This reinforcing loop between roadbuilding and car ownership ("R5 increasing road capacity reduces perceived safety of active travel, reinforcing dependence on car travel") did not come from Armah et al. (2010) but was, rather, identified by a GCGP interviewee.

*"Peterborough has existed for a long time, but the new town development happened in around the 60's and it was massively expanded. It was built around the car [...]. It's got parkways all around it. Big dual carriage ways. It's easy to get around in a car, but it doesn't necessarily feel particularly pedestrian and cyclist-friendly."* (Interviewee 6)

*"There are a lot of people who depend on their cars to get to work. If you can't afford to live in Cambridge, you may decide to live in Haverhill or somewhere like that [where] it's cheaper. And then you have the problem of very few sustainable transport links between there and, for instance, the Biomedical Campus. So, unless you [...] are prepared to cycle for a long distance, which is difficult when there aren't, by and large, sustainable off-road bike paths for long distances, then your options are quite limited."* (Interviewee 11)

As congestion increases in the mid-term, rail may become more attractive than private road transport, but bus services become less attractive as their journey times lengthen and the service's reliability is impaired. This trend discourages "investment [in bus services]", triggering a downward spiral ("R8 ever-increasing (or declining) public transport ridership"). Declining ridership leads to cuts to uneconomic bus routes, reducing the coverage, and therefore quality, of the public transport system.

To generate exponential growth (rather than decline) in public transport ridership, the “attractiveness of driving relative to public transport” must decrease. One way to achieve this, as suggested by GCGP stakeholders, is to implement 'car-restraint'/demand-management measures, i.e. interventions that decrease the attractiveness of private transportation and raise revenues to be redirected toward public transport.

*"The Government has a target to double the levels of cycling by 2025. If we're going to get anywhere close to that, we really have to start thinking about car-restraint [...]. But when we bring forward proposals for car restraint, it's seen as completely outlandish, as if we're coming from a different planet." (Interviewee 18)*

*"We're making it more expensive to park in the city. [...] Then you bring in a bus service... so it's the carrot & stick approach." (Interviewee 7)*

*"That's what Peterborough really suffers with. It's really cheap to park. You can park all day for £2. You try parking in Cambridge all day, it'll cost you £30." (Interviewee 17)*

Another common measure is to reallocate space from private vehicle to bus and cycling lanes.

*"If we're going to see the required shift, we need to be looking at big steps. [...] You can criticize Boris an awful lot, but his vision for cycling in London was strong, and he wasn't afraid to remove lanes of traffic and pass spaces to people. And that segues nicely onto Mayor Palmer and the Combined Authority. He is going to have a devolved transport budget. He is going to be able to call a lot of shots." (Interviewee 18)*

Now that the structure of the transport system has been largely summarised, its relationship to other subsystems may be better understood.

### Subsystem interlinkages: Transport and the housing market

Local economic growth creates an incentive for infill development, which lowers the “<ave. travel distance to work, services and amenities>” and improves the “<walkability of neighborhoods>”. In this way, there can be a reinforcing feedback between economic growth and the alleviation of traffic (R3). However, due to the land economy and housing market dynamics previously presented, housing affordability limits brownfield development and eventually pushes development further afield to greenfield sites. This development increases average travel distances and, thereby, traffic volumes, which negatively impacts the local economy (B6).

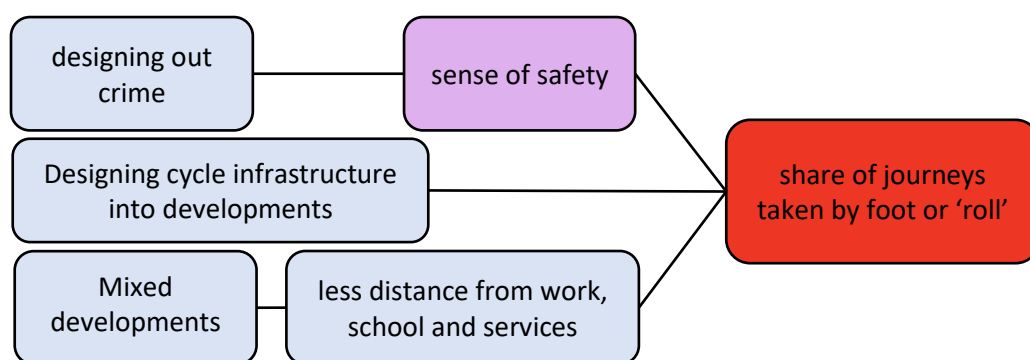
To remove this constraint on growth, Government devolved a transport infrastructure budget to both the Combined Authority and the Greater Cambridge Partnership (Cambridge City Council and South Cambridgeshire District Council). Should these bodies pursue a strategy of continued, short-term improvements in road capacity to reinforce economic growth (R2), problems associated with air pollution, greenhouse gas emissions, and accessibility will worsen. Alternatively, these budgets could ‘unlock’ growth by supporting a modal shift to public transportation and active travel (see interventions “CA [...] co-invests in light rail” and “GCP and CPCA investment in active-travel infrastructure”). If successful, this investment could facilitate a significant transition away from the incumbent private road transport regime, fundamentally changing the structure of the transport system. For example, the balancing loop between economic growth and congestion (B6) may no longer hold.

The reinforcing relationship between transport infrastructure development and economic growth would remain, however, meaning that balancing loops between transport infrastructure development and things like housing affordability and ecosystem services would still be active.

### Subsystem interlinkages: Transport and housing design

The “Housing & Transport” subsystem presents a number of ways in which the design of the built environment influences transport outcomes, such as the “share of journeys taken by foot or ‘roll’” (see Figure D19).

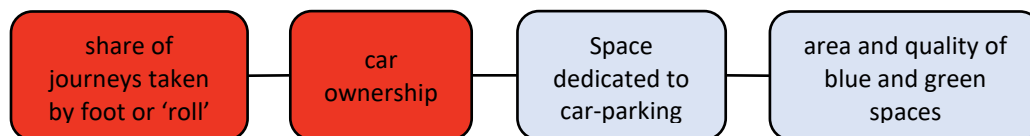
*"Spatial design can also increase the take up of sustainable transport option if they're planned in. [...] I mentioned briefly that Peterborough has this Green Wheel, which is a cycling route that goes all around the city. [...] Having that infrastructure there enables people to use it."* (Interviewee 6)



**FIGURE D 19: HOUSING DESIGN IMPACTS ON TRANSPORT BEHAVIOUR**

These outcomes may feedback and reinforce design decisions (see Figure D20).

*There's an awful lot of evidence out there that people who are physically active enjoy higher levels of wellbeing, have better quality of life, improved mental health. Yet, in terms of planning, [...] in the UK, too much of our housing/planning is focused around the private motor vehicle. The way we design these spaces emphasizes that status quo [...]. Whereas housing gives you a real opportunity to create an environment that is conducive to people being active [and living well]."*



**FIGURE D 20: TRANSPORT BEHAVIOUR IMPACTS ON HOUSING DESIGN**

### Subsystem interlinkages: Transport and community

The existing transport system (physical artefacts, preferences, social practices, etc.) was said to have a number of negative impacts on community (see Figure D21). One such impact is the effect of car-dominant environments on social interaction between neighbours.

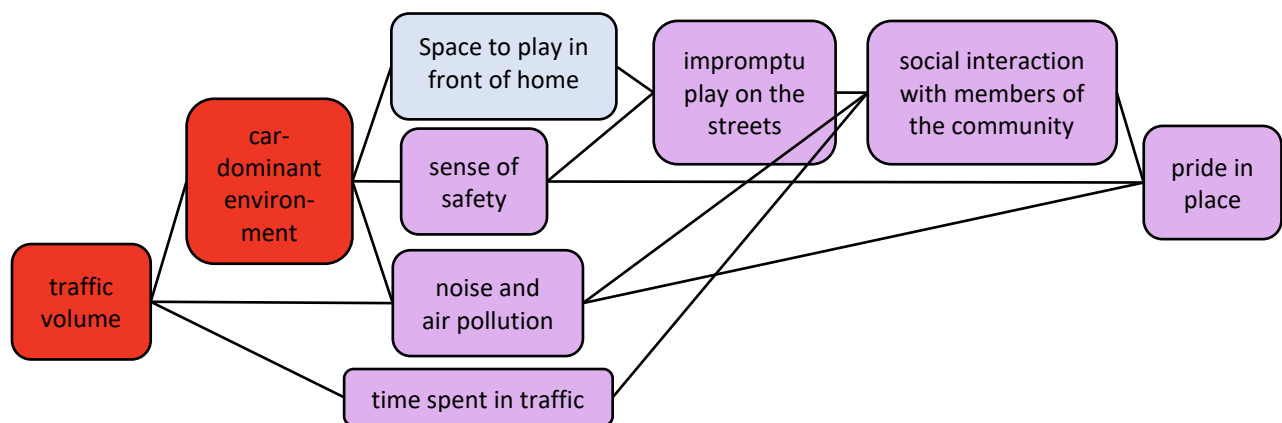
*"There's a paper by Appleyard in the late 60's? [...] that looked at how well you know your neighbours, and essentially, the busier the road was outside the front of your house, the less likely*

*you were to know your neighbours. Whereas, if you had a quiet road or space that was banned to cars, the number of relationships you had with your community was enormous [...]. I mean, crikey. That's 50+ years of that sort of understanding, and yet we are still building developments that allow lots of motor vehicles to be parked all over the place."* (Interviewee 17)

*"'Jumpers for goal posts'... that's what everyone called it. You'd just put a couple of jumpers down on the street and you'd have a football match. You rarely see that anymore because you get someone saying, 'Don't scratch my car!', or there just isn't space... or you sort of get pushed into these manicured spaces as part of the development. And that sort of 'informal play' has been lost."* (Interviewee 18)

Another, indirect, impact is the effect of road congestion and longer travel distances on one's availability to socialise with neighbours, volunteer and attend community events.

*"If you are having to travel a long distance to do any of those things not only is it taking away from your time, but it is also reducing the community engagement you have locally."* (Interviewee 16)



**FIGURE D 21: TRANSPORT SYSTEM IMPACTS ON COMMUNITY**

In turn, the health of a community can impact the transportation system. A GCGP interviewee identified a reinforcing feedback loop between roadbuilding and social trust (R6), whereby roadbuilding creates car-dominant environments that chip away at community and social trust. This lack of social trust may lead to a poor sense of safety in one's neighbourhood, suppress active travel rates, and increases dependence on the car. This dependence, in turn, leads to a greater demand for road capacity and, thereby, roadbuilding.

### Subsystem interlinkages: Transport and the environment

The transport system has a direct, negative impact on the environment via air pollution, but as well, indirect negative impacts on the environment via land use and climate change. "<Parking provision>" provided by LAs in the UK takes up more land area than the size of Birmingham (BPA & Skyblue Research, 2013). This excludes private parking on residential properties, commercial and retail parking, and parking provided by the NHS Trust and universities, which, taken together, account for a significantly larger land footprint than LA-regulated parking. This land could instead be used to increase the area of blue and green spaces within developments or to increase housing density – reducing the overall land footprint of housing.

The transport system is said to impact upon the climate in a number of ways – not only through direct emissions from burning petrol. For example, long commutes consume time that could otherwise be spent engaging in individual, sustainable practices or community organising around climate mitigation, such as becoming involved in community repair cafes or community renewable energy projects.

The potential conflict between decarbonising private vehicles and decarbonising heat was also mentioned. The “<electric vehicle transition>” will significantly increase “electricity demand from [the] transport sector”, increasing the “ave. price of electricity” and negatively impacting the “price ratio of heat pumps:grid heating”. This may deter households from investing in heat pumps and other renewable heat technologies powered by electricity.

## Appendix E: Frontrunner workshop appendix

### Original workshop agenda

TABLE E 1: PILOT WORKSHOP AGENDA

ACTIVITY	DESCRIPTION	PURPOSE
<b>Proposal and rating of interventions</b>	Participants individually brainstorm interventions in their sector, then report them back to the group for 'rating'.	Establish which interventions participants prioritise pre-modelling
<b>Intervention rating</b>	<p>Participants rate interventions based on their perceived level of impact on future wellbeing (in 2060).</p> <p>3 = "high, positive impact"</p> <p>2 = "medium, positive impact"</p> <p>1 = "low, positive impact"</p> <p>0 = "no impact"</p> <p>-1 = "negative impact"</p> <p>Note: participants can only rate <u>up to two</u> interventions as "high priority."</p>	
<b>(i) Model review</b>	Participants are given time to review assigned Causal Loop Diagrams, individually or in pairs.	Familiarise participants with the model
<b>(ii) Model editing</b>	Participants are given the opportunity to make revisions to the model if they disagree with any theoretical relationships or believe key elements are missing.	Facilitate social learning and learning about the system's structure
<b>(iii) Future scoping</b>	Participants are introduced to a number of emerging risks that threaten sustainable development in the Greater Cambridge, Greater Peterborough city-region and are then asked to reconsider their system models in light of 'future risks'. Any 'future' variables or new relationships are drawn in with blue pen to distinguish them.	
<b>(iv) Modelling proposed interventions</b>	Participants integrate 'interventions' proposed in the first activity into their diagram, regardless of the level at which interventions are 'actioned' (e.g., 'national' level).	Facilitate social learning and learning about system dynamics
<b>(v) Causal tree activity</b>	Participant draw causal trees from their assigned intervention to wellbeing	

	indicators (including causal links that feed through interconnected sectors), checking for any unintended consequences of intervention as they go. Findings are reported back to their breakout group.	
<b>(vi) Re-rating interventions</b>	Participants re-rate interventions based on their perceived impact on future wellbeing using the aforementioned scale	Establish which interventions participants prioritise post-modelling
<b>(vii) Rating interventions against the 'H&amp;W Performance Evaluation Framework'</b>	Participants review proposed interventions against the 'H&W Performance Evaluation Framework'. Based on the average group score, 1-2 'high priority' interventions are selected for each group, which are used in the following 'Getting into Action' activity to brainstorm real-world initiatives.	<ol style="list-style-type: none"> <li>1. Narrow down proposed interventions to 8-10 around which local initiatives can be designed (holds stakeholders accountable to the weighted objectives selected in previous visioning workshops)</li> <li>2. Observe to what extent the Evaluation Framework prioritises interventions differently from participants' personal evaluations</li> </ol>
<b>(viii) Getting into action</b>	Participants self-select into groups to brainstorm local initiatives that could act upon prioritised 'system leverage points'	Produce a list of 'transition experiments' that the Combined Authority and other local stakeholders can realise
<b>(ix) Post-workshop questionnaire</b>	Participants individually fill out the post-workshop questionnaire before the workshop closing.	<ol style="list-style-type: none"> <li>1. Gather reflections from participants regarding their experience with the co-modelling activities (activities iii to vii),</li> <li>2. Gather reactions to using the 'H&amp;W Performance Evaluation Framework' for narrowing down proposed interventions.</li> </ol>

## Missing stakeholders

**TABLE E 2: STAKEHOLDER GROUPS NOT REPRESENTED AT THE FRONTRUNNER WORKSHOP**

Theme	Stakeholders
HOUSING DEVELOPMENT	<ul style="list-style-type: none"> <li>- Real estate trust</li> <li>- Lenders (banks, building societies, and specialised mortgage companies)</li> <li>- Home builders federation</li> <li>- National Landlord Association</li> <li>- Community-led development (e.g., Community Land Trust)</li> </ul>
TRANSPORT	<ul style="list-style-type: none"> <li>- Highways England</li> <li>- Rail service providers</li> <li>- Bus companies</li> <li>- Walking &amp; cycling advocacy groups</li> </ul>
LOCAL/NATIONAL GOVERNANCE	<ul style="list-style-type: none"> <li>- Department of Communities and Local Government</li> <li>- Homes and Community Agency</li> </ul>
ENERGY	<ul style="list-style-type: none"> <li>- UK Power Network</li> <li>- National Grid</li> <li>- Green Deal accredited firms</li> <li>- mortgage companies offering energy improvement mortgages</li> <li>- Local colleges offering training in construction</li> <li>- Institute for Historic Building Conservation</li> </ul>
CLIMATE CHANGE ADAPTATION	<ul style="list-style-type: none"> <li>- Local Adaptation Advisory Panel</li> <li>- Insurance companies</li> </ul>
ACCESSIBILITY HEALTH & WELLBEING	<ul style="list-style-type: none"> <li>- National charities such as Age UK and Sense</li> <li>- Cambridgeshire and Peterborough NHS Trust</li> <li>- Cambridgeshire County Council and the Peterborough Unitary Authority social care</li> <li>- private social care providers</li> </ul>





## Research questions and methods of data collection and analysis

**TABLE E 3: RESEARCH QUESTIONS AND METHODS OF DATA COLLECTION AND ANALYSIS**

Research question	Data collected	Method of analysis
(1) How, and to what extent, did the workshop facilitate systems learning?	<p><b>(a) Rating sheet data</b> To investigate whether the co-modelling process facilitated learning about the system in which intervention is needed, participants were asked to twice rate the imagined impact of each intervention on future wellbeing – once before and once after the co-modelling exercises.</p> <p>-1 Negative impact</p> <p>0 Neutral impact</p> <p>1 Low impact</p> <p>2 Medium impact</p> <p>3 High impact</p> <p>If participants changed their rating after co-modelling exercises, they were asked to provide an explanation.</p> <div style="border: 1px solid black; padding: 10px; margin-top: 10px;"> <p><b>If your rating changed after the co-modelling exercise, please mark <u>all</u> the reasons that apply</b></p> <ul style="list-style-type: none"> <li><input type="radio"/> Using the model to support their reasoning, another participant explained why the intervention might be more/less useful than I originally thought.</li> <li><input type="radio"/> Without using the model, another participant explained why the intervention might be more/less useful than I originally thought.</li> <li><input type="radio"/> The unintended consequences presented in plenary revealed new considerations.</li> <li><input type="radio"/> The model revealed that the intervention might be more/less useful than I original thought.</li> <li><input type="radio"/> Other interventions were suggested that seemed 'higher' priority.</li> <li><input type="radio"/> Other (explain): _____</li> </ul> </div>	<p><b>(a) Rating sheet data</b> Test statistical significance of changes in prioritisation scores, excluding changes in scores made for reasons other than systems learning</p> <p><b>(b) Observation notes</b> Deductive and inductive thematic analysis of note-taker notes</p>

	<p><b>(b) Observation (see prompts 1 to 3)</b></p> <ol style="list-style-type: none"> <li>Co-modelling prompts <ul style="list-style-type: none"> <li><i>“Note down examples where participants’ assumptions were challenged by causal relationships discussed during the group editing process.”</i></li> <li><i>“Note down any examples where participants expressed ‘new learning’ as a result of the model structure (e.g., feedback loops).”</i></li> </ul> </li> <li>Rotation prompt <ul style="list-style-type: none"> <li><i>“How often were insights gained from previous co-modelling rounds referenced in your group discussion? What role did they play in map-editing process?”</i></li> </ul> </li> <li>Post-modelling rating prompt <ul style="list-style-type: none"> <li><i>“Did the process of moving between maps (to learn about interlinkages between systems) change the prioritization of interventions?”</i></li> </ul> </li> </ol>	
(2) How, and to what extent, did the workshop help build consensus around ‘system leverage points’?	<p><b>(a) Intervention rating sheet</b> Participant ratings + explanation for why they changed their rating issued before and after modelling</p> <p><b>(b) Post-workshop questionnaire</b> <i>Q: “How, and to what extent, did the workshop help build consensus on which interventions to prioritise?”</i></p> <p><b>(c) Observation (see Prompts 1 and 2)</b></p> <ol style="list-style-type: none"> <li>Co-modelling prompt <ul style="list-style-type: none"> <li><i>“Note down examples where discursive debate, supported by the co-modelling activity, changes participants’ views toward consensus on model structure.”</i></li> </ul> </li> <li>Intervention evaluation prompt <ul style="list-style-type: none"> <li><i>“Note down examples where discursive debate, supported by the Evaluation Framework, changes participants’ views toward consensus on intervention prioritization.”</i></li> </ul> </li> </ol>	<p><b>(a) Intervention rating sheet</b> Test statistical significant of pre-/post-model variation by group, where reduced variation = ‘improved consensus’</p> <p><b>(b) Post-workshop questionnaire</b> Inductive, thematic analysis of open responses</p> <p><b>(c) Observation</b> Deductive, thematic analysis of note-taker notes</p>
(3) How, and to what extent, did	<p><b>(a) Post-workshop Questionnaire (Item 1, Q4)</b> <i>Q4: “Are there any participants you are now more or less inclined to work with? Why? Note: We are more interested in</i></p>	<b>(b) Post-workshop questionnaire</b>

the workshop facilitate social learning?	<p><i>the ‘why’ than the ‘who’. (Remember, all responses are anonymous.)”</i></p> <p><b>(b) Observation (see prompts)</b></p> <ul style="list-style-type: none"> <li>- <i>“Throughout the workshop, did participants seemingly grow more or less open to learning from others? Please describe your observations and explain how you think this was facilitated by the workshop.”</i></li> <li>- <i>“Throughout the workshop, did participants seemingly grow more or less empathetic toward one another? Please describe your observations and explain how you think this was facilitated by the workshop.”</i></li> <li>- <i>“Do you believe the workshop helped build inter-personal relationships between any of the participants? If so who, and how do you think this was facilitated by the workshop?”</i></li> </ul>	<p>Inductive, thematic analysis of open responses</p> <p><b>(b) Observation</b> Deductive, thematic analysis of note-taker notes</p>
(4) How, and to what extent, did participation engender a sense of ‘ownership’ over the transition challenge and solution(s)?	<p>(a) Post-workshop Questionnaire (Item 1, Q5-7)</p> <p>5. Before having participated in today’s workshop, on a scale of 1 to 6, what level of ownership did you feel over the long-term challenges discussed today?</p>  <p>No ownership Full ownership</p> <p>6. After having participated in today’s workshop, on a scale of 1 to 6, what level of ownership did you feel over the long-term challenges discussed today?</p>  <p>No ownership Full ownership</p> <p>7. Please explain why your level of ownership over long-term challenges did or did not change as a result of today’s workshop</p> <p><b>(b) Follow-up survey 4 months after workshop</b> Questions to determine whether a ‘transition network’ has been (further) developed and whether stakeholders are progressing on any of the proposed initiatives</p>	<p><b>(a) Post-workshop questionnaire</b> Q5&amp;6: Test for statistical significance of workshop impact, where move to the right = improved ownership Q7: Thematic analysis of open response</p> <p><b>(b) follow-up survey</b> Deductive analysis of closed and open responses</p>
(5) How, and to what extent, did the workshop help strengthen or	<p><b>(a) Post-workshop Questionnaire (Item 1, Q1&amp;4)</b></p> <p>Q1: <i>“Moving forward, would you like to get involved in any of the initiatives proposed today? If so, which initiatives and in what capacity? If not, why not?”</i></p>	<p><b>(a) Post-workshop Questionnaire</b> Inductive, thematic analysis</p>

initiate a new 'Transition Network'?	<p>Q4: <i>"Are there any participants you are now more or less inclined to work with? Why? Note: We are more interested in the 'why' than the 'who'. (Remember, all responses are anonymous.)"</i></p> <p><b>(b) Follow-up survey 4 months after workshop</b></p> <p><b>(c) Observation</b></p> <ul style="list-style-type: none"> <li>- <i>"Did participants seem intent on scheduling future meetings with co-participants or others not at the workshop? Please describe your observations."</i></li> </ul>	<p>of open responses</p> <p><b>(b) Follow-up survey</b> Deductive analysis of closed and open responses</p> <p><b>(c) Observation</b> Deductive, thematic analysis of note-taker notes</p>
(6) Did the use of the 'evaluation framework' sufficiently steer outcomes? If not, why not (e.g., stakeholder co-optation, insufficient time to complete activity, workshop design, etc.)?	<p><b>(a) Follow-up survey 4 months after workshop</b> Questions to determine to what extent any progressed initiatives have diverted from interventions having scored highest under the 'Housing &amp; Wellbeing Evaluation Framework', and reasons for this diversion (e.g., co-optation; results of feasibility assessment; etc.)</p> <p><b>(b) Observation (see prompt)</b></p> <p>'Getting into action' activity prompt</p> <ul style="list-style-type: none"> <li>- <i>"Please note if initiatives drifted from the intended 'welling functions' of participants' selected interventions. What caused this drift?"</i></li> </ul>	<p><b>(a) Follow-up survey</b> Deductive analysis of closed and open responses</p> <p><b>(b) Observation</b> Inductive, thematic analysis of note-taker notes</p>
(7) How, and to what extent, did the use of the Evaluation Framework and/or CLDs affect stakeholder buy-in?	<p><b>(a) Post-workshop Questionnaire (Item 1, Q1&amp;3 and Item 3, Q1)</b></p> <p>Item 1/Q1: <i>"Moving forward, would you like to get involved in any of the initiatives proposed today? If so, which initiatives and in what capacity? If not, why not?"</i></p> <p>Item 1/Q3: <i>"Are there any initiatives proposed today that you would have liked to support, but which were excluded from the final activity? If so, which?"</i></p> <p>Item 3/Q1: <i>"Did you agree with selecting initiatives based on the 'Evaluation Framework'? Explain."</i></p> <p><b>(b) Observation (see prompts)</b></p> <ol style="list-style-type: none"> <li>1. Co-modelling prompt</li> </ol>	<p><b>(a) Post-workshop questionnaire</b> Inductive analysis of open responses</p> <p><b>(b) Observation</b> 1. Inductive, thematic analysis of note-taker notes</p>

	<ul style="list-style-type: none"> <li>- <i>"Note down when participants express frustration toward having to use the group model to review interventions. Why do you think this happened?"</i></li> </ul> <p>2. Intervention evaluation prompt</p> <ul style="list-style-type: none"> <li>- <i>"Note down when participants express frustration toward having to use the Evaluation Framework to review interventions. Why do you think this happened?"</i></li> </ul> <p>3. 'Getting into action' prompt</p> <ul style="list-style-type: none"> <li>- <i>"How and to what extent did the use of the Evaluation Framework and CLD during the 'intervention prioritization' activity affect stakeholder buy-in?"</i></li> </ul>	
(8) How, and to what extent, did the use of the Evaluation Framework improve the perception of process legitimacy by participating stakeholders?	<p><b>(a) Post-workshop Questionnaire (Item 3, Q1)</b></p> <p>Item 3/Q1: <i>"Did you agree with selecting initiatives based on the 'Evaluation Framework'? Explain."</i></p> <p><b>(b) Observation</b></p> <p>1. Intervention evaluation prompt</p> <ul style="list-style-type: none"> <li>- <i>"How, and to what extent, did the use of the Evaluation Framework improve the perception of process legitimacy by participating stakeholders? Please note any negative or positive comments re: the Evaluation Framework and its creation as part of aforementioned 'Visioning' workshops."</i></li> </ul>	<p><b>(a) Post-workshop questionnaire</b> Inductive, thematic analysis of open responses</p> <p><b>(b) Observation</b> Deductive, thematic analysis of note-taker notes</p>
(9) What technical barriers arose during the workshop?	<p><b>(a) Observation</b></p> <p>Co-modelling prompts</p> <ul style="list-style-type: none"> <li>- <i>"What technical challenges arose when adding sub-system interlinkages?"</i></li> <li>- <i>"What technical challenges arose when trying to map interventions onto the group CLD?"</i></li> <li>- <i>"What technical challenges arose during the causal tree activity?"</i></li> </ul> <p>Intervention evaluation prompt</p> <ul style="list-style-type: none"> <li>- <i>"What technical challenges arose when evaluating interventions against the 'Housing &amp; Wellbeing Evaluation Framework'?"</i></li> </ul>	<p><b>(a) Observation</b> Inductive, thematic analysis of note-taker notes</p>