Socio-technical Challenges to the Smart City: a citizen-centric perspective

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Abstract

By 2050, approximately 70% of the global population will be living in cities, catalysing both socio-economic and environmental challenges. Therefore, in order to ensure sustainable growth, cities around the world are adopting the concept of 'smart cities'. There is consensus that the smart city has the potential to address the urgent need for sustainable urbanism through innovations and ICT systems that are both designed to reduce energy consumption and carbon emissions, and that can provide high-quality living for its citizens. However, the concept has been broadly critiqued for being driven by technocratic agendas and not actually meeting the needs of the citizens. While recent initiatives claim to include citizens in smart city developments through collaboration and co-creation, there is significant debate regarding the extent to which this has stimulated a more inclusive approach. Consequently, to create a more citizen-centric smart city there remains a need to introduce citizens' perceptions and improve engagement. Institutions such as universities are playing an increasingly important role in the urban sustainability challenge and energy transitions in smart cities. Through conducting a survey of students (*n*=1007) living in the smart city district of Manchester, UK, this research found low awareness and understanding of the smart city concept, with three-quarters of respondents reporting they had never heard of the smart city. Moreover, interviews with smart city implementers (*n*=12) revealed contesting perceptions of 'smart'. Whilst both students and implementers placed technology at the heart of the concept, students understood it as a city that would ensure protection of the environment whilst implementers adamantly claimed it would increase quality of life of citizens. However, when implementers described the role of citizens in the smart city, this research found that their perceptions were underpinned by a tokenistic rhetoric. Furthermore, by adopting a co-creational approach with citizens, this research explored the potential for smart solutions to overcome a split incentive scenario energy challenge. An Innovation Challenge (*n*=13) and focus groups with students (*n*=49) found encouraging indications that provision of contextualized information using intuitive visual cues which, coupled with gamification, could change students' energy behaviours in halls of residence where financial drivers do not exist.

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List of Abbreviations and Acronyms

AI	Artificial Intelligence
ANT	Actor Network Theory
App	Application
BSL	Birley Student Living
CCA	Climate Change Act
CCTV	Closed-circuit Television
CO_2	Carbon Dioxide
DECC	Department of Energy and Climate Change
DPD	Data Protection Directive
EU	European Union
EPC	Energy Performance Certificate
GHG	Greenhouse Gas
HESA	Higher Education Statistics Agency
ICT	Information and Communication Technology
IoT	Internet of Things
IT	Information Technology
KPI	Key Performance Indicators
Manchester Met	Manchester Metropolitan University
MOH	Multiple Occupancy Housing
NEP	New Ecological Paradigm
NO_2	Nitrogen Dioxide
ONS	Office for National Statistics
Qual	Qualitative
Quan	Quantitative
SME	Small Medium Enterprise
STS	Socio-technical Systems
T&C	Terms and Conditions
TAM	Technology Acceptance Model
UK	United Kingdom
VR	Virtual Reality

Chapter 1. Introduction

Approximately 55% of the world's population now live in cities and with an annual growth of around 2%, this will rise to approximately 70% by 2050 (World Bank 2018a; b). While, urbanisation continues to be an enabler for economic growth, it has provoked new challenges such as social inequalities and significant environmental issues (Harvey, 2012; While and Whitehead, 2013).

In past debates, scholars attempted to generalise cities, theorising them as closed entities with set internal dynamics (Amin and Thrift, 2002). However, the more recent drivers for urbanisation such as globalisation, neo-liberalism and the digitalisation of society have changed cities from closed to open systems, where external factors are being recognised for their impacts on the city (Emery, 2000; Davis et al., 2014). Therefore, as these new urban trajectories continues to shape society and space, this produces new understandings of cities due both to their diverse nature and that of their citizens (Amin and Thrift, 2002).

As a result, several competing strategies for tackling contemporary urban challenges have emerged. There is general consensus that urbanism must be dealt with in a sustainable manner to accommodate further growth (Farr, 2008). This has led to the concept sustainable urbanism which is now the most commonly used term in this discourse. However, there are several barriers to optimising sustainable urbanism, the main barrier being human behaviour.

The concept of the smart city has emerged as one of the most applied solutions in contemporary urbanism (de Jong et al., 2015). The concept is dominantly defined and catalysed by IT corporations, with citizens' perceptions in the implementation process remaining limited. Whilst the term 'smart' is ambiguous, the concept uses technologies and information and communication technology (ICT) systems to lower energy consumption and reduce emissions whilst increasing the quality of lives of citizens (Caragliu et al., 2011). As such, data driven agendas of smart city initiatives decide what the problems in smart cities are and what the solutions should be.

1.1 The Research Problem

Citizens' understandings and perceptions of the smart city are almost absent from this discourse, and although the academic literature highlights concerns and benefits about the concept from a citizen perspective, these are not voiced by citizens themselves. Whilst implementers of the smart city claim to increasingly move towards more citizen-centric agendas, it is highly debatable whether they are and if this in fact produces more inclusive smart cities (Cardullo and Kitchin, 2018a; Engelbert et al., 2019). However, as society becomes increasingly automated, it begs the question what the role of the citizen is in smart cities and what type of citizen has a role in the smart city.

Some smart city technologies intended to overcome challenges within smart city contexts are subject to human behaviour. An example of this is smart energy technologies aimed at lowering energy consumption in households. Therefore, smart solutions should be explored in collaboration with citizens in order to co-design inclusive solutions and to ensure participation in the implementation and use of these. Moreover, in a more general sense, there is a need to include citizens in defining problems and solutions to urban challenges in order for smart cities to achieve their overarching environmental aspirations.

Thus, this research is exploratory in nature and framed by the following aim:

To critically analyse socio-technical challenges to smart city implementations and aspirations.

1.2 Thesis Outline

The overall structure of the thesis is illustrated in Figure 1.1 and each chapter is summarised below.

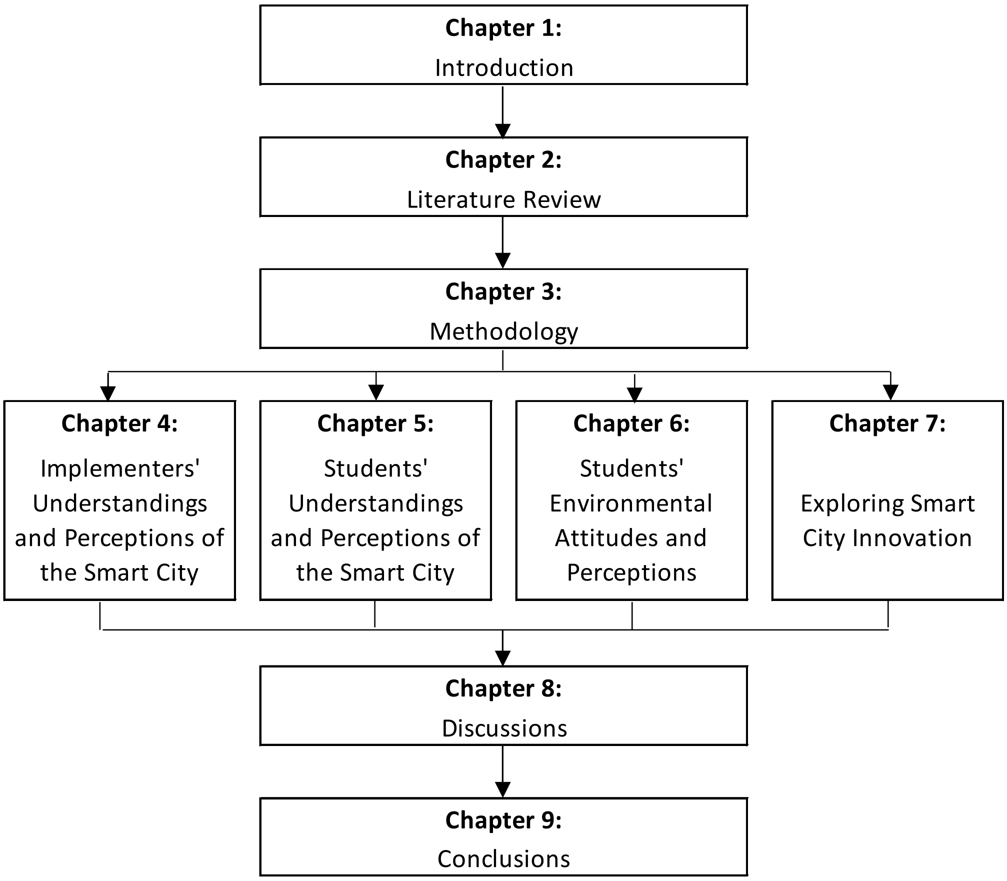

Figure 1.1. Outline of Thesis

Chapter 2 comprises of a literature review that provides the context for the thesis. It examines contemporary urbanism and associated challenges, sustainable urbanism and the barriers to achieving this, the ‘smart’ label, the conceptual background of the smart city and broader concerns about the concept, smart citizenship as well as specific energy challenges in the smart city and the potential for smart solutions to overcome them. The overall research aim and associated objectives are presented in conjunction with the summary.

Chapter 3 provides justification of the research methodology, starting with a discussion of the chosen philosophical paradigm and research design and methods. This study adopted a pragmatist philosophy employing mixed methods and utilised fully qualitative methods; semi-structured interviews, focus groups and workshop-based research, and a pure mixed cross-sectional survey-based questionnaire.

Chapter 4 presents the results from the interviews with smart city implementers, analysing their understandings and perceptions of the smart city concept, including perceived benefits and concerns, and their perceived role of citizens in smart cities.

Chapter 5 presents the results from a student survey examining their understandings and perceptions of the smart city, including perceived benefits and concerns about the concept.

Chapter 6 reports the results from another part of the student survey that examined their environmental attitudes and perceptions, as well as their experience with seeing and responding to real-time energy information.

Chapter 7 presents the results from a workshop-based Innovation Challenge and focus groups with students exploring the potential for a smart solution to overcome barriers to energy conservation in the split incentive scenario of Birley Student Living.

Chapter 8 brings together the results from the three strands of research and provides triangulation-based discussions of the findings. Here, the empirical work will also be placed against the broader context of the published literature.

Chapter 9 draws primary conclusions based on the discussions in Chapter 8 and includes theoretical contributions to knowledge. It also outlines recommendations for future research inquiries.

1.3 Contribution to Knowledge

This research is both novel and timely, especially as more cities around the world are adopting the smart city concept as a response to urban challenges (de Jong et al. 2015). Furthermore, as critiques demand more citizen-centric smart cities, smart city initiatives are required to engage citizens more in smart city in order to successfully achieve this.

The work contributes to literature developed by key smart city critics such as Cardullo and Kitchin (2018a; b) who look at citizen participation in the smart city, and Vanolo (2014; 2016) and Shelton and Lodato (2019) who examine the role of the 'smart citizen'. The research also contributes to the debates regarding co-creation of smart solutions to overcome urban energy challenges (Evans and Karvonen, 2014; Voytenko et al., 2016). Moreover, the work contributes to the technocratic critiques of the 'smart' label developed by scholars such as Hollands (2008) and Söderström et al. (2014). Additionally, the research expands on broader concerns with the concept from a citizen-centric perspective (Leszczynski, 2016; Grossi and Pianezzi, 2017; van Zoonen, 2016).

As little is currently known about citizens' understandings and perceptions of the concept, the main contribution of this research is to bring citizens voice into the smart city discourse. From a practical perspective, this research is of interest to smart city initiatives as it identifies socio-technical challenges to implementations, especially from a citizen perspective.

The empirical work has also achieved a number of research outputs including conference presentations, and a published magazine article in the *Journal of the Institution of Environmental Sciences* entitled 'Gamification in a Living Lab: Energy saving challenges in student halls' which is based on preliminary results from the part of the student survey presented in Chapter 6 (see Appendix 12 for all research outputs).

Chapter 2. Literature Review

2.1 Chapter Outline

Section 2.2 critically reviews the characteristics of contemporary urbanisation and the factors driving this urbanism. Section 2.3 assesses the main socio-ecological challenges contemporary cities face, whilst 2.4 reflects on how sustainable urbanism addresses these challenges. Section 2.5 outlines the barriers to sustainable urbanism and how cities attempt to overcome them. Section 2.6 introduces smart urbanism followed by a terminological discourse of the ‘smart’ label in 2.7. Section 2.8 expounds the smart city followed by a critical evaluation of the concerns associated with the concept in 2.9. Section 2.10 investigates the ‘smart citizen’ through a review of citizen engagement debates in the smart city along with a review of tools and theories related to environmental behaviour and technological solutions. Finally, section 2.11 provides a summary of the literature review followed by the aim and objectives.

2.2 Urbanisation

When the industrial revolution occurred between 1750 and 1850, people moved to cities for employment. As personal income rose in correlation with the population growth, urbanisation flourished in the western world (More, 2000). Castells (1977:9) highlights two distinct understandings of urbanisation: (1) “The spatial concentration of a population on the basis of certain limits of dimension and density”, and (2) “The diffusion of the system of values, attitudes and behaviour called 'urban culture’”. Since then, cities have increasingly become attractive to live in for better access to public services, and opportunities for innovation and business outputs (Storper and Scott, 2009). Unlike historic urbanisation, contemporary urbanisation is different in scale, rate, location, form, urban life and function (Seto et al., 2010). Therefore, the implications of urbanisation are expanding in scope and with the rapid global population growth. Contemporary cities go beyond geographical boundaries where sub-urban areas and hinterlands are economically and politically tied to that of cities (Brenner, 1999; Amin and Thrift, 2002).

The way in which this new urbanisation shaped cities also brought with it the ideology of neo-liberalism upon which contemporary policies are based. Through neo-liberalism, the free market has been enhanced by increasingly mixed private and public services and together with globalisation, cities are at the forefront of innovation and individualism (Leitner et al., 2007). However, not all cities have experienced a boosted economy as a result of globalisation and neo-liberalism (Harvey, 2006). On the contrary, they have undergone gentrification and urban shrinkage (Smith, 2002; Hubbard, 2006; Martinez-Fernandez et al., 2012). This has resulted in the expanded boundaries of cities with increased urban sprawling and suburbanisation (Scott and Storper, 2003; Martinez-Fernandez et al., 2012). Again, this is mostly witnessed in already industrialised cities, whereas in countries undergoing a technological shift, urbanisation is expanding (Martinez-Fernandez et al., 2012).

It is important to note that urbanisation is not a homogenous process as cities differ in nature, especially between developing and developed countries (Amin and Thrift, 2002; Seto et al., 2010). Whereas urban transitions have to a great extent occurred in Europe and America, the urbanisation witnessed today is mainly expanding in Asia and Africa, especially in countries like China and India (Castells, 2010; Seto et al., 2010). While there are some main and common drivers for global urbanisation, modern cities have evolved into intricate socio-technical systems (STS) (Graham and Marvin, 2001; Newton, 2012; Luque-Ayala and Marvin, 2015), which means different cities have diverse needs and aspirations. As parts of the world have evolved differently, contemporary cities are therefore difficult to generalise as they are open systems influenced by global economic, environmental, political, societal and technological factors (Urry, 1995; Amin and Thrift, 2002). These complex socio-economic dynamics and political processes driving contemporary urbanisation were enhanced by the technological revolution of the twentieth and twenty-first century, truly changing how citizens interact with their cities and the global environment (Castells, 2010; Seto et al., 2010). New “distance shrinking technologies” (Taylor, 2000:6) emerged which in turn facilitated increased communication across the globe, amplifying mobility of people, products and services (Sassen, 2001; Urry, 2001; Castells, 2010). Increased mobility has facilitated new means of urban lifestyles, and these new technologies and the way in which they are utilised enabled globalisation to flourish. Additionally, centralisation of public services has shaped cities into economic, political and cultural hubs of countries with urban living becoming an increasingly attractive choice of life (Urry, 1995; Sassen, 2002; Amin, 2006; Seto et al., 2010).

There are both push and pull factors driving for people moving to cities. While, some urban population growth can be explained by natural global population growth, many migrate to cities for work and other economic reasons rural areas cannot offer (Bulkeley and Betsill, 2003). Many also move to cities nowadays as it offers a certain lifestyle (Seto et al., 2010; Martinez-Fernandez et al., 2012). With global trade, a competitive free market and a highly digital society, the freedom of choice has never been greater (Sennet, 2006; Seto et al., 2010). Availability of products and services are versatile and moving to urban areas offer a certain lifestyle where access to a wide range of global goods are available. With this availability, there are several ways in which cities manifest themselves in everyday life and how citizens interact with the city, thereby shaping their identity (Amin and Thrift, 2002; Giddings et al., 2002). Moreover, this has resulted in an increased part of the world practicing a western lifestyle. Coupled with more people inhabiting urban areas, social and environmental challenges are on the rise, and there are urgent calls for solutions to address them (Farr, 2008).

2.3 Main Challenges

Cities are locations of high consumption and waste production (Bulkeley and Betsill, 2003). With the urban population growing, contemporary cities have an increasing energy demand, approximately 75% of global production (Lazaroiu and Roscia, 2012). Greenhouse gas (GHG) emissions have become more concentrated and urban areas account for around 80% of CO_2 emissions (Bulkeley and Betsill, 2003; Lazaroiu and Roscia, 2012). Cities have also seen an increase in traffic which is causing heavy congestion, contributing to the increase in air pollution. Additionally, urban population growth has provoked housing shortages and many places have difficulties providing sufficient accommodation in correlation with the population growth (Gauzin-Müller, 2002).

This has resulted in an amplified contribution to climate change in cities, with a stronger need to meet climate change targets. There are global legislations such as the Kyoto Protocol (UN, 1998) and the Paris Agreement (UN, 2015) to ensure countries are legally bound and committed to emission reduction targets. Through the Climate Change Act (CCA), the UK has committed to reduce emissions by 80% from the 1990 baseline by 2050 (DECC CCA, 2008, Sec. 1, §1). Whilst climate change is not a threat exclusive to cities, it has become increasingly important for cities to address as they are responsible for 80% of emissions as mentioned above. This has led cities to strategically focus on reducing energy consumption and lowering CO_2 emissions in order to meet climate change targets (Urry, 2011).

With urban energy consumption and GHG pollution on the rise, there is a call for an energy transition to cleaner and greener energy systems in cities. This has resulted in higher demands for more self-sufficient energy solutions such as solar panels and other renewables (Schiermeier et al, 2008). However, energy is presented as a trilemma that is difficult to achieve. The energy trilemma has three dimensions: energy must be reduced in order to lower GHG emissions, security of reliable energy supply must be ensured, and energy must be accessible and affordable for all (Heffron et al, 2015; Broto, 2017). These are often seen as competing demands and facilitating all of them is difficult. Failing to deliver all dimensions of the trilemma can lead to social and environmental inequalities, and barriers to inclusive urban growth.

Therefore, these challenges have prompted new urban trajectories to tackle them. While there are clearly many challenges to contemporary cities, high density areas provide manageable opportunities for increased sustainable urban development.

2.4 Sustainable Urbanism

As a response to these challenges, the concept of sustainable development emerged to accommodate growth. The concept of sustainable development was defined in World Commission on Environment and Development's Brundtland Report as:

> "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987:37).

However, using the concept of sustainable development to address challenges around the world has met critique as there are still several interpretations on how it should be carried out in practice (Sneddon et al, 2006). The sustainable economic growth encouraged often challenges the utilisation of natural resources as well as the administration of the environment. It has also been suggested that sustainable development fails to address stakeholders acting unsustainably in favour of their own monetary gains (Sneddon et al, 2006). These new economic aspirations often have tensions with social issues and usually, citizens have relied on the government to fix the problems (Seto et al, 2010). However, with a less powerful state and a stronger free market, underlying social urban problems are being neglected at the cost of economic sustainability (Harvey, 2006; 2012). Based on the 80% emission reduction target set in the CCA (2008, Sec. 1, §1), DECC's (2012) policy "Energy Security Strategy" presents compromising guidelines for sustainable development through utilisation of fossil fuels, though stating needs for technological innovation for renewable energy. It demonstrates governmental investments for low carbon solutions and attempts price security for consumers which is especially applicable for people living in fuel poverty and low Energy Performance Certificate (EPC) rated properties in the private rented sector, both domestic and non-domestic (Ástmarsson et al., 2013; DECC, 2014). Yet, a market driven approach to energy supply is dominant (DECC, 2012) which means despite initiatives trying to move towards a greener economy, the market for fossil fuels is still vibrant and the reliance on those resources remains strong.

Despite the growing concerns regarding migration to cities, dense urban areas provide excellent platforms for developing solutions for efficient energy systems. However, whilst making systems more efficient is beneficial, it is also worth noting that it has been suggested that greater efficiency can lead to increased consumption (Schiermeier et al, 2008). Nevertheless, sustainable development has become an integral part of contemporary government policies and a key element when addressing sustainable *urban* development (Bulkeley and Betsill, 2003). Sustainability has not always been central in urbanism (Roggema, 2016), but with cities being perceived as vulnerable to climate change, this has become an increased priority (While and Whitehead, 2013). This approach has been named sustainable urbanism, and is built on the concept of sustainable development, but adapted to an urban context. Sustainable urbanism has been defined as:

> "…walkable and transit-served urbanism integrated with high performance buildings and high-performance infrastructure" (Farr, 2008:42).

Nevertheless, the definition of sustainable urbanism provided by Farr (2008) suggests that the concept is highly technology focused. In theory, this demonstrates a weak sustainable development approach, where the notion is that natural capital can be exhausted as long as technological innovation and machinery compensates for these factors (Hopwood et al., 2005). This has been critiqued for not ensuring that the social dimension is emphasised. While the social dimension to sustainable urbanism is widely accepted as part of the concept, it is ambiguous as to what it involves (Dempsey et al., 2009). Ambiguity has led to several different approaches being adopted to achieve sustainable urban development in contemporary cities such as for example co-creation which urges as an inclusive approach with collaboration between citizens and stakeholder groups (Roggema, 2016). There are however several barriers to implementing sustainable urbanism.

2.5 Main Barriers

Whereas some implementation barriers to sustainable urbanism are conscious and manageable determinants, some uncertainties are more unpredictable (Roggema, 2016). Boost in migration and advancements in technological development are typical wicked problems (Rittel and Weber, 1973; Castels et al., 2014). Coupled with rapid urbanisation, especially for cities in environmentally vulnerable areas, having to deal with the impacts of global warming is challenging (While and Whitehead, 2013). Additionally, enforced transitions to green or low carbon economies urge cities into transformations (Roggema, 2016). It can be argued that the neo-liberal market has acted as a barrier to achieving all the elements of sustainable urban development due to economic growth being prioritised above social and environmental sustainability (Giddings et al., 2002; Harvey, 2006; Dempsey et al., 2009; Seto et al, 2010). While economic sustainability is contributing to green growth, this has downplayed the importance for protecting the environment and maintaining spatial and social equalities (Roggema, 2016). As demonstrated in the previous section, underlying urban problems can often be left undealt with in contemporary policy. In 1968, Lefebvre emphasised in his book ‘The Right to the City’ that capitalism had transformed urban space and governance into exclusive privileges for a minority of citizens (Harvey, 2008). Harvey (2008) argued that it should be within all citizens’ rights to access urban resources and to be included in reshaping the city. In modern time, Lefebvre’s ideas have been revived and prompted The United Nations (UN) to promote what they call ‘The New Urban Agenda’ in Habitat III which focuses on types of poverty, reduction of inequality, inclusive growth and how to achieve sustainable development (UN, 2016).

While this has increased the focus on citizens in sustainable urbanism, there are critiques suggesting that local governments still have an insufficient dialogue with citizens, leading to low participation in urban developments (Dempsey et al., 2009). The main actors in developing sustainable urbanism are local governments due to their influence over transport and energy management, and institutions such as universities and corporate organisations. However, there are calls for the need to accept citizens as equal, if not more important, actors in the implementation of sustainable urbanism in order to ensure social justice (Bulkeley and Betsill, 2003). In addition, individual behaviour of citizens is also a major contributor to environmental issues. Domestic household energy consumption is an important dimension in order to reach the climate change targets as it is a major contributor to cities energy consumption (Martiskainen and Coburn, 2011). Therefore, coupled with city level solutions, citizens must change their behaviour and lower their consumption in order to achieve climate change targets and mitigate climate change (Urry, 2011).

Nevertheless, there is a certain avoidance to engage citizens in these agendas as human behaviour can be considered a barrier to implementation of sustainable urbanism. This is due to the complex nature of human behaviour as humans do not always act rational (Boyd and Crawford, 2012) and the freedom of choice in contemporary cities is diverse (Seto et al., 2010). Therefore, human behaviour can be seen as the main barrier to sustainable urbanism (Urry, 2011). The understandings of sustainable urbanism such as the one provided by Farr (2008) is by definition technocratic. This means the current perception is that technological innovations can compensate for negative exploitations of the natural environment. In order to achieve sustainable urbanism and tackle the unsustainable behaviour of humans, smart technologies emerged. These technologies are designed to manipulate actions and overcome the human behaviour barrier (Martiskainen and Coburn, 2011).

2.6 Smartness

2.6.1 Smart Technologies and IoT

In the light of the digital revolution to solve urban environmental challenges, smart technologies have emerged and become an integrated part of modern everyday life. Attempting to address the barriers to sustainable urbanism, smart technologies use artificial intelligence (AI) including interfaces and algorithms to adapt to human behaviour, displaying information to assist people in making more efficient decisions (Wilson et al., 2017). In addition, everyday household objects are increasingly being designed to have internet connection and being controllable through for example apps.

These ubiquitous solutions have collectively been given the term Internet of Things (IoTs) (Stojkoska and Trivodaliev, 2017).

Today, smart technologies and IoTs are both part of ubiquitous computing and crucial in planning public spaces and are broadly adopted for increased home control. However, the perception that these technologies will aid the urban energy transition is strongly rooted in the technocratic belief that all will adopt, interact with and respond rationally to the information provided by these interfaces (Geels and Smit, 2000; Geels, 2004; Boyd and Crawford, 2012). This view does not account for the unpredictable human interactions with technologies or unintended consequences. Therefore, this has led to the critique of building urban futures on these technologies, suggesting it fosters speculative future planning as the behavioural impact of emerging smart technologies remains diffuse (Geels and Smit, 2000; Leszczynski, 2016).

Despite broad adoption of smart technologies and IoTs into our homes, there is solid evidence of end-user resistance and concerns around the quantification of behaviours. This has especially manifested itself in the national roll out of smart meters where many people refuse to have one installed or in arguments stating that the quantitative data gathered by smart meters do not explain everyday behaviours of users (Cardullo and Kitchin, 2018a). Whilst smart meters aim to turn energy into something tangible for residents, it has been found that end-users often have little trust in the utility companies offering the smart meters and the public struggle to understand the value a smart meter add to their homes (Wilson et al., 2017). In contrast, many other smart technologies and IoTs are voluntary purchases and end-users see them as a positive contribution to their homes (Balta-Ozkan et al., 2013; Wilson et al., 2017). Nonetheless, some may perceive smart technologies as pervasive and intrusive, especially if end-user benefits are unclear (Graham, 1998; Wilson et al., 2017).

Debates therefore continue around the importance of social aspects of smart technologies, with several studies suggesting there is a need to involve end-users in a co-creation process to ensure that the technology solves the defined problem and that the benefits of the technologies are clear and relevant (Evans et al., 2015; McFarlane and Söderström, 2017; Voytenko et al., 2016). Therefore, to address the critique of the lack of understanding of complex human technology interactions to aid the urban energy transition, smart technology solutions are being tested in real-life settings such as living labs. A living lab approach:

> "…offers a collaborative platform where professionals from different disciplines work together with future users and public and private stakeholders to generate solutions that are rooted in the dynamics of daily life practices" (Herrera, 2017:9).

While living labs can drive innovation through the co-production of knowledge, they are also limited in terms of replicability and sustained long term effects on behaviour change. This is a common issue found in intervention studies (Steg and Vlek, 2009, Yun et al., 2013) and whilst utilising living labs to study these interactions, some of the broader urban challenges can be hard to consider and assess within such smaller controlled environments (Evans and Karvonen, 2014; Evans et al., 2015). Therefore, using smart technologies in the agenda towards urban energy transitions can facilitate sustainability, however, there are socio-technical factors implicating on this challenge that remains unexplored (Chourabi et al., 2012). These must be disentangled and addressed, although, the term 'smart' remains somewhat ambiguous which can potentially act as a barrier to implementation.

2.7 The 'Smart' Label

The 'smart' label is frequently used to describe a variety of objects, but also extending beyond the technical to labelling even people smart (Strengers, 2013). However, there is ongoing debate as to what the label truly entails. Defining 'smart' is problematic due to the various understandings (Hollands, 2008; Vanolo, 2014). There is no universal agreement as to what 'smart' entails (Angelidou, 2014; Caragliu and del Bo, 2015) and the label remains ambiguous. Contesting terminologies have largely been driven by Information Technology (IT) companies and therefore, scholars have critiqued the label for being a constructed buzzword to market technocratic urban agendas (Hollands, 2008; Söderström et al., 2014). As Söderström et al. (2014) argue, smart is fabricated 'corporate story telling' controlled by technology driven governmentalities and organisations.

Also, the academic literature demonstrates many different understandings. Strengers (2013:1) states that 'smart' entails an ideal that focuses on "efficiency, security and utilitarian control" within an environment facilitating advanced technology. 'Smart' also includes information and communication technology (ICT) systems and energy efficient technologies (de Jong et al., 2015). The understanding from an engineering and computer science perspective is techno-centric and that 'smart' requires little to no human interaction (Batov, 2015; Eremia et al.,2017; Lacinák and Ristvej, 2017). It also focuses on 'smart' as intelligent systems with broad use of ICT and technological infrastructure to solve real-life problems (Nam and Pardo, 2011). While these understandings are based on ICTs, Strengers (2013) also argue that 'smart' is not limited to technologies, but also stretches to that of people. Therefore, technology alone does not make up the meaning of 'smart'. The adjective 'smart' also includes knowledge and intelligence (Hollands, 2008; Vanolo, 2014; Albino et al., 2015). Despite these understandings demonstrating what can be interpreted as a somewhat positive take on urbanism, there is something fundamentally problematic in the way the 'smart' label is applied as a prefix in different sectors (Hollands, 2008; Paulin, 2016). Therefore, not only does it demonstrate definitional issues as a jargon heavy term, but in recent years, these smart technologies have shaped competitive urban agendas. The application of 'smart' in the urban context is increasingly being referred to as 'smart urbanism' (Luque-Ayala and Marvin, 2015; McFarlarne and Söderström, 2017; Taylor Buck and While, 2017; Martin et al., 2019).

From governance to economy and people, cities are practicing 'smart' in all aspects of the urban environment, and smart urbanism is the latest re-interpretation of sustainable urban development. With the technology focused definition of sustainable urbanism given by Farr (2008), it is evident that this understanding has gained strong roots in recent years. The use of smart technologies and IoTs has transformed urban life and systems, with emphasis on rational human actions and increasing efficiency (Hajer and Dassen, 2014; Hollands, 2014). Whilst a city that runs clean and smooth is pleasant in theory, several scholars agree that it can be described as a technocratic utopian imaginary (Datta, 2015; Anthopoulos, 2017). High-tech, smart, clustered areas that drive innovation such as for example Silicon Valley have become the ideal aspiration for many cities (Townsend, 2013; de Jong et al., 2015) and not unlike sustainable urbanism, the deployment of smart technologies is expected to solve urban sustainability challenges. Smart urbanism has become a neo-liberal response to austerity (Luque et al., 2014) and at the forefront of this new form of urban development are technocratic governmentalities and IT companies (Kitchin, 2013; Söderström et al., 2014). However, this has fuelled the critique that smart urbanism focuses on economic growth through innovation and underlying social and cultural issues are greatly downplayed (Hollands, 2008). This has led to discussions around potential tensions between the smart and the sustainable (Martin et al., 2018). Whilst the economic growth of smart urbanism can benefit businesses, it prompts higher resource demand which long term is unsustainable (Viitaen and Kingston, 2014). The pressure on urban eco-systems is almost neglected in the smart urban vision and critics suspect that the environmental benefits of individual smart technologies are limited due to expectations of rational responses to information provided through them (Karvonen, 2013; Martin et al., 2018). In the dystopian imaginary associated with the concept, there is a risk that innovation will be unevenly distributed and that smart technologies will marginalise and disempower the citizens as they become living sensors rather than creating a platform where they can make informed and efficient decisions (Hollands, 2014; Viitaen and Kingston, 2014). This therefore poses questions as to how successful the practical applications of these visions are.

Despite the contesting understandings of 'smart', the assembly of smart technologies and IoTs have been conceptualised in the urban context in the past years. The concept of 'Smart City' is frequently being used and is now the most quoted concept when addressing the sustainable urbanism discourse (de Jong et al., 2015). Governments are increasingly embracing the concept and basing their policies and future agendas on the smart city model. Nevertheless, conceptualising the city with such an ambiguous idea has established strong and broad critiques among scholars. Equal to the terminological debate around 'smart', discussions continue around what the smart city is and can achieve.

2.8 The Smart City

2.8.1 Conceptual Background

Cities have illustrated several concepts aiming to achieve sustainable urbanism such as sustainable, smart, resilient, low carbon, eco and knowledge cities (de Jong et al., 2015). While each concept approaches sustainable urbanism differently, the three sustainable development components of environment, economy and society are central in all initiatives. For example, whilst low carbon cities focus on emission reduction to meet zero emission targets, eco-cities value harmony with nature and environmental protection. In contrast, knowledge cities are more associated with economic improvements and innovation. Nevertheless, de Jong et al. (2015) found that the most frequently mentioned concept since 2011 in the sustainable urbanism discourse is that of 'Smart Cities'. Smart cities generate large, real-time datasets through deployment of ICTs and the Internet of Things (IoT), empowering citizens to make informed and efficient decisions. There is a general agreement that the smart city model addresses the urgent need for sustainable urbanism by focusing on innovations and ICT systems ultimately designed to reduce energy consumption and carbon emissions and provide high-quality living for its citizens (Hollands, 2008; Caragliu et al., 2011; Vanolo, 2014; de Jong et al., 2015; Donohue and Biggs, 2015).

However, there is currently no uniform understanding, and the concept remains ambiguous and poorly defined. The broader European working definition of the concept is:

> "(S)ystems of people interacting with and using flows of energy, materials, services and financing to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society" (EIPSCC, 2013:5).

Though many attempt to define the smart city based on their understanding of the concept, the literature has scoped out a set of suggested domains by which a smart city can be understood: Smart economy; Smart environment; Smart energy; Smart mobility; Smart governance; Smart living and Smart People (Giffinger and Gudrun, 2010). Each of these are illustrated in Figure 2.1.

SMART ECONOMY (Competitiveness)	SMART PEOPLE (Social and Human Capital)
▪ Innovative spirit ▪ Entrepreneurship ▪ Economic image & trademarks ▪ Productivity ▪ Flexibility of labour market ▪ International embeddedness ▪ *Ability to transform*	▪ Level of qualification ▪ Affinity to lifelong learning ▪ Social and ethnic plurality ▪ Flexibility ▪ Creativity ▪ Cosmopolitanism/Open-mindedness ▪ Participation in public life
SMART GOVERNANCE (Participation)	**SMART MOBILITY (Transport and ICT)**
▪ Participation in decision-making ▪ Public and social services ▪ Transparent governance ▪ *Political strategies & perspectives*	▪ Local accessibility ▪ (Inter-)national accessibility ▪ Availability of ICT-infrastructure ▪ Sustainable, innovative and safe transport systems
SMART ENVIRONMENT (Natural resources)	**SMART LIVING (Quality of life)**
▪ Lack of pollutionof natural conditions ▪ Pollution ▪ Environmental protection ▪ Sustainable resource management	▪ Cultural facilities ▪ Health conditions ▪ Individual safety ▪ Housing quality ▪ Education facilities ▪ Touristic ▪ Social cohesion

Figure 2.1. Domains and criteria for Smart Cities (Giffinger and Gudrun, 2010:14-15)

Together with the domains in Figure 2.1, certain characteristics have been identified that conceptualises the features of the ideal smart city (de Jong et al., 2015). The specific characteristics acknowledged in the literature are illustrated in Table 2.1.

Table 2.1. Characteristics of Smart Cities (After: Caragliu et al., 2011:67-69)

Characteristics of Smart Cities
Improving administrative and economic efficiency and enabling the development of culture and society by utilizing networked infrastructures.
An underlying emphasis on business oriented urban development.
A strong focus on the goal of realizing the social inclusion of different kinds of urban residents in public services.
Emphasizing the significant role of high-tech and creative industries in long-term growth.
Paying close attention to the function of social and relational capital in city development.
Taking social and environmental sustainability as an important aspect of smart city development.

These characteristics consider social, economic, environmental and technological factors by linking them together. It is, therefore, suggested that the smart city requires technology and data to be deployed within a broader context to achieve a successful dynamic and not consider technology as an individual factor (de Jong et al., 2015).

As discussed in the previous section the term 'smart' articulates the typical wicked problem reflected in the widespread interpretations of the concept (Rittel and Webber, 1973; de Jong et al., 2015). Though the identified conceptualisation of the ideal smart city demonstrates a balanced relationship between society and technology, it is debated whether this is the reality (Hollands, 2008). Currently dominated by a techno-centric understanding (Söderström et al., 2014), ICT systems are expected to solve urban environmental issues as well as increase the quality of life for citizens (Bolton and Foxon, 2015). The key belief is that the smart technologies will boost efficiency throughout the mentioned domains in Figure 2.1 (Giffinger and Gudrun, 2010; Lazaroiu and Roscia, 2012). Nevertheless, this high dependency on technology as a problem solver leaves a number of social concerns unaddressed. This suggests that there is a disagreement whether the principles of smart cities will successfully provide urban sustainability (Tainter, 2011; Townsend, 2013).

Smart cities can therefore be understood as complex STS where both technological and social determinism influences behaviour change (Carvalho, 2014). STS theory is based on the ideology of joint optimization between society and technology and the co-evolution of the two (Trist, 1981; Carvalho, 2014). The first attempted definition of the concept was coined by Cooper and Foster (1971:468): "The interaction of social and technical systems constitute the socio-technical system". With today's globalisation and interconnected societies, STS are open systems (Emery, 2000; Challenger and Clegg, 2011; Davis et al., 2014). This aligns with, Eason's (2008) interpretation that STS is a collective term that can be used for any system in which ICT is utilized as a method of communication. Although socio-technical theory focuses on social interactions with technology, it does not consider how technology may interact with people (Leonardi, 2012).

There has been an attempt to generalise contemporary cities. This idea has now been transferred to the smart city concept where practitioners are attempting to establish a standardised framework for measuring the 'smartness' of cities. In order to measure the enactment of a smart city, several key performance indicators (KPI) have been identified based on the characteristics of the model (Lazaroiu and Roscia, 2012; de Jong et al., 2015). Therefore, the implications of the monitoring and assessment framework for smart cities are - to a great extent - determined by the understanding of these characteristics in relation to recognized KPI's. Because of the diffuse understandings of 'smart' and the smart city, the concept is now moving towards an ISO standardisation to clarify the terms of 'smartness' (ISO, 2015). This is meant to apply to all smart cities, however, what is 'smart' for one city might not be 'smart' for another.

Procedures for a road to standardisation of smart cities have been implemented (ISO, 2015) and frameworks with set indicators to measure the 'smartness' and performance of a smart city developed (Pires et al., 2017). Quantification of social spaces is ruling the urban data revolution; however, this technocratic governance only offers a 'God's eye approach' with lack of understanding of values, culture and social indicators (Kitchin, 2013; Kitchin, 2014b; Söderström et al., 2014). Ahvenniemi et al. (2017) found that social aspects of energy indicators were extremely limited in smart city frameworks and Luque-Ayla and Marvin (2015) argue that the notions of 'smartness' greatly lack empirical evidence in form of narratives and practices, especially from the citizens' perspective. These challenges posed by this technocratic approach to big data leave the understanding of citizens severely undermined. Pires et al. (2017) highlight the importance of rather than criticise the clear problems with big data, geographers should offer solutions based on public engagement. This suggests that a citizen-centred, problem solving approach needs to be presented in the geographical discourse.

de Jong et al. (2015) demonstrate that the concept of smart cities is dominating the discourse of sustainable urbanism. Triggered by the urban data revolution, implementers are progressively working towards standardised smart city frameworks to quantify and simplify urban data (Ahvenniemi et al., 2017; Pires et al., 2017). However, similar to smart urbanism, the smart city is increasingly described by critics as a utopian concept consisting of urban imaginaries (Townsend, 2013; Datta, 2015; Vanolo, 2016). Vanolo (2016:25) describes imaginaries as "…an assemblage of fragments of ideas, feelings, stereotypes, fantasies, labels we associate with something". Taking this definition of imaginaries into account, it becomes clear that current, quantifiable, standardised frameworks fail to address this from a citizen perspective. In addition, there are key social factors that can only be obtained by qualitative examination of the population such as "norms, desires and demands" (Pires et al. 2017:6). Therefore, there is a call for dismissal of standardisation as these are spatial and cultural variables that data and algorithms cannot capture (Leszczynski, 2016). Additionally, as Vanolo (2016:26) explains: "different people may have different ideas and different visions".

Employing the concept, smart city stakeholders collaborate on initiatives implementing smart city solutions. As the concept itself is ambiguous, smart city initiatives are different in nature and can vary in which domains they focus on. Despite initiatives supposedly aiming to improve quality of lives of citizens (de Jong et al., 2015), several different strategies to achieve this are carried out. Not only does contesting aspirations between initiatives strengthen the definitional issues around 'smart', but when these occur within the same city, it creates problems for both implementation and engagement. As the debate around the shortfalls of smart cities continues, the broader critique of these challenges to implementations and barriers to engagement are unfolding in the academic discourse.

By acquiring extravagant funds for projects and initiatives and sales of 'smart' solutions, organisations are contributing to a dysfunctional and superficial understanding of contemporary cities and the concept itself (Angelidou, 2014). It is even questioned if the smart city really exists and what it actually represents (Hollands, 2008). Though idea for frameworks vary due to stakeholders' conflicting interests (Angelidou, 2014), the goal of the smart cities is constant: increase quality of life of citizens. Throughout these possible future scenarios and critiques, the crucial question remains: who is the ideal 'Smart Citizen' and who will ultimately benefit from the implementations and the policies.

Despite the smart city concept only recently emerging, it has established a central discussion on how to approach sustainable urbanism (de Jong et al., 2015; Vanolo, 2014). It is distinctive from other concepts such as 'digital cities', 'green cities' or 'livable cities' as in its broader considerations of both social and technological factors (de Jong et al., 2015; Calzada and Cobo, 2015). However, the critics argue that though the social and technical factors should be balanced (Kitchin, 2013; 2014c; Calzada and Cobo, 2015). This therefore begs the question as to how the smart city can mitigate social concerns in a highly technical and contextualised environment. Some critiques highlight a significant gap in the social angle regarding energy indicators in smart city frameworks (Ahvenniemi et al., 2017).

The next section of this chapter will firstly examine the privacy and security issues raised regarding smart cities. Secondly, it will address how the concept has fuelled the concerns about the smart city potentially causing social exclusion. Finally, it will lead on to how these issues combined have sparked further critiques around how it is affecting the role of the citizen.

2.9 Broader Concerns Regarding the Smart City

The previous section examined the conceptual challenges to the smart city. While the contesting understandings of 'smart' and the various implementation processes generate its own challenges, there are some broader concerns about the concept that has triggered alarms among scholars. The recent smart city discourse disclosed issues about how the concept is implemented. As the smart city builds on big data, which involves active and passive citizen interactions with smart technology and IoTs, privacy and security concerns arise as the debate continues to question whether citizens are adequately informed and protected. Additionally, the questions around ownership of the data generated by and about citizens for local authorities or large corporations have initiated a call for bottom-up initiatives.

However, these are not the only broader concerns brought about by the smart city. Whilst smart city initiatives have been critiqued for not being citizen-centric, the implementation of the concept has sparked further urban concerns regarding access, social exclusion and social equity. As participation in the smart city requires a certain level of techno-literacy, and access to both big data and smart technology and IoTs, this begs the question as to who the smart city facilitates for. Combining these concerns, implementers of smart city initiatives are confronted with issues that are, not only important to tackle in terms of engagement, but crucial to successful implementation.

2.9.1 Big Data Society

The rise of big data commenced in the 1990s and has in recent years spurred urbanisation into a new era and increasingly facilitated a neoliberal audit culture (Kitchin and McArdle, 2016; Pires et al., 2017). Big data have been broadly defined in the literature and despite the wide range of understandings between disciplines, Kitchin (2013:262) has identified seven key traits:

- ‘huge in *volume*, consisting of terabytes or petabytes of data;
- high in *velocity*, being created in or near real-time;
- diverse in *variety* in type, being structured and unstructured in nature, and often temporally and spatially referenced;
- *exhaustive* in scope, striving to capture entire populations or systems (n=all);
- fine-grained in *resolution*, aiming to be as detailed as possible, and uniquely indexical in identification;
- *relational* in nature, containing common fields that enable the conjoining of different data sets;
- *flexible*, holding the traits of extensionality (can add new fields easily) and scalability (can expand in size rapidly)’.

Particular emphasis has been placed on the first three points, also referred to as the three V’s (Leszczynski, 2016; Kitchin and McArdle, 2016) as the key traits. To disentangle what big data are, Batty (2013:274) states that it is ‘any data that cannot fit into an Excel Spreadsheet’. Through sensors and various other gadgets, big data are generated in cities at all times, facilitating great opportunities to generate large, rich datasets about the city in a cost-effective manner. These data can then be used to make decisions about urban planning, and it is argued that it is a valuable method to achieve smarter urbanism.

Despite big data offering powerful and extensive snapshots of the city, it quantifies human behaviour. Using big data to make decisions about problems and solutions in cities has raised questions regarding the societal consequences surrounding this type of data driven governance (Leszczynski, 2016). This in turn has brought to light the concerning lack of understanding of the temporal implications of big and real-time data on urban living (Kitchin, 2014b; 2019). As big data are not concerned with individual values or behaviour, only that of the crowds, it fuels the argument that the smart city concept is hegemonic and paternalistic in nature (Cardullo and Kitchin, 2018b).

Moreover, concerns have also been raised about how data errors can affect this type of automated decision making. Whilst technologies are being implemented to increase resilience of urban systems (de Jong et al., 2015; Taylor Buck and While, 2017), sceptics argue that a society highly dependent on technology is a vulnerable one (Ash et al., 2018). Consequently, smart city implementers are critiqued for their technological solutionism to urban problems (McFarlane and Söderström et al., 2017). Therefore, big data pose complex ethical issues that are less obvious and often brushed off as unintended consequences (Boyd and Crawford, 2012; Kitchin, 2013; 2016).

2.9.2 Data Ownership and Privacy

The big data revolution has changed the way cities are interpreted and researched, leading to new epistemologies of cities (Kitchin, 2013; 2014c; Pires et al., 2017). The dawn of smart cities has shed light on issues around data ownership and questions around who owns big data are raised upon the realisation of its value (Nuaimi et al., 2015). Additionally, it sparks questions surrounding the stake citizens have in ownership of big data. Open data platforms have become a means for new urban business models, and economic growth and investments. However, this has triggered the question as to why citizens are not profiting. After all, the data is generated by their actions (Townsend, 2013). Whilst this can be counter argued by local authorities and IT companies by stating that citizens benefit from accessing the solutions deriving from big data, there is an access issue to big data that can in return urge new digital divides (Boyd and Crawford, 2012). It has been suggested to think of big data as part of urban commons in order to overcome this barrier, however, this increases the many underlying ethical concerns such as privacy, making extended public ownership of big data complicated (Townsend, 2013).

As mentioned, critical to big data is the collection and display of ‘real-time’ information. In the world of computing, this is anticipated to make cities plannable short term in minutes and hours rather than long term in years or decades (Batty, 2013). Some of these data are generated through voluntary adoption of IoT, while other through deployment of public sensors in the city. Therefore, it is split into directed, automated and voluntary sources of big data. Whilst voluntary data are given away by citizens willingly, directed data are typically linked to surveillance instruments such as closed-circuit television (CCTV), and automated data are generated when certain tasks are undertaken e.g. purchasing products in a shop (Kitchin, 2014b). With big data being linked to space, time, movement and location, critics suggest that urban living is now under surveillance and citizens are being monitored (Graham and Wood, 2003; Wood and Webster, 2010; Batty, 2013; Kitchin and Lauriault, 2015). This has led to a broad discussion as to how big data are threatening citizens’ privacy.

Historically, the notion of privacy was characterized by “media, territorial, communication, and bodily privacy” (Ziegeldorf et al., 2013:2729). In contemporary cities where high amounts of data are generated, this has shifted towards information-based privacy. All three sources of ‘big data’ in cities have been critiqued for being invasive in both private and public spaces. This has led to the dystopian smart city rhetoric that claims the concept is shaping a ‘Big Brother’ society (Boyd and Crawford, 2012). As the smart city is a data driven concept, the mining of and exploitation of this data is of high concern in terms of citizens’ privacy and security (Martínez-Ballesté et al., 2013; Ziegeldorf et al., 2013). This indicates that although many citizens may be unfamiliar with the concept of smart cities or IoT, concerns are rooted in the ownership and utilisation of smart technologies. However, this refers to the question as to what extent people are concerned and in case what their concerns are.

Elmaghraby and Losavio (2014:493) suggest that the main privacy and security concerns regarding technology applications in smart cities revolve around the following:

(1) The ‘‘privacy’’ and confidentiality of the information.

(2) The integrity and authenticity of the information.

(3) The availability of the information for its use and services.

The most widely used smart technology is the smart phone through which a myriad of apps are downloaded (Townsend, 2013; Kitchin, 2016). Smartphone penetration in today’s society is high, and by just carrying a smart phone, citizens become walking sensors (Townsend, 2013). Privacy policies exist to protect the end-users, but these often come with ‘small prints’. It is questionable as to whether citizens actually read these as they potentially appear long and hard to understand (Rowan and Dehlinger, 2014). This often prompts end-users to accept the terms and conditions and allow access without truly knowing what they are consenting to (Rowan and Dehlinger, 2014; Kokolakis, 2017). This suggests that the end-user is not considered when developing these, and that there is a need for greater transparency regarding privacy questions related to smart technologies and IoTs (Rowan and Dehlinger, 2014).

When downloading well-known apps, there is also a certain level of trust that sensitive data will not be collected or exploited (Gu et al., 2017). For example, Reinfelder et al. (2014) found that iOS users were less concerned and less aware about their privacy than Android users, suggesting trust in both phone brand and app developer plays a significant role in how concerned people are about their privacy when using smartphones and apps.

Additionally, iOS users also tended to be less concerned with location tracking than Android users (Reinfelder et al., 2014). van Zoonen (2016) suggests that the privacy concerns for citizens in smart cities is dependent on type of data and the purpose for collecting the data.

These concerns of open, big data have produced issues such as citizens' right to privacy contra the benefits of the data on a personal level, to the smart city and the greater public (Batty et al., 2012). Regarding the ideology of transparency and open data, the main concern is exploitation of this data for the wrong reasons (Boyd and Crawford, 2012). This idea is built upon a rationalist assumption where citizens utilise the data with good intentions (Pires et al., 2017). In this case, it is crucial to distinguish between voluntary and involuntary participation in the smart city. Involuntary participation involves sensors throughout the city, while the voluntary are items adopted by end-users (Boyd and Crawford, 2012). Crucial to the latter context is the evolving ubiquity of IoT. Ziegeldorf et al. (2013:2729) illustrate that privacy in relation to IoT is threefold:

> **(1)** "Awareness of privacy risks imposed by smart things and services surrounding the data subject.
>
> **(2)** Individual control over the collection and processing of personal information by the surrounding smart things.
>
> **(3)** Awareness and control of subsequent use and dissemination of personal information by those entities to any entity outside the subject's personal control sphere".

Boyd and Crawford (2012) also point out that the level of awareness of data collected is fundamental to the privacy concerns among citizens. In addition, it has been argued that people's perception of personal information differs and that this understanding determines whether data is perceived sensitive or not (Ziegeldorf et al., 2013, van Zoonen, 2016). Nevertheless, as noted, it is suggested that the perceived personal benefit and value of the data determines whether citizens are willing to share data (Wilson et al., 2017). Therefore, it is an evident exchange ongoing between privacy and public services. This begs the question as to how the concept foster unhealthy interactions between citizens and smart city technologies as participation requires giving up personal information in order to become a beneficiary of the smart city.

However, broader research about smartphone privacy awareness suggests that while most end-users are concerned about their privacy, they are still unaware of many of the related issues (Martinez-Balleste et al., 2014; Reinfelder et al., 2014). As seen in the recent Cambridge Analytica/Facebook scandal (Cadwalladr and Graham-Harrison, 2018), social network sites provide access to third-party applications which often harvest profile information from the end-users without their knowledge. In the light of this recent event, the new General Data Protection Regulation (GDPR) was rolled out May 2018, replacing the 1995 Data Protection Directive (DPD) (Voigt and von dem Bussche, 2017). However, with the new GDPR, the praxis around how big data are processed, analysed and used can in turn potentially limit the growth of big data trends (Zarsky, 2017). Also, despite being the response to the challenges of big data practices and the digital era, it is debatable whether GDPR does increase privacy protection of citizens as the jurisdictions give end-user little increased control over their own data other than being able to request to receive information companies keep about them (Voigt and von dem Bussche, 2017).

Data are being collected about citizens' behaviour and movement and their daily life is under constant scrutiny (Batty et al., 2012; Kitchin, 2016). By participating in and accessing public information and services, citizens give up personally identifiable information in exchange for efficiency and other benefits (Kitchin, 2016). This praxis has been normalised and majority of people accept this without questioning the consequences (Wood and Webster, 2010). This has sparked privacy concerns, yet these are generally disregarded by providers as the data are supposedly anonymised (Batty et al., 2012). There is consensus that the intentions for the data collection are for provision of good public services and safety, but the question is when it overlaps with surveillance.

However, the discourse about surveillance poses a question as to how citizens' awareness of privacy within the boundaries of their own homes. Through the ubiquitous nature of IoT, 'smart' homes are exposed to a number of privacy concerns (Patton et al., 2014). This has not only sparked serious privacy concerns regarding use of public spaces and discretion in personal homes, but also security of IoT and what it means for citizens and general cyber security. Therefore, IoT has - by critical scholars - been flagged as invasive and intrusive (Graham and Wood, 2003; Graham, 2009; 2011; Wood and Webster, 2010; Clavell, 2013).

As discussed, integration of big data provides the fundamental basis for the smart city's functionality with the aim to improve public services by integrating automated systems (Batty, 2017). With the increasing data driven governance, it provokes questions as to what kind of future the smart city constitutes and who the smart city is really for (Vanolo, 2016; Pires et al. 2017).

2.9.3 Smart Utopia or Technocratic Dystopia?

The concept is portrayed by describing smart utopias with green technologies, efficient infrastructure and happy citizens (Grossi and Pianezzi, 2017). However, the critical literature on smart cities argue that the concept conceals speculative, and dystopian futures where citizens' rights will be suppressed and their role in the city diminished (Leszczynski, 2016). According to Vanolo (2016), there are four main imaginaries that has evolved in contemporary smart city discourse:

Smart cities from scratch: The "perfect" hyper-tech idea presenting new smart city experiments as a solution to existing urban issues. Often in areas with already high levels of injustice including elites vs. slums such as in India where 100 new smart cities have been planned to be built (see Datta, 2015). Instead of defragmenting society, this risks reinforcement of exclusions and inequalities.

Smart 'no-freedom' cities: The pessimist belief that smart technologies function similar to Big-Brother and strip citizens of all democracy and freedom by creating urban 'totalitarian regimes'. Despite it painting a severely dystopian interpretation, this stigma is not completely irrational as issues such as lack of privacy, control and security (Kitchin, 2016) have already transpired such as when Ukraine experienced a big power cut due to hacking.

Neo-liberal smart cities: Based on responsible citizens acting rational and actively participating in the smart city (Boyd and Crawford, 2012). Giving power to citizens and aiding them in ICT adoption to influence the shaping of smart city policies may create opportunities for citizens (van den Berg and Winden, 2002). However, it jeopardises citizens with them becoming walking sensors and automated nodes in a black boxed society (Paulin, 2016). It also stresses that involved citizens must be tech-savvy and technologically literate and willing to share data from daily life, which ultimately causes a strong digital-divide. Yet, this is considered the most popular vision for future cities.

The sustainable smart city: Focuses on the needs of the next generation within the principals of sustainable development (Martin et al., 2019). However, planning for not-yet-existing humans and ambiguous spaces deprives current citizens of their real needs. By constantly suffering trade-offs for the wellbeing of future people, citizens may become embroiled in the smart city initiatives, resulting in undesirable behaviour. In other words, this imaginary can be unjust for current citizens.

Despite technologies having disrupted society for decades and forced urban transitions (Graham, 2009) these imaginaries have sparked new concerns around citizens in the smart city. As such, the literature argues that the smart city exhibits spatial and social exclusions and urban inequalities (Vanolo, 2016; Engelbert et al., 2019). However, these complex social issues currently remain fuzzy in socio-technical urban systems (Kitchin, 2016). The literature suggests that smart cities are driven by technocratic, algorithmic and neo-liberal governmentalities that lacks transparency (Leszczynski, 2016). Coined by the French Philosopher Michael Foucault, the concept of governmentality:

> "…involves the way in which subjects perceive themselves and form their identities through processes of government which control, incite or suppress actions by drawing a line between what is 'acceptable' and what is 'unacceptable'" (Vanolo, 2014:885).

These governmentalities produce citizens that generate data through their movements and behaviour. However, as smart city initiatives work towards standardised smart city frameworks based on big data that ignores social and cultural values, they risk implementing "one size fits all" smart city in a box solution (Kitchin, 2014a:10). As this implicates the development and deployment policies, it is fundamental to question what kind of citizen the smart city is truly made for (Vanolo, 2016). While big data are often portrayed as "politically benign" (Kitchin, 2014a:8), the governance and governmentalities driving this digital change proves otherwise through what Kitchin (2014a:9) frames well as: "a selective sample […] are framed within a thought system". This links back to the same limitations living labs face due to being circumstantial and highly contextualized environments.

Scholars driving this exposure of technocratic fetishism argue that reigning models of smart cities pose three main hegemonic problems: creating inequalities, facilitating social and urban exclusions, and depriving citizens of freedom of choice and democracy

(Vanolo, 2014; Viitanen and Kingston, 2014; Krivý, 2016; Kummitha and Crutzen, 2017). Therefore, it has become evident that smart city implementations and policies can cause concerns regarding inequalities and exclusion challenges that revolves around citizen access, control and power.

The technological solutions facilitate an urban environment in which only citizens with privileged access can participate (Harvey, 2003). The smart city that creates a so called 'digital divides' in society. The digital divide addresses the issue of people's unequal access to technology and ICTs and the societal consequences of this (Partridge, 2004). This access can be limited by two factors, knowledge and affordability. Although the knowledge gap is slowly closing as the new generation of 'digital natives' is growing (Bennet and Maton, 2010), the digital divide will continue to present itself in relation to affordability (Harvey, 2003). However, scholars argue that smart city utopias have become a neo-liberal gimmick that diverts attention from such underlying urban problems (Wiig, 2015).

Despite one of the aims for smart cities is to increase quality of life for citizens, human behaviour poses challenges to the utopian equilibrium encouraged by the concept (de Jong et al., 2015). The smart city states that it also addresses urban issues, albeit it has become questionable whether it does, consequently disrupting the overall goal of smart city. It is therefore vital to capture the citizens' understandings, attitudes, beliefs and values in this highly conceptualized and constructed environment to contribute to democratic solutions.

The hidden hegemony of smart cities shapes urban futures and the data driven governmentalities largely impact on citizens' identity and role in the smart city (Vanolo, 2014). Furthermore, it has also been stated that the identity imposed on citizens does not reflect the true and diverse identity of the city as a whole in a highly globalised environment (Vanolo, 2014; Krivý, 2016). This therefore poses serious social justice questions as to who the smart city is *really* for and if it is only for the tech-savvy, social elite (Dorling, 2015).

2.10 The Smart Citizen

'Smart people' or 'smart citizens' has, as illustrated in Figure 2.1, been grounded as one of the main characteristics of the smart city. Nonetheless, despite the smart city taxonomy reserving a domain for ‘smart people’ (Giffinger and Gudrun, 2010; Nam and Pardo, 2011, de Jong et al., 2015), the characteristic alone is as vague as the smart label itself. Drawing upon neo-liberal ideologies, ‘smart people’ are “linked to the level of qualification of human and social capital, flexibility, creativity, tolerance, cosmopolitanism and participation in public life” (Vanolo, 2014:887).

Carvalho (2014:4) explains that society is expected to accommodate new technologies and innovations by adapting “user’s preferences and cultural practices, legal standards, planning requirements, actor’s networks, privacy expectations and business models”. This in turn, Söderström et al. (2014:309) argue, produces “new relations between technology and society”. In order to approach these advanced socio-technical challenges it is therefore essential to focus on the roles of both human and non-human actors and their relations in order to understand socio-technical challenges in smart city systems from a holistic perspective. This aligns with Actor Network Theory (ANT) which frames equal consideration of technological artefacts as actors within a network (Latour, 1996).

ANT has been criticised for its consideration of non-human capacities as equal participants in networks (Winner, 1986), for being too descriptive in nature and for failing to scientifically explain social processes (Amsterdamska, 1990). However, ANT seeks to establish a truth and a solution to a problem (Law and Hassard, 1999), but it is not necessarily the only truth as different views will illustrate different epistemologies. McFarlane and Söderström (2017) suggest that smart cities require a new and alternative epistemological understanding, which by utilising ANT as the underpinning theory can facilitate this. Moreover, Söderström et al. (2014:310) adopt ANT to investigate actors in the smart city and questions “who has the power to define the smartness of cities and what the discussions around this theme should be concerned with” arguing that IT companies attempt to establish themselves as “indispensable actors”. However, if citizens are not included as central actors, private companies could soon define the urban environment in which they live (Townsend, 2013). Therefore, it is a need to establish the citizens as indispensable actors in the smart city.

Considering the concerns outlined in Section 2.9, understandings imply that a smart citizen is someone who is stereotypically tech-savvy, connected and generates data about their urban behaviour (Gabrys, 2014; Shelton and Lodato, 2019). Additionally, the ideal smart citizen may be an early adopter of smart city technologies that help the concept achieve its aims (Shelton and Lodato, 2019). As such, when put into a more practical context, ‘smart’ in relation to the citizen address their role and level of power in the smart city.

2.10.1 Citizen Engagement

As a result of broad critique, smart city initiatives adamantly claim they are moving towards a citizen-centric smart city model. However, there is substantial debate regarding the extent to which this has stimulated a more inclusive approach (Luque-Ayala and Marvin, 2015; Cardullo and Kitchin, 2018a; Shelton and Lodato, 2019; Engelbert et al., 2019). Despite attempting to adjust top-down approaches toward a citizen-centric focus, these initiatives are often implemented *for* citizens not *with* citizens. As this continues to be the reality, IT companies are deciding what the citizens need, fuelling the hegemonic concerns regarding the smart city. Therefore, in order to create a 'more just' smart city there remains a need to introduce citizens' narratives and perceptions into developments to achieve bottom-up focussed initiatives.

However, critics suggest the citizens involved are so called ‘do-it-yourself-urbanists’ or other already engaged or informed citizens. While it is a positive shift involving citizens, it is concerning that solutions may then result in not reflecting the needs and aspirations of the broader general public (Iveson, 2013). In addition, it is important that citizens are not just part of finding the solution, but also the process of identifying the urban problems smart technologies are expected to address. As mentioned earlier in this chapter, Lefebvre’s ideas around citizens ‘right to the city’ have raised questions in contemporary urban discourses as neo-liberalism has undoubtedly modified the way citizen participation is enacted in urban space production (Cardullo and Kitchin, 2018b). With the increasingly ubiquitous nature of smart technologies and IoTs, democratic participatory approaches should therefore be in focus during smart city implementation. This begs the question as to how smart city initiatives can engage with citizens in a way that moves them from passive to active and empowered actors in the smart city.

Arnstein (1969) developed an eight stepped ladder in order to measure levels of participation as illustrated in Figure 2.2.

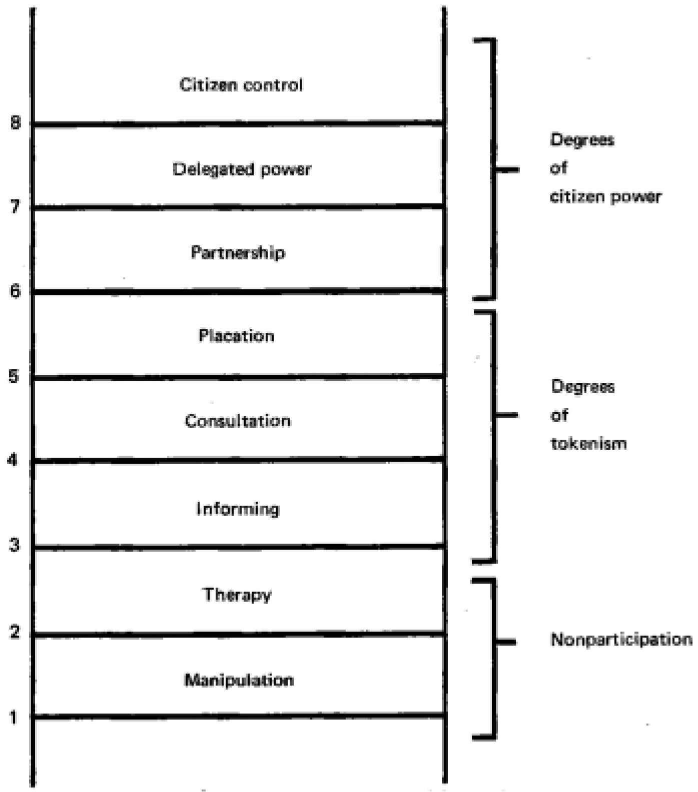

Figure 2.2. The Ladder of Citizen Participation (Arnstein, 1969:217)

The bottom two steps on the ladder demonstrate levels of 'non-participation' where citizens are not enabled to participate in the implementation processes. This gives more power to those implementing solutions as their aim is to only educate participants. The next two steps (three and four) illustrate degrees of tokenism where underrepresented groups have a voice, but only through a small number of people to illustrate symbolic effort to include them. This also limits the actual influence people have on making a change. Whilst step five is a higher level of tokenism where participants can advise, the powerholders are those making the final decisions. Steps six to eight demonstrate higher levels of citizen power where they can form partnerships with powerholders, be delegated power or be in control to manage and make final decisions about plans and processes.

Arnstein's ladder of participation has been critiqued as some argue that empowerment and high levels of participation may not always be the societal goal, or dispute that citizen control promotes inclusiveness (Collins and Ison, 2009). Some also suggest that experts should remain in power of their domains (Tritter and McCallum, 2006). Additionally, data driven governmentalities are implemented to prevent that bottom up solutions that are owned/co-owned or ran by citizens disempower the state or spark a new era of capitalism and urban anarchy (Leszczynski, 2016). However, despite these critiques, the ladder remains an appropriate instrument to measure how involved citizens are in processes.

As a response to the technocratic critiques of the smart city, Cardullo and Kitchin (2018a) adapted the ladder of participation to a smart city context as illustrated in Table 2.2.

Table 2.2. Scaffold of Smart Citizen Participation (After: Cardullo and Kitchin, 2018a:5)

<table>
<tr><th colspan="2">Form and Level of Participation</th><th>Role</th><th>Citizen Involvement</th><th>Political discourse/framing</th><th>Modality</th></tr>
<tr><td rowspan="3">Citizen Power</td><td>Citizen Control</td><td>Leader, Member</td><td rowspan="2">Ideas, Vision, Leadership, Ownership, Create</td><td rowspan="2">Rights, Social/Political Citizenship, Commons</td><td rowspan="3">Inclusive, Bottom-up, Collective, Autonomy, Experimental</td></tr>
<tr><td>Delegated Power</td><td>Decision-maker, Maker</td></tr>
<tr><td>Partnership</td><td>Co-creator</td><td>Negotiate, Produce</td><td rowspan="2">Participation, Co-creation</td></tr>
<tr><td rowspan="3">Tokenism</td><td>Placation</td><td>Proposer</td><td>Suggest</td><td rowspan="6">Top-down, Civic Paternalism, Stewardship, Bound-to-succeed</td></tr>
<tr><td>Consultation</td><td>Participant, Tester, Player</td><td>Feedback</td><td rowspan="2">Civic Engagement</td></tr>
<tr><td>Information</td><td>Recipient</td><td rowspan="2">Browse, Consume, Act</td></tr>
<tr><td>Consumerism</td><td>Choice</td><td>Resident, Consumer</td><td>Capitalism, Market</td></tr>
<tr><td rowspan="2">Non-Participation</td><td>Therapy</td><td rowspan="2">Patient, Learner, User, Prodct, Data-point</td><td rowspan="2">Steered, Nudged, Controlled</td><td rowspan="2">Stewardship, Technocracy, Paternalism</td></tr>
<tr><td>Manipulation</td></tr>
</table>

As seen in Table 2.2, there are four additional columns to what Cardullo and Kitchin (2018a) call the 'scaffold' of participation: citizen involvement, political discourse/framing and modality. The first addition addresses the role of citizens in the smart city. The most common form of interaction for citizens is as consumers through using apps where they exchange their data for services. The second addition involves how citizen involvement is enacted in projects and in what ways they are engaged. The third addition to the ladder revolves around which political discourse frames, justifies and drives the level of participation. The last column added examines the modality of participation, whether it is top-down or bottom-up. This new instrument can help disentangle the various aspects about how citizen participation is enacted in smart cities and how empowered smart citizens really are. Despite increased efforts of shifting towards a citizen-centric smart city, scholars argue that citizen enactment in initiatives remain within consumerism and tokenism, dominated by top-down and paternalistic modalities (Cardullo and Kitchin, 2018a; Engelbert et al., 2019; Shelton and Lodato, 2019). Moreover, this illustrates a distinct neo-liberal underpinning and conception of smart citizenship (Cardullo and

Kitchin, 2018b). This therefore suggests that policies regarding the new citizen-centric rhetoric are not translating into practice (Wiig, 2015; Shelton and Lodato, 2019).

In addition, as smart cities represent a society where automation is increasing, questioning the forthcoming role of the citizens their control in technological processes is highly appropriate. There are three levels of human control over technological processes. First, In-the-loop refers to the human being in control of the technology and makes the decisions. Second, on-the-loop refers to the technology operating automatically but is being overseen by a human who can interfere in the decision making. Third, off-the-loop refers to the technology system operating independently without any human interaction (Coletta and Kitchin, 2017). The latter would mean that urban systems run on decisions made by automated algorithms without the possibility for humans to intervene. Whilst eliminating human errors, freedom of choice is limited and the extreme dystopian imaginaries of technological singularity in which 'the rise of the machines' and AI taking over becomes a concern (Kurzweil, 2005; Krivý, 2016; Vanolo, 2016).

Some have suggested the need to move beyond technological solutionism and onto a more knowledge intensive focus in smart urbanism as this could provide 'just' use of digital technologies (McFarlane and Söderström, 2017). As human behaviour is perceived as a barrier to achieving the efficient and environmentally sustainable smart city utopia, this aspect is often overlooked. However, for the concept to truly achieve its aspirations, there is an urgent need to address this issue, and start considering the needs of the citizens.

2.10.2 Environmental Attitudes and Perceptions

Energy consumption in the residential sector is extremely high (Chwieduk, 2008), accounting for around 40% of energy consumption in the EU (Ástmarsson et al., 2013). Therefore, one of the aims for smart cities is to bring this consumption down (Giffinger and Gudrun, 2010). As noted in the above sections, consideration for human behaviour interrupts the efficient concrete utopia smart cities stand for. As such, human behaviour becomes problematic when attempting to lower energy consumption in buildings. Infrastructural changes and design of buildings can help increase efficiency with for example automated lighting or sustainable retrofitting (Chwieduk, 2008; Ástmarsson et al., 2013), and appliances are becoming more energy efficient (Abrahamse and Steg, 2011). However, as long as there are opportunities for people to control the energy levels, consumption remains subject to occupant behaviour.

There are several factors potentially influencing energy behaviour. Research suggests that awareness of consequences influences behaviour (Schwartz, 1968). Stern and Aronson (1984) also note that energy invisibility is a barrier to energy conservation. Energy is for many not tangible past costs of bills (Goodchild et al., 2017). When operating home appliances, it is common forget where the energy powering these appliances comes from because “seeing is believing” (Stern and Aronson, 1984:38). Therefore, knowledge and concern about environmental issues such as climate change can influence energy conservation (Steg, 2008). Moreover, awareness (or lack thereof) about how individual behaviour can impact on the environment is implicating on energy consumption (Halady and Rao, 2010).

Conversely, belief systems and worldviews have been proven to influence environmental concern which in turn influences behaviour (Dunlap et al., 2000). From this assumption, Dunlap et al. (2000) proposed an instrument to measure public environmental concern: The New Ecological Paradigm (NEP). Through agreement or disagreement with 15 statements related to people’s attitudes and beliefs about reality of limits to growth, anti-anthropocentrism, fragility of nature’s balance, rejection of exceptionalism, and possibility of an eco-crisis, the NEP scale measures people’s environmental concern. Studies have shown that scoring high on the NEP scale i.e. demonstrating a pro-ecological worldview, is associated with pro-environmental behaviour (de Groot and Steg, 2008), including energy conservation (Poortinga et al., 2004).

Furthermore, research argue that personal values are strongly related to environmental concern (Stern, et al., 1993; Stern and Dietz, 1994; Schultz, 2001; Schwartz, 2006). Schwartz (1994:21) define values as:

> “…desirable transsituational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity”.

Majority of studies draw on Schwartz’s Value Theory (1992; 1994) that comprise of 10 value types that demonstrate how these values drive various motivations. These value types are represented in four individual clusters as shown in Figure 2.3.

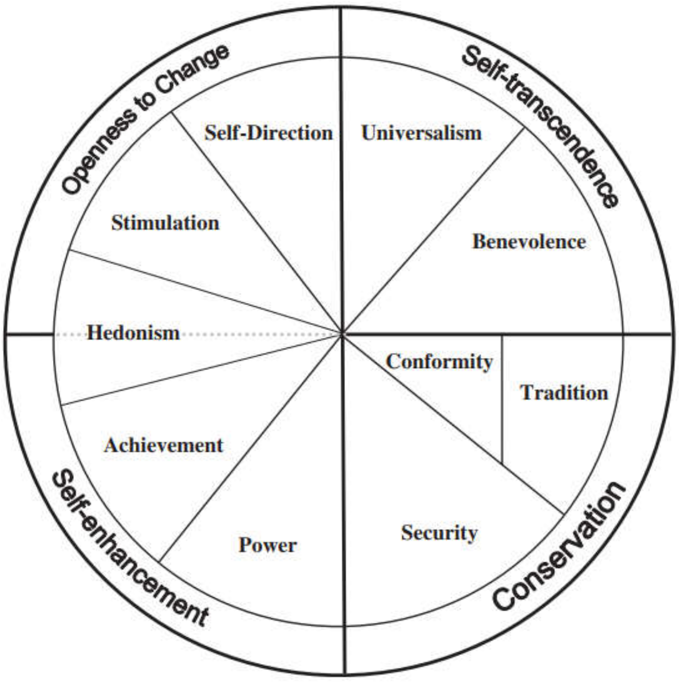

Figure 2.3. Schwartz's Basic Human Value Types and Motivations (Davidov et al., 2008:585)

Figure 2.3 demonstrates the two dimensions where one of them opposes openness to change to conservation and the other opposes self-transcendence to self-enhancement (Sagiv and Schwartz, 1995), whilst hedonism is related to both openness to change and self-enhancement.

Based on Schwartz's Value Theory, de Groot and Steg (2008) developed a survey instrument measuring people's value orientation. Three value orientations are measured with the instrument: egoistic, altruistic and biospheric. Each value orientation comprises of value items that people rate based on how important it is to them. Several studies indicate that ascribing to biospheric values correlates with pro-environmental behaviour, whilst ascribing to egoistic values is associated with negative environmental behaviour (de Groot and Steg, 2007; 2008; 2010; Abrahamse and Steg, 2011; Howell, 2013).

However, environmental attitudes have been found to be more related to behaviour with low personal impact than higher personal impact such as energy use (Gatersleben et al., 2002). Therefore, research has found that energy consumption is related socio-demographic factors such house size and income, the latter providing a strong financial driver for energy conservation (Abrahamse and Steg, 2011).

However, there are situations where financial incentives for energy conservation is eliminated such as in the split incentive scenario where environmental attitudes and perceptions have greater implications on energy consumption. The split incentive scenario presents itself in a two-way avenue as illustrated in Figure 2.4.

Tenant pays energy bills	**Landlord** has **no incentive** to improve energy performance of building
Landlord pays energy bills	**Tenant** has **no incentive** to reduce energy use

Figure 2.4. The Tenant/Landlord Split Incentive Scenario (Adapted from: Gillingham et al., 2010)

First, in rented accommodation where the tenant is responsible for paying their energy bills, the landlord or owner of the property has no incentive to improve the energy performance of the building. Second, when the landlord pays for the energy bills, the tenant has no incentive to reduce energy consumption. These scenarios are both problematic. In the first instance, issues such as landlords refusing to make alterations to properties can result in people living in fuel poverty (Ástmarsson et al., 2013). However, in the other instance, when the tenant does not have any financial incentives to save energy, research suggest that consumption may increase (Gillingham et al., 2010). Therefore, the split incentive scenario is a major challenge to energy conservation.

One specific example is in university halls of residence where students' energy usage is included in their accommodation cost (Bekker et al., 2010). Household size is also an implication here as such halls of residence are subject to multiple occupancy housing (hereafter: 'MOH'), which creates an additional barrier to energy conservation (Abrahamse and Steg, 2011). With smarter buildings and technology controlling energy usage, people become less aware of the importance of energy conservation as they are in less control (Petersen et al., 2007). However, universities both directly and indirectly impact on the environment, and it is estimated that occupant behaviour controls approximately 50% of energy consumption, meaning a change in activities and choices within the halls can reduce usage (Abrahamse et al., 2005; Petersen et al., 2007). As such, students have high levels of control over electricity consumption within their accommodation for example with light in their rooms or appliances either in their kitchen, bathrooms or rooms.

In addition, universities play an important role in the urban sustainability challenge and energy transitions in smart cities (Guan et al., 2016). Universities are central in educating the leaders of tomorrow and facilitate excellent opportunities for co-design and co-production of knowledge in smart cities by linking together stakeholders from different sectors (Trencher et al., 2014). Moreover, due to the elimination of financial drivers and the controlled environment university halls of residence offer, they have become increasingly popular testbeds for technological solutions to energy challenges (Evans et al., 2015; Karvonen et al., 2018).

2.10.3 Solutions to Energy Challenges

Despite studies suggesting residents in private homes struggle to adopt smart meters (Wilson et al. 2017), research has given positive indications that using real-time energy displays can indeed reduce electricity consumption in university halls of residence (Chiang et al., 2014; Petersen et al., 2007; Emeakaroha et al., 2014). Conversely, van der Horst et al. (2015) argue that students' inability to monitor their real-time energy consumption is a barrier to changing their energy behaviour.

However, the challenge is to engage the students in utilising smart solutions implemented to solve the energy challenge as only displaying real-time energy consumption may not be enough to encourage reduction long-term (Emeakaroha et al., 2014). Students should be empowered to use the smart solution to make informed decisions about their energy consumption, and Szalma (2009:386) points out three main factors that could motivate people to engage with the technology:

> "…(1) providing a meaningful rationale for doing the task; (2) acknowledging that the activity may not be interesting to the person; (3) emphasizing choice rather than control by an external authority".

The Technology Acceptance Model (TAM) suggests technology adoption depends on perceived usefulness and ease of use (Venkatesh et al., 2003). This links to the importance of co-creating the solutions as otherwise, user groups may resist the technology (Voytenko et al., 2016). In addition, studies have identified a range of intervention strategies in order to succeed, especially with long-term engagement.

Continuous engagement triggers people's emotions or curiosity to participate and three overarching types of strategies have been proposed: instructional, motivational or supportive (Geller, 2002).

Within instructional strategies, education, advice and self-monitoring are the most common approaches. Coupled with real-time energy information allowing self-monitoring, Szlada (2009) and Foster et al. (2012) stress that people are required to know why they are participating as lack of knowledge can lead to non-participation. Therefore, teaching students about why they should conserve energy is crucial. It is a good approach for people with no background of sustainability and provides contextual understanding as to why it is important to conserve energy (Geller, 2002; Steg and Vlek, 2009). However, it is important to also inform them about energy saving measures and provide suggestions as to what they can do to conserve energy (Geller, 2002; Foster et al., 2012). In contrast, nudging could prompt subconscious behaviour change for people that may care less about the environment (Geller, 2002; Chiang et al., 2014; Agha-Hossein et al., 2014).

Supportive strategies acknowledge there is a social dimension to every intervention, involving the culture, values and norms of the site studied (Geller, 2002). Communication between participants can have a major impact on the intervention (Odom et al., 2008). For example, if everyone is trying to be more environmentally friendly, it creates a community feeling around the issue which can be particularly important in MOH settings. This community feeling applies a certain social pressure on participants as they may not want to disappoint the others (Petersen et al., 2007). Nevertheless, several studies have used incentives to motivate energy saving such as raffle prizes, cash prizes, winner donates to charity, and celebratory cookouts (Petersen et al., 2007; Odom et al., 2008; Foster et al., 2012; Yun et al., 2013). Whilst this may help overcome the engagement barriers with those who care less about the environment, there can be problems with sustaining the behaviour past the intervention period or with people only participating for the prize. Additionally, it can therefore be difficult to evaluate whether the intervention strategy or the incentive is the cause of the behaviour change (Steg and Vlek, 2009). Therefore, if no incentives are chosen, a rigorous experimental design is required, "that reveal the effectiveness of single as well as combinations of interventions for one or more 'treatment' groups and a comparable control group" (Steg and Vlek, 2009:314). In contrast, enforcement may be used as a strategy where bad energy behaviours have consequences (Geller, 2002). Bad energy behaviours may be habitual and if change is experienced as an inconvenience, consequences are usually necessary (Geller, 2002). Nevertheless, pledge boards have been identified to potentially help overcome this issue (Geller, 2002; Odom et al., 2008).

There have been some motivational studies pursuing elements of gamification in order to encourage participation for energy conservation. Gamification involves using elements of game designs in contexts that are not naturally gamified (Deterding et al., 2011). Visual cues have been used in forms of eco-visualisation, or ambient displays (Odom et al., 2008; Yun et al., 2013). Additionally, using intuitive visual cues to place energy usage in context is highly important as otherwise it is hard to know whether performance is good or bad (Yun et al., 2013). Odom et al. (2008) and Foster et al. (2012) both found that numbers and statistics are generally not motivating unless they can be related to a broader context. Foster et al. (2012) also identified that displays of information or other interactive methods should be linked to a league table or other competition tools. Being able to see how people do compared to others in terms of energy conservation has been proven successful in previous studies (McMakin et al., 2002; Yun et al., 2013; Emeakaroha et al., 2014). Additionally, competition and league tables are popular amongst participants in intervention studies as it enhances the discussions around energy conservation whilst competition is ongoing (Petersen et al., 2007; Odom et al., 2008; Peschiera et al., 2010; Foster et al., 2012). In goal framing theory, goal setting is another form of challenging way to encourage sustainable behaviour where targets have to be set and achieved (Lindenberg and Steg, 2013; Emeakaroha et al., 2014). This has been proven successful as it establishes commitment to change and community goals (Abrahamse et al., 2005). Additionally, including supportive techniques such as prizes or rewards for achieving goals or for winners of competitions as an extra incentive have been proven successful (Petersen et al., 2007).

In split incentive scenarios such as in student halls of residence, environmental attitudes and concerns may play a more significant role in reducing energy consumption as financial drivers are eliminated. Having access to real-time energy information is proven to have helped students reduce electricity usage (Petersen et al., 2007). Yet, studies often couple real-time energy feedback with other approaches such as education, gamification and rewards in order to achieve participation (Emeakaroha et al., 2014). Therefore, as universities provide excellent facilities to test technological solutions, students should be part of co-designing smart solutions to overcome the energy challenges in halls of residence and ensure long-term engagement.

2.11 Chapter Summary

'Smart' is an ambiguous term that drives contesting visions and agendas. As such, the literature review identified that challenges to smart city implementations and aspirations are both social and technical (Hollands, 2008; Angelidou, 2014; Söderström et al., 2014; Cardullo and Kitchin, 2017; Taylor Buck and While, 2017). The dominating view on smart cities is techno-centric and the literature demonstrates a significant lack of empirical research around citizen narratives in the smart city (Luque-Ayala and Marvin, 2015). Therefore, citizens' role within the smart city needs to be examined as challenges to deployment of smart technology have mainly been researched from a technological perspective with little consideration for impact on its citizens. The techno-centric interpretation of the concept signifies the role of technology in society as the ultimate problem solver (Carvalho, 2014). However, this understanding fails to view technology as assemblages that adapt to users and *empower* citizens who interact with the smart city to make decisions based on information generated through its technologies in order to overcome challenges. Thus, the aim and objectives following in 2.11.1 were determined for this thesis.

2.11.1 Research Aim and Objectives

AIM: This PhD aims to critically analyse socio-technical challenges to smart city implementations and aspirations.

OBJ1: Investigate stakeholders' perceptions of the smart city.

Despite the literature outlining various understandings, little is known about citizens' perceptions of the smart city. This includes how citizens understand the 'smart' label, their concerns about the concept and the benefits they associate with it. Additionally, there is a need to examine the similarities and differences between citizens' perceptions and that of the implementers of the smart city.

OBJ2: Analyse the perceived role of citizens in the smart city.

Initiatives claim to move towards a citizen-centric smart city, there is a need to analyse how citizen participation is currently enacted in the smart city, and how smart initiatives engage citizens as part of the implementation processes.

OBJ3: Explore the potential for smart solutions to encourage energy savings in a split incentive scenario.

Human behaviour is a barrier for energy conservation, more so in split incentive scenarios where occupants have no financial incentive to lower their consumption. As the smart city aims to test various technological solutions to energy challenges, there is a need to explore the potential for a technological solution in split incentive scenarios.

OBJ4: Critically evaluate how the findings contribute to the smart city and broader sustainable urbanism.

The research overall evaluates the theoretical and practical implications of the findings in relation to the smart city concept and broader sustainable urbanism.

Chapter 3. Research Methodology

3.1 Chapter Outline

This chapter presents the methods undertaken to address the overarching aim and subsequent objectives introduced in Chapter 2. Section 3.2 outlines the philosophical paradigm adopted, whilst 3.3 offers a justification for utilisation of mixed methods research design. 3.4 presents the case study framing this research, and subsequent sections (3.5-3.7) outline the strategy of inquiry for each research strand, including data analysis and associated strengths and limitations. Section 3.8 provides an overview of the ethical considerations of the research, before concluding with a chapter summary in 3.9.

3.2 Research Paradigm

The adopted research paradigm impacts on the development of the research design, choice of methods and how the empirical data is interpreted and treated (Tashakkori and Teddlie, 1998; Clough and Nutbrown, 2012). Guba and Lincoln (1994:105) have defined a paradigm as:

> "…the basic belief system or worldview that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways".

Thus, the paradigm frames the worldview of the researcher that guides the research inquiry (Tashakkori and Teddlie, 1998). Tashakkori and Teddlie (1998) explain that there is continuous debate as to which paradigm represents the best research model, also referred to as the paradigm war. There is a series of established philosophical paradigms and the choice of research paradigm may vary on behalf of the discipline background of the researcher. In social and behavioural sciences, frequently used paradigms are: constructivism, interpretivism, pragmatism, transformative, and positivism (Tashakkori and Teddlie, 1998; Teddlie and Tashakkori, 2009; Saunders et al., 2015). Table 3.1 illustrates the detailed differences between the paradigms in terms of epistemological and ontological stance, axiology, research logic and methods.

Table 3.1. Contrasts between Research Paradigms (After: Tashakkori and Teddlie, 1998:23; Mertens, 2007:216; Saunders et al., 2015:136; Teddlie and Tashakkori, 2009:88)

Dimension	Research Paradigm				
	Constructivism	**Interpretivism**	**Transformative**	**Pragmatism**	**Positivism**
Epistemology: *the researcher's view regarding what constitutes acceptable knowledge*	Subjective point of view. Knower and known are inseparable	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Both objectivity and interaction with participants valued by researchers	Both objective and subjective points of view, depending on stage of research cycle	Objective point of view. Knower and known are dualism
Ontology: *the researcher's view of the nature of reality or being*	Relativism. Multiple constructed realities	Socially constructed, subjective, may change, multiple	Multiple realities that are socially constructed	External, multiple, view chosen to best enable answering of research question	Naïve realism. External, objective and independent of social actors
Axiology: *the researcher's view of the role of values in research*	Inquiry is value bound	Inquiry is value bound	All aspects of research guided by social injustice	Values play a role in interpreting results	Inquiry is value free
Research Logic	Inductive	Inductive	Inductive and deductive	Inductive and deductive	Deductive
Method(s)	Qualitative	Qualitative	Qualitative and Quantitative	Qualitative and Quantitative	Quantitative

Constructivism and positivism represent contrasting characteristics in all dimensions. Whilst constructivism is value bound and subjective through employing qualitative (hereafter 'Qual') methods with an inductive logic, positivism is value free and objective and employs quantitative (hereafter 'Quan') methods with deductive logic (Teddlie and Tashakkori, 2009). Interpretivism is closely related to constructivism, however they are ontologically different. Interpretivists believe the nature of reality is socially constructed and whilst it is subjective, it may change (Denzin and Lincoln, 2000). These purist paradigms reject one another and argue that Qual and Quan research strategies should not be mixed (Tashakkori and Teddlie, 1998; Johnson and Onwuegbuzie, 2004). Qual purists (constructivists or interpretivists) argue that their paradigms obtain deep and rich observational data, whereas Quan purists emphasise the ability for their findings to be generalised (Johnson and Onwuegbuzie, 2004). However, Teddlie and Tashakkori (2009:94) argue that:

> "In the real world of research, however, continua of philosophical orientations, rather than dichotomous distinctions, more accurately represent the positions of most investigators".

This methodological continuum eliminates the need to treat the paradigms as mutually exclusive by viewing the philosophical paradigms as a spectrum. Figure 3.1 illustrates the philosophical orientations as a spectrum rather than individual stances.

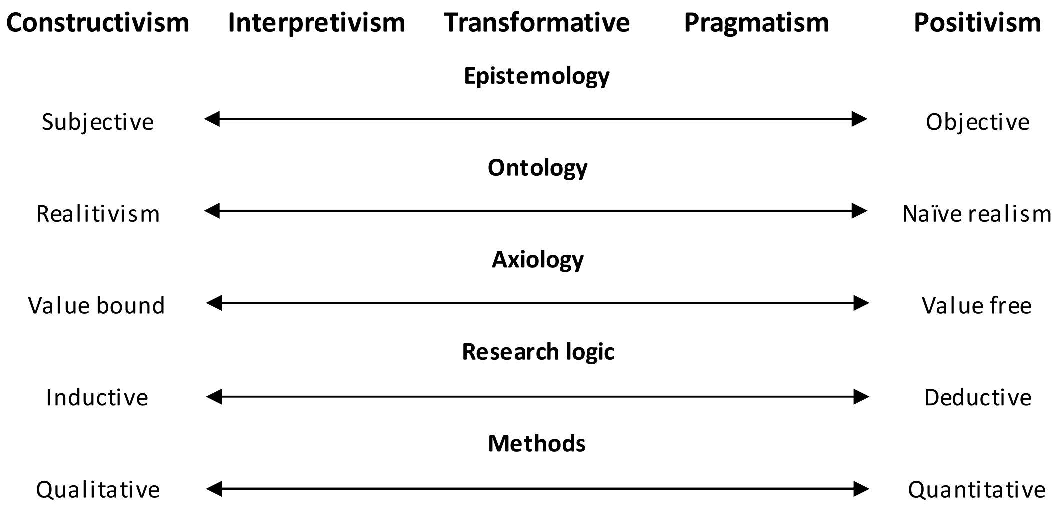

Figure 3.1. Spectrum of Philosophical Paradigms (Adapted from Teddlie and Tashakkori, 2009)

Pragmatism and the transformative paradigm both emerged and enabled the use of both Qual and Quan methods within the same study, however, the two orientations have axiological differences. Mertens (2007) argue that the transformative paradigm places emphasis on social injustice and marginalised groups. In pragmatism, values play a role in interpreting the results, but the research is not driven by them (Teddlie and Tashakkori, 2009). Johnson and Onwuegbuzie (2004) further explain that pragmatism seeks to establish a middle ground between the paradigms in an attempt to end the paradigm war. Therefore, pragmatism rejects the need to choose between the contrasting philosophical paradigms (Tashakkori and Teddlie, 1998).

Using Qual and Quan methods, pragmatism offers flexibility to decide the most appropriate strategies to address the research objectives (Teddlie and Tashakkori, 2009). Taking this into account, pragmatism accepts that individuals develop their own understanding of the world (Saunders et al., 2015). Knight (2002) explains that research conducted with only one method can fail to address complex social phenomena and that multiple methods are required to provide comprehensive analysis. Key strengths associated with pragmatism are thus the adaptability it equips the researcher with and the interactive research process (Knight, 2002; Tashakkori and Teddlie 1998; Saunders et al., 2015).

Considering the aspects of all paradigms, each presents individual advantages and disadvantages, yet none is superior to the other. Given the exploratory nature of this research and a growing need to examine contrasting perspectives, this research adopted a non-purist pragmatic philosophical paradigm allowing the researcher to critically evaluate and decide the appropriate strategies to address the research objectives (Johnson and Onwuegbuzie, 2004). This facilitated the opportunity for the research to adopt a mixed methods approach in order to triangulate and compliment methods undertaken (Tashakkori and Teddlie, 1998). The following section provides an in-depth discussion of the adopted mixed methods design for this study.

3.3 Mixed Methods Research

Research designs are important and provide guidance and rigour to how best achieve the research objectives (Creswell and Plano Clark, 2003). As such, the mixed methods design emerged as a strong methodological approach in social and human sciences due to the value of combining Qual and Quan data within the same study (Johnson et al., 2007; Denscombe, 2008; Creswell, 2009). Mixed methods research design has been defined by Tashakkori and Creswell (2007:4) as:

> "…research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry"

Through growing adoption of the pragmatic philosophical paradigm, a mixed methods approach to research has become an increasingly common choice over pure Qual or Quan studies (Tashakkori and Teddlie, 1998). Table 3.2 illustrates the advantages and disadvantages of Qual and Quan strategies.

Table 3.2. Advantages and Disadvantages of Qualitative and Quantitative Methods (Adapted from: Creswell, 2015)

Strategy	Advantages	Disadvantages
Qualitative	Detailed perspectives of a smaller sample	Limits opportunity for generalisability
	Captures participants' voices	Provides only soft data (not hard data e.g. numbers)
	Participants' experiences are understood in context	Small samples
	Based on participants' view as opposed to the researcher's	Highly subjective
	Appeals to enjoyment of stories	Limited use of researcher's expertise
Quantitative	Conclusions based on large samples	Impersonal
	Efficient data analysis	Does not record words
	Examines relationships within data	Limited contextual understanding
	Investigates causes and effects	Researcher driven
	Controls bias	
	Appeals to preferences for numbers	

Qual methods resonate with constructivist and interpretivist paradigms and provide the opportunity for rich narrative data from a smaller sample where participants' experiences are understood in context (Teddlie and Tashakkori, 2009; Creswell, 2015). These methods include interviews and focus groups, as well as more ethnographic approaches such as participant observation where observations and detailed narratives of specific groups of people are collected (Creswell, 2009). Qual methods are often adopted in studies using grounded theory (grounded in participants perspectives where data guides the research inquiry) (Urquhart, 2013) or phenomenological studies (based on participants' experiences of particular events) (Creswell, 2009). However, due to the smaller samples and highly subjective nature, this limits possibilities for generalisations. Quan methods align with the positivist paradigm and allow conclusions to be drawn based on data from large samples (Creswell, 2015). Whilst this may strengthen the reliability of the findings, the contextual understanding is limited as words or personal experiences of participants are not recorded. Methods often include surveys collecting numeric data that allows for statistical analysis (Creswell, 2009).

With a mixed methods approach, *both* Qual and Quan methods are used, limiting some of the associated disadvantages to each strategy. Additionally, with a mixed methods design the complexities of problems and phenomena are better addressed (Creswell and Plano Clark, 2003). As demonstrated in Table 3.3, there are several useful reasons for mixed methods designs to be adopted.

Table 3.3. Justifications for using Mixed Methods Design (After: Greene et al., 1989:259)

Purpose	Explanation	Rationale
Triangulation	Seeks convergence, corroboration, correspondence of results from the different methods	To increase the validity of constructs and inquiry results
Complimentarity	Seeks elaboration, enhancement, illustration, clarification of the results from one method with the results from the other method	To increase the interpretability, meaningfulness, and validity of constructs and inquiry results
Development	Seeks to use the results from one method to help develop or inform the other method where development is broadly construed	To increase the validity of constructs and inquiry results
Initiation	Seeks the discovery of paradox and contradiction, new perspectives of frameworks, the recasting of questions or results from one method with questions or results from the other method	To increase the breadth and depth of inquiry results and interpretations by analyzing them from the different perspectives of different methods and paradigms
Expansion	Seeks to extend the breadth and range of inquiry by using different methods for different inquiry components.	To increase the scope of inquiry by selecting the methods most appropriate for multiple inquiry components.

Methodological triangulation seeks to identify convergence and divergence between different methods which in turn increases validity and reliability of results (Creswell, 2009). This allows the researcher to understand the research problem more comprehensively through more than one method. However, triangulation can be limited by choice of unsuitable methods for the research inquiry (Oberst, 1993). Therefore, it is vital that the researcher critically evaluate which methods best address the research objectives.

Complementarity and expansion purposes are rooted in the opportunity to elaborate on and clarify the results from data collected with one method by using another (Greene et al., 1989). Here, adoption of mixed methods may fill gaps (where one method falls short), increase validity, and increase the scope of investigation as methods are chosen to suit the inquiry (Greene et al., 1989; Tashakkori and Teddlie, 1998; Saunders et al., 2015).

There are two overarching ways to utilise mixed methods: monostrand design and multistrand design. Monostrand designs include both Qual and Quan strategies to analyse the same data, typically used when for example quantitising qualitative data (Teddlie and Tashakkori, 2009). In contrast, multistrand designs include two or more strands of research where the study mixes Quan and Qual methods either within and/or across the strands. According to Creswell (2009) there are three common approaches to a mixed methods multistrand design:

Sequential designs are adopted when the research aims to expand or elaborate on findings of one method with another. The methods are undertaken in stages, for example starting with large sampled Quan inquiry to explore a theory or concept followed by Qual inquiry with a smaller sample of people allowing more detailed examination.

Concurrent designs seek convergence between Qual and Quan data, ensuring comprehensive analysis of the research problem. The researcher collects Qual and Quan data simultaneously before integrating both in interpreting the overarching results.

Transformative designs are used when the researcher adopts a theoretical lens within a study comprising of both Qual and Quan data. When using a theoretical lens for interpreting data, collection of that data may be either sequential or concurrent.

The use of Quan and Qual methods within the strands are varied but can be explained and conceptualised through the continuum illustrated in Figure 3.2.

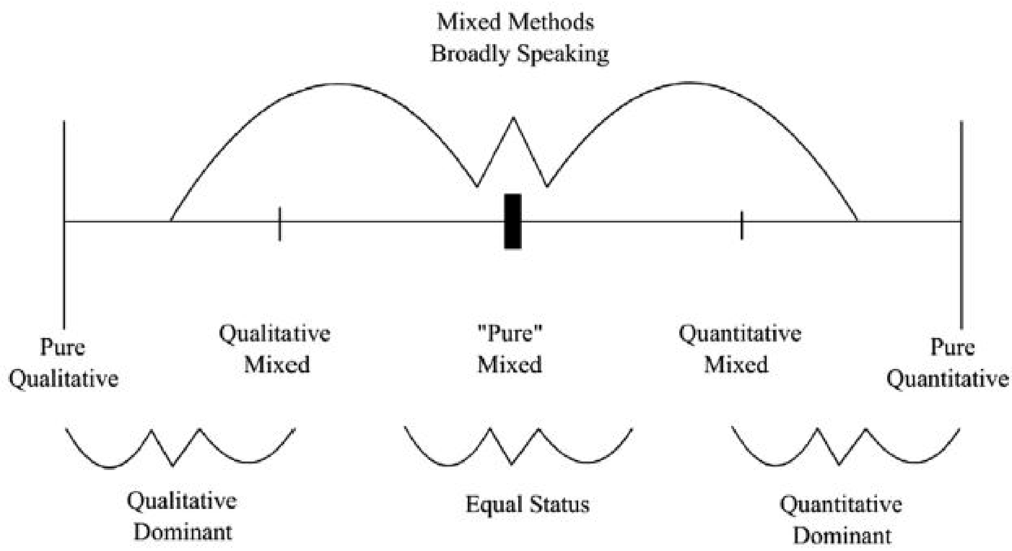

Figure 3.2. Mixed Methods Qual - Quan Continuum (Johnson et al., 2007:124)

Strands within mixed methods designs can therefore be pure Qual or Quan, dominant in one or the other but include components of both, mixed Qual or mixed Quan, or pure mixed (Johnson et al., 2007).

As this study adopted a pragmatic philosophical paradigm, a mixed methods approach was undertaken based on the justification of triangulation and opportunity for complimentary clarification of data. Given the exploratory nature of this research, a multistrand design was adopted as illustrated in Figure 3.3.

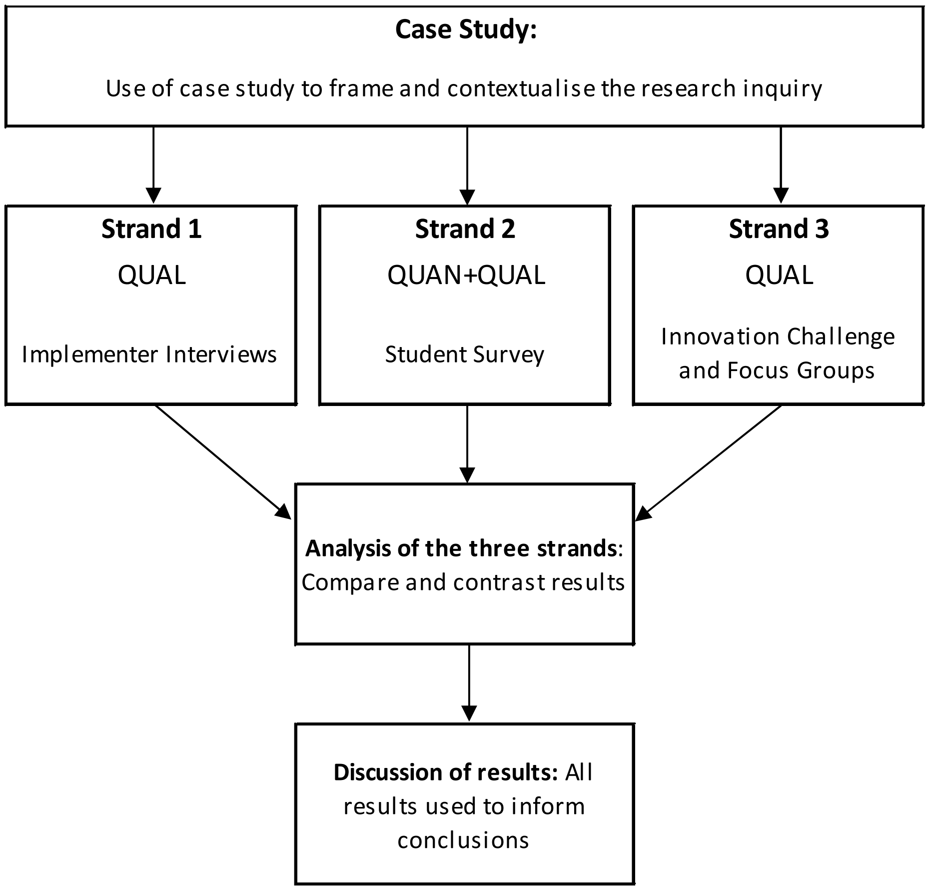

Figure 3.2. Multistrand Mixed Methods Research Design Adopted for this Study

QUAL Strand 1 sought to capture perspectives of smart city implementers through semi-structured interviews. Specifically, their perceptions of the smart city (Objective 1) and their views on the role of citizens in smart cities (Objective 2). The QUAN+QUAL Strand 2 sought to capture students' perspectives of the smart city in a survey-based questionnaire. Firstly, it examined their perceptions of the smart city (Objective 1) intended for triangulation with results from Strand 1. Secondly, it investigated environmental attitudes, beliefs and characteristics of the students (Objective 3) for triangulation and complimentary purposes with Strand 3. QUAL Strand 3 aimed to explore the potential of a smart solution to overcome energy conservation barriers through an Innovation Challenge and Focus Groups with students (Objective 3). Moreover, it elaborated on students' perceptions of the smart city (Objective 1), thus complimenting results from Strand 2. Together, results provided basis for robust analysis of the research problem and informed implications on the smart city and broader sustainable urbanism (Objective 4).

3.4 The Case Study

3.4.1 Case Study Approach

Case studies are commonly utilised in empirical research inquires. The approach allows the research to establish a holistic and contextual investigation of a contemporary event, whilst capturing significant characteristics and in-depth details of social phenomena (Yin, 2009; Bleijenbergh, 2010). A case study approach is particularly appropriate when the research seeks to answer 'how' or 'why' related questions about the social phenomena under investigation (Yin, 2009). A case study can be single-case or multiple case (Morgan and Morgan, 2009), and according to Stake (2000), there are three types of case study approaches: the intrinsic case study, the instrumental case study, and the collective case study. Whilst collective case studies seek to investigate a phenomenon across multiple cases, intrinsic and instrumental case studies examine one case in depth. The difference between the latter is the scope for generalisation of findings. Whilst intrinsic case studies do not attempt to generalise findings beyond the case in question or build theories as a result, instrumental case studies investigate a case that is representative of other cases in order to critically evaluate issues within these (Stake, 2000).

Although methods such as participant observation (Di Domenico and Phillips, 2010) or in-depth interviews (Barlow, 2010) are more traditionally used in case study research, cross-sectional surveys can also be used in order to sample larger quantities of a population within a case in a time efficient manner (Chmillar, 2010). As such, a case study approach is commonly adopted within mixed methods research designs for triangulation purposes as applying both inductive and deductive reasoning provides rigour to the case study results (Kitchenham, 2010). Due to the methodological flexibility of the case study approach, it is well suited to a pragmatic approach in which both Quan and Qual methods are utilised and triangulated (Rosenberg and Yates, 2007).

Case study approaches have been adopted in smart city research as it allows researchers to examine in-depth details and contextual characteristics of the phenomenon in specific geographical locations (single-case) (cf. Cardullo and Kitchin, 2018a) or enables comparative analysis across multiple cities (cf. Anthopoulos, 2017). As this thesis aims to analyse socio-technical challenges to smart city implementations and aspirations, this research adopted a single-case instrumental case study approach. The rational for using a case study approach for this study is rooted in the excellent suitability with a pragmatic methodology due to the potential for triangulation of multiple strands of data collection and analysis, and the aim to understand contextual aspects of the smart city concept through in-depth investigation of emergent themes and patterns in a single geographical location (Stake, 1995; Kitchenham, 2010).

3.4.2 Selecting a Case

By adopting an instrumental case study approach, the researcher was not looking for an extreme case, rather a case that could illustrate typical examples of smart city implementations (Bleijenbergh, 2010). Convenience and access played a role in selecting the case, but were not the determinant factors (Silverman, 2013). Three main criteria were considered when selecting the case:

- The case was required to be within set boundaries of an urban space characterised as a smart city district as this maximises access to appropriate stakeholders more likely to be aware of the smartification of the city.
- The case study location should be influenced by a mix of smart city initiatives actively working on implementing smart solutions in a range of the domains identified in Chapter 2, Figure 2.1.
- Given that this research sought to examine the concept of smart cities from different stakeholders' perspectives, access to geographically co-located samples was vital.

3.4.3 Introducing the Case

The Manchester Oxford Road Corridor

After careful consideration of the case criteria, the Manchester Oxford Road Corridor (hereafter: 'the Corridor') was selected. The case met all the criteria as the Corridor demonstrated a vibrant range of smart city initiatives within well-defined boundaries of an urban space where the researcher would have access to a range of stakeholders (Karvonen et al., 2018).

Manchester is often described as the capital of the North West and is home to approximately half a million people (excluding Greater Manchester) (Manchester City Council, 2017). After its' intriguing industrial history, Manchester has undergone large scale urban renewal (Peck and Ward, 2002) and established itself as one of the leading smart cities in the UK. As part of Manchester Smarter City vision, the Corridor (Figure, 3.3) emerged as the cosmopolitan innovation district of the city (Oxford Road Corridor, 2019a). South of Manchester city centre, the Corridor stretches from St Peter's Square to Whitworth Park, and from Higher Cambridge Street in West to Upper Brook Street in the East.

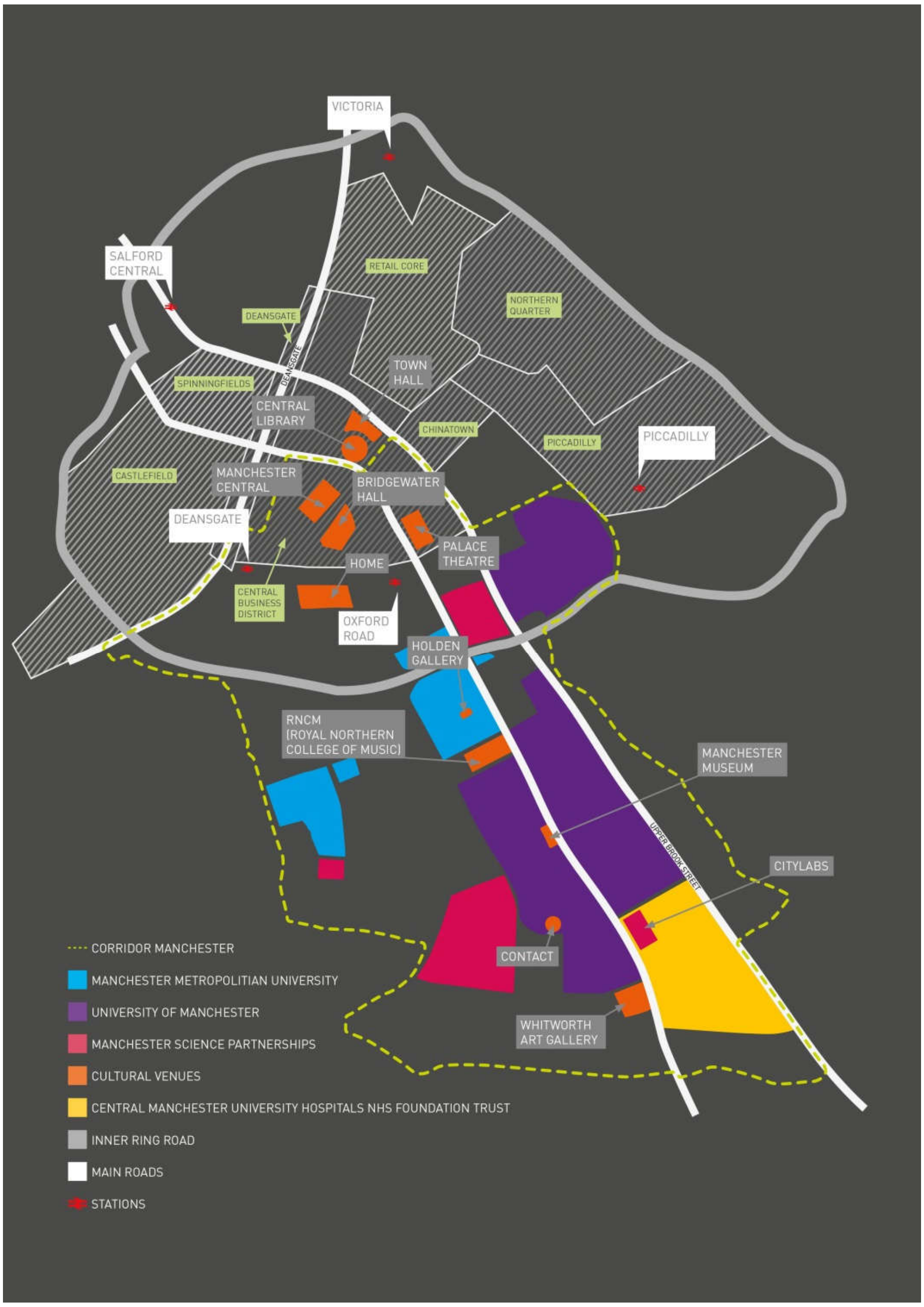

Figure 3.3. The Manchester Oxford Road Corridor (Oxford Road Corridor, 2019b)

Here, two major smart city initiatives, CityVerve and Triangulum (Manchester City Council, 2019), involve several stakeholder partners ranging from large IT corporations to universities and focus on a number of domains including energy and environment, transport and mobility, and public engagement (Triangulum, 2018; CityVerve, 2019).

Whilst CityVerve is a Manchester specific initiative, Triangulum is an EU Horizon 2020 project with the aim to demonstrate, disseminate and replicate solutions from three lighthouse cities: Manchester, UK, Eindhoven, Netherlands, and Stavanger, Norway.

Manchester Metropolitan University

Universities play an important role in the broader urban sustainability debate. With increased attention on campus greening and addressing energy challenges of campus buildings, universities have emerged as test beds for smart city solutions (Karvonen et al., 2018). Manchester Metropolitan University (hereafter: 'Manchester Met') is one of the universities situated within the Corridor and is actively involved in multiple smart city initiatives linked to the district. Coupled with a student population of 33,088 (HESA, 2018a), this makes Manchester Met a key stakeholder in the smart city district of Manchester.

Birley Student Living: The Challenge

In 2014, Manchester Met's Birley campus opened, facilitating new student residences: Birley Student Living (hereafter: 'BSL'). These residences comprise of 37 flats, housing eight students per flat, and three blocks of townhouses with 56 flats, housing 12 students per flat, all built to high energy efficiency standards. Additionally, with real-time energy monitoring enabled on a flat and block level, this student accommodation presents replicates of flats with identical energy demand. The only variable determinant in energy use is that of the students' occupying the accommodation.

As part of the Triangulum project, in which Manchester Met is a key stakeholder, the campus has recently installed a battery for electricity storage. The aim is to charge the battery through solar panels on the rooftops of the campus' university buildings and discharge this electricity to meet the campus' energy demand during peak hours (5pm – 7pm), taking the campus off the national grid within this time (Karvonen et al., 2018). However, in order to achieve this and avoid the battery running out, thus connecting to the national grid again, electricity consumption needs to be reduced. This is especially a challenge in student halls as the students' energy bills are included in their accommodation fees, removing all financial drivers for saving energy, thus placing them in a split incentive scenario.

3.5 Strand 1 (Qual) - Implementer Interviews

To provide broader contextual understanding of the ‘smart’ label and assess the problematic role of the citizens in the smart city, smart city implementers’ perspectives were required. This would also identify potential tensions and contesting perceptions with those of the citizens. In order to gain access to these expert opinions and explore the issues in detail, in-depth interviews with undertaken.

3.5.1 In-depth Interviews

One of the most commonly used methods within qualitative research is in-depth interviews. Interviews are conversational in nature and aim to capture opinions and beliefs from the person being interviewed (Dunn, 2000). DiCicco-Bloom and Crabtree (2006:315) further explain that:

> “…individual in-depth interview allows the interviewer to delve deeply into social and personal matters”.

Interviews can be powerful in various ways. They are utilised to efficiently provide in-depth knowledge that other methods such as observations or quantitative strategies cannot. In Quan or Quan-qual methods such as questionnaire-based surveys, the possibility for elaboration or clarification from respondent is limited whereas interviews allow richer data to be obtained (Dunn, 2000). Whilst interviews usually collect data from a smaller sample than questionnaire-based surveys, they are useful in order to compliment and triangulate results with data obtained through these other methods (Tashakkori and Teddlie, 1998; Diefenbach, 2006). Therefore, interviews are well suited within mixed method research designs. Additionally, interviews are used to examine complex behaviours and motivations and collects a range of meanings, opinions and experiences (Dunn, 2000). Whilst these expressions are subjective to that of the interviewees, these factors can expose differences between interviewees and potentially reveal interesting contesting perceptions.

Different types of interviews

There are three approaches to using interviews in Qual research: structured, unstructured and semi-structured.

Table 3.4. Different Interview Approaches (adapted from: Longhurst, 2003; Tashakkori and Teddlie, 2003; DiCicco-Bloom and Crabtree, 2006; Bryman, 2012)

Structured	Unstructured	Semi-structured
Characterised by a formal approach and follows a set schedule	Characterised by an informal approach, with very few pre-determined questions	Characterised by a mixed approach, following some pre-set questions
Does not open for further discussion based upon answers given by respondents	Highly conversational and leads the interview in whichever direction the conversation goes	Flexible by allowing conversation and further queries based on responses given

As seen in Table 3.4, the main difference is the use of pre-set questions and openness to broader discussions. Structured interviews follow a set schedule and can be particularly useful when comparing responses amongst groups or when the interviews are done in waves (Firmin, 2008a). Unstructured interviews are based on few pre-determined questions and are usually employed when there is limited knowledge on the topic, for example in inductive ethnographic studies where the researcher has limited pre-set notions about the topics (Firmin, 2008b). Semi-structured interviews on the other hand engage with pre-set questions but allows the interviewer to further query responses given by the interviewee, making it a flexible approach (Dunn, 2000).

Smart city examples

In-depth interviews have been used in smart city research. Table 3.5 illustrates examples of studies using in-depth interviews, with specification of interview approach where known.

Table 3.5. Examples of Smart City Studies using In-depth Interviews

Example Studies	Research Inquiry	Type of Interview
Kitchin (2019)	In-depth interviews with smart city stakeholders, considering smart cities from a temporal perspective	Unspecified
Cardullo and Kitchin (2018b)	In-depth interviews with smart city stakeholders investigating the space and control for citizens in projects	Unspecified
Thomas *et al.* (2016)	On the street, face-to-face interviews with citizens in three different smart cities, reflecting on their perceptions of the concept	Semi-structured
Carvalho (2014)	Face-to-face interviews with pilot's proponents and smart city stakeholders mapping out smart city visions	Semi-structured
Nam and Pardo (2014)	Face-to-face interviews with government officials to gain practical insight to smart city projects	Semi-structured
Paroutis et al. (2013)	Face-to-face interviews with IBM managers investigating technological applications in smart cities	Structured
AlAwadhi and Scholl (2013)	Face-to-face interviews with smart city professionals, examining their definitions of a smart city	Semi-structured

3.5.2 Semi-structured Interviews

Due to the flexibility to stray away from the set questions and ability to generate data on a discussion basis, the semi-structured interview approach was adopted in this research. This was framed with both an inductive and deductive logic seeking to explore themes from the literature review and new emerging from the data.

Semi-structured interviews are ideal when examining perceptions and understandings which was particularly important given the nature of this study. Table 3.6 provides an overview of the advantages and disadvantages of a semi-structured interview approach.

Table 3.6. Advantages and Disadvantages of Semi-structured Interviews (Adapted from: Longhurst, 2003; Tashakkori and Teddlie, 2003; Diefenbach, 2008; Creswell, 2009; Bryman, 2012)

Advantages	Disadvantages
In depth, rich answers	Potential bias due to view and role of interviewer
Enrich quantitative data findings	Skill of interviewer to stay on topic
Allows clarification of vague answers	Access to interviewees
Allows more freedom to explain	Time consuming analysis
Access to non-quantifiable data	Accurate recording and interpretation of data

Semi-structured interviews focus on designing an interview schedule that is open for further inquiry and discussion. With some set questions, the interviewer is able to steer the discussion by identifying interesting points raised during the session (Tashakkori and Teddlie, 2003; Bryman, 2012). While this is useful, the interviewer is at risk of spending too much time on one question. Therefore, the skill of the interviewer is highly important in this chosen method (Bryman, 2012).

Interview Schedule

Before commencing the interviews, a schedule with a set of questions was designed to guide the interview (Appendix 3). Such schedules are often associated with the semi-structured approach to interviewing and is useful to remind the researcher of the intended points of discussion (Dunn, 2000; Longhurst, 2003). Themes identified from the literature review and consideration of the research objectives provided the basis for the interview schedule. The schedule was divided into three sections:

Section 1: the ‘smart’ label.
Section 2: concerns, perceptions and aspirations.
Section 3: smart citizenship.

Section 1 sought to identify the implementers’ conceptual understanding of the smart city and what they believed makes a technology smart. They were encouraged to define the smart city and provide characteristics and examples of smart technologies.

Section 2 investigated the implementers' perceptions of the smart city. They were asked to identify benefits they believed the smart city could bring and potential concerns they had about the concept. Additionally, they were asked what their future aspirations of the smart city are.

Section 3 examined their perceptions around smart citizenship and citizens' role in the smart city. They were asked to describe what makes a citizen smart. Then they were asked what approaches they believed to be most effective in engaging citizens in smart city developments. Finally, they were asked how they believed citizen participation is currently enacted in the smart city, followed by their perceived barriers to citizen engagement.

According to Jacob and Furgerson (2012), interviews should not exceed 90 minutes considering time for different commitments for the interviewees. With this in mind, the interviews were designed to last approximately one hour.

Sampling strategy

The interviewees in this study were selected due to meeting the criteria of having direct impact on smart city implementations in Manchester through working for an organisation involved in a smart city initiative. A purposive sampling technique was adopted in order to ensure the criteria were met and that the sample represented a wide range of stakeholder backgrounds (Ritchie et al., 2013). The participants were all recruited via email and approached with an introduction to the study explaining what the aim was and why they were being asked to participate (see Appendix 1 for a sample of email invitation. Note every email was tailored to the potential participant). Attached to the email was also a participant information sheet (Appendix 2A) explaining details about the study and the confidentiality of any data obtained.

Pilot

Before the interviews could commence, the interview schedule was piloted with a smart city implementer face-to-face. The pilot interview lasted one hour, hence did not exceed the suggested time limit for a one-to-one interview (Furgerson, 2012). The researcher ensured that the interviewee was put at ease from the start by opening with a casual conversation around their role in smart city implementations. In turn, this helped establish a good rapport before proceeding to the questions in the interview schedule (Majid et al., 2017).

The questions in the interview schedule all generated interesting discussions, however, the flow was slightly inconsistent in places. This was overcome by changing the order of the questions. Additionally, there was no feedback from the interviewee indicating the need to alter any questions, thus no questions were changed or removed. Therefore, the data obtained from this interview has been included in this study which is appropriate if the questions do not drastically change (Breen, 2006).

Procedure

12 semi-structured interviews were conducted with a range of implementers of smart city solutions in the Corridor (Table 3.7).

Table 3.7. Interviewees Profile

Interviewee	Role Field	Organisation	Interview Date
SCI0	Transport and Mobility	University	Jul-18
SCI1	Programme Management	Technology Developer	Aug-18
SCI2	Communications	Agency	Aug-18
SCI3	Energy Management	University	Sep-18
SCI4	Energy Management	IT Corporation	Oct-18
SCI5	Programme Management	Agency	Oct-18
SCI6	Digital Grid Strategies	IT Corporation	Oct-18
SCI7	IoT Research	Telecommunications	Oct-18
SCI8	Platforms and Sensors	Technology Developer	Oct-18
SCI9	Programme Management	Council	Oct-18
SCI10	Environmental Sustainability	University	Nov-18
SCI11	Transport and Mobility	Transport Agency	Feb-19

Interviews took place face-to-face at the implementer's work location, in a public space or over the telephone. As the research had a clear focus and the interviews were conducted with intention to triangulate results, a smaller sample was appropriate as saturation (when no new codes emerge) is reached faster (Morse, 2000). None of the interviews lasted longer than one hour. Before the interviews commenced, all the interviewees were presented with a consent form (Appendix 2A) to sign and the opportunity to ask the researcher any questions they had. After the interview, the interviewees were thanked for their participation and asked if the researcher could ask follow-up questions at a later time may there be any.

Transcription and Coding Approach

All interviews were audio recorded on a Dictaphone or mobile phone device, and the researcher took notes throughout the interviews as advised by Dunn (2000). The latter allowed the researcher to revisit interesting themes later in the interview when it was appropriate to do so and also secured a form of back-up in case of technical errors. Thereafter, data through audio recordings were transcribed into written forms for analysis (Bailey, 2008). Researchers make decisions about what to include and how to include it in transcriptions (Davidson, 2009) and the transcription approach needs to suit the purpose of the research (Lapadat, 2000). Full transcription is common within Qual research where the researcher is interested in verbatim details or non-verbal interactions (Oliver et al., 2005; Halcomb and Davidson, 2006) such as studies adopting grounded theory, ethnography and phenomenology (McLellan et al., 2003). As transcription is a time-consuming process (Bailey, 2008), research seeking out reoccurring patterns and themes may adopt partial transcription as this can be completed with less text (McLellan et al., 2003). Additionally, listening to the audio recordings can be part of the interpretive coding process (Lapadat, 2000; Bailey, 2008). Coding is defined as:

> “The coding in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data”. (Saldaña, 2016:4).

Codes can be either etic or emic. Whilst emic codes are generalities and patterns deriving from the data analysis, etic codes are ideas imposed on or applied to the data (Drisko, 1997).

This study intended to undertake thematic analysis of the transcripts. Therefore, in order to ensure that the transcription approach undertaken suited the aim of the study and provided rigour to the analysis, the first two interviews were fully transcribed and assorted into master-codes and sub-codes following the strategy of Kitchin and Tate

(2000). The following two interviews were partially transcribed and coded in the same manner in to identify whether full transcription was required. This revealed that the two approaches provided the same level of identification of codes and rigour of analysis and therefore, the researcher decided that partial transcription was sufficient enough in order to identify themes and patterns in the data. As coding is an iterative process (Saldaña, 2016), the researcher re-listened to relevant parts of previous audio recordings whenever new codes emerged in order to ensure all evidence to support codes was transcribed and coded. Thereafter, all the partial transcriptions were thoroughly examined again, ensuring no evidence was missed for the established codes.

3.5.3 Thematic Analysis

Data collection and analysis were conducted simultaneously which enabled the data to lead the inquiry (Miles et al., 2013). When the coding process was completed for each transcript, thematic analysis of these codes was undertaken. Thematic analysis is the process that allows the researcher to identify patterns of themes within and across data sets in order to make sense of the data and make the data more manageable (Braun and Clarke, 2006; Bryman, 2012). This is particularly beneficial when the study consists of several qualitative transcripts. With thematic analysis, links between themes can be examined and linked to broader theoretical concepts and issues (Braun and Clarke, 2006). It is a flexible analytical process, but requires rigour to establish trustworthiness, consistency and cohesion through analysis.

This study adopted thematic analysis due to undertaking both inductive and deductive logic, allowing themes to emerge from the data whilst having some structured notions regarding the more specific codes. This was differentiated by stating whether the code was etic or emic. The codes were shaped into analytical themes guided by the literature review and the research objectives. Thereafter, these were used to establish a thematic code table in Microsoft Excel which helped the researcher sort all the themes into categories and identify relationships between them (Miles et al., 2013). Table 3.8 illustrates an extract of the code table while the full version can be viewed in Appendix 4.

Table 3.8. Extract of Interview Code Table

Master Code	Definition	Sub-code	Definition	Code Type
Smartness	Relates to understandings and perceptions of what 'smart' entails and means to different participants	Smart City	Relates to their understanding of the smart city	Etic
		Smart Technology	Relates to their understanding of what makes a technology smart	Etic
		Smart Citizen	Relates to their understanding of what a smart citizen is	Etic
		Technological development	Relates to how rapid technological development can be a challenge when it comes to delivering smart city projects	Emic
		Tangibility	Relates to how they think people associate smart with something that is tangible	Emic
		Terminologies	Relates to how their notions regarding the smart terminologies in different settings	Emic

3.5.4 Limitations

Purposive sampling enables the researcher to choose interviewees. Whilst this technique can be judgemental, it is not biased in nature and is often used when seeking expert opinions that can be representative of the population (Ritchie et al., 2003). There is a continuous debate in qualitative research regarding "how many is enough". This study followed the recommendations by Guest et al. (2006) and determined that the interview process was complete when saturation had been reached, which in this case was 12. Additionally, a small-scale sample is acceptable when using purposive sampling following robust criteria such as in this study (Ritchie et al., 2003).

Social desirability bias must always be considered a possibility when relying on self-reported data. The social desirability bias happens when participants in a study presents what they believe to be a favourable image of themselves, thus can reduce the validity of the data (van de Mortel, 2008). However, this bias is more likely to occur in response to sensitive and personal questions which this study does not involve (King and Bruner 2000).

The risk of asking leading questions when engaging in further discussions to the responses provided by the interviewees could be a limitation. However, the researcher ensured wherever possible that “non-directive probes” (Mandel, 1974:20) were used such as “could you elaborate on that?” and “what influences your answer?” rather than “do you think that because…?” so that questions remained as open-ended as possible. Nevertheless, when needing to clarify what the interviewee meant and provide structure around the information, further questions such as “do you mean ...?” “you feel that ...?” or “are you saying ... ?” were used (Mandel, 1974:20-21). Additionally, it is crucial that while steering the conversation, the interviewer remain as objective as possible in order to not “agree” or “disagree” with the interviewee as this may bias the results (Tashakkori and Teddlie, 1998; DiCicco-Bloom and Crabtree, 2006; Bryman, 2012).

3.6 Strand 2 (Pure Mixed) – Student Survey

The limited literature on citizens’ understanding of ‘smart’ and perceptions of real-time energy information coupled with the need to establish some basic characteristics of the students’ worldviews and values driving their environmental perceptions provided the justification for the collection of cross-sectional survey data. In order to establish a representative sample for the large and diverse student population, an online survey was chosen.

3.6.1 Survey Development

The survey instrument was an electronic, self-administered questionnaire distributed using online survey tools (the survey tools will be elaborated on in 3.5.3). An introductory page provided respondents with information about the study, the researchers and supervisory teams’ contact details, and encouragement that there were no right or wrong answers (Fisher, 1993). Deutskens et al. (2004) suggest the length of surveys affects both response rate and the quality of responses. Therefore, the survey was designed to take 10 - 15 minutes to complete, although if students wished to leave lengthy responses for the open-ended questions, it could take longer.

The survey was divided into three overarching sections:

Section 1: understandings of ‘smart’.
Section 2: perceptions of the environment and attitudes towards real-time energy information.
Section 3: demographic data.

Section 1 explored students' understandings and perceptions of the smart city, smart technology and the Internet of Things (IoT).

Questions involved:

- Familiarity with and understanding of the smart city concept.
- Concerns and benefits related to the smart city.
- Understandings of what makes a technology smart.
- Familiarity with the term IoT and their understanding of it.
- Smartphone ownership and associated privacy concerns.

This section contributed to achieving Objective 1: investigate stakeholders' perceptions of the smart city, by addressing it from the students' perspective. It identified the students' familiarity with the concept before exploring their understandings of the smart city, and perceived benefits and concerns about the concept. The students' understanding of the 'smart' label was further examined through their descriptions of smart technologies and familiarity and understanding with the term IoT. These questions were mandatory for all students.

The privacy related questions were only available to students who answered "yes" to owning a smart phone. Questions examined students' level of concern regarding their privacy when using their smartphones and whether they read terms and conditions when downloading apps.

Section 2 sought to identify students' perceptions and concerns about the environment, drivers for energy conservation and attitudes towards real-time energy information.

Questions involved:

- Attitudes and perceptions of the environment and society.
- Concern about climate change.
- Importance and drivers for energy conservation.
- Motivational actors for pro-environmental behaviour.
- Previous experience with smart meters, monitors and thermostats, frequency of use of these devices, and how and to what extent they encouraged them to conserve energy.
- Perceived usefulness of seeing real-time energy consumption and likelihood of it encouraging students to conserve energy.

This section contributed to achieving Objective 3: explore the potential for smart solutions to encourage energy savings in a split incentive scenario. Firstly, the students' attitudes and perceptions of the environment and society were examined as well as their concerns about climate change. This provided characteristics of the students' worldviews and values which could help explain what influenced their other responses. Secondly, general questions regarding importance of energy conservation and motivations for pro-environmental behaviours enabled the researcher to identify students' drivers for energy conservation. These questions were mandatory for all respondents.

This section also identified students' previous experience with smart meters, monitors and thermostats and whether it encouraged them to conserve energy. The students with no previous experience with these smart devices skipped the related questions. Nevertheless, all students were asked if they would find real-time energy information useful and to what extent this was likely to encourage them to conserve energy. Together, this gave a preliminary indication as to how a smart solution could be adapted to the case study scenario outlined in Section 3.4.3 and highlighted potential barriers to engaging with such devices.

Section 3 collected demographical data and information about the students' household background.

Firstly, students were required to report their household background and whether they were responsible for paying energy bills in order to determine whether they lived in a split incentive scenario. Secondly, this section asked socio-demographic questions which was mandatory for all respondents, however, they were provided with the option 'prefer not to say'. Socio-demographic information is essential in identifying characteristics about the respondents that may influence their opinions expressed in the survey (Stoutenborough, 2008). As recommended by Stoutenborough (2008), the socio-demographic measures were placed at the end of the survey in order to: first, build rapport with respondents, second, prevent respondents to drop out due to personal questions early on and allowing them to answer the core questions first, and third, avoid priming respondents.

3.6.2 Formulation of Questions

When formulating the questions for this survey, the researcher acted on the advice by Fowler (2012). This provided attention to the wording of questions and consistent meaning of the questions for all respondents and ensured provision of definition of ambiguous terms needed to understand questions. This sought to increase reliability and validity of the data obtained (Fowler, 2012).

The survey comprised of both open and closed questions. The majority of the closed questions were based on Likert-scales commonly used in survey research (Likert, 1932; Vagias, 2006). Whilst debates exist whether to use 5 or 7-point scales, Dawes (2008) found in his experiment that both scales produced the same mean scores. Coupled with this, 5-point scales can be easily transferred to 7-point scales for analysis should the researcher wish to do so (Dawes, 2008), thus 5-point scales were adopted for the majority this survey. However, the questions utilising frequency scales were extended to a 6-point scale as this allowed the 'never' option (Vagias, 2006). A few questions were multiple choice, allowing respondents to select all that were applicable to them. Additionally, two well-known theoretical scales (as described in Chapter 2, Section 2.10.2) were used in order to measure students' attitudes and perceptions towards the environment: The New Ecological Paradigm (hereafter: the 'NEP Scale') (Dunlap et al., 2000) and the survey instrument developed by de Groot and Steg (2007; 2008) based on Schwartz's Value Theory (1992; 1994) (hereafter: the 'Value Scale'). The NEP Scale was based on a 5-point scale and the Value Scale was a 9-point ranking scale.

In order to enrich the data, closed questions (apart from the NEP Scale and Value Scale) were followed by an optional open comment box where respondents could elaborate on their answer (Andres, 2012). The open-ended questions were useful in order to obtain unexpected and exploratory answers that reflect respondents' perceptions (Fowler, 2012). Fowler (2012) also points out that open-ended questions are important as participants like to describe responses in their own words and that closed questions limits their expression of thought. The open-ended questions were particularly useful for Section 2 of the survey.

When the survey was complete, students were able to opt into a prize draw to win one of four £25 amazon and/or an iPad Mini. Prize draws for such incentives are often good alternatives to paying participants for their time, especially when the sample size is large

(Head, 2009). Additionally, respondents were provided with an open comment-box at the end of the survey where they could elaborate further on any answers or leave any kind of additional comments if they wished to do so.

3.6.3 Sample

The target population for this survey was students enrolled at Manchester Metropolitan University. A total of 1007 usable responses were obtained. The survey was voluntary, and the sampling was random where no particular group of students were targeted. Table 3.9 demonstrates the breakdown of the students' gender, age, country of domicile, ethnicity and their level of study. Comparing the demographic ratios to that of the student population at Manchester Met (HESA, 2018a; b), the sample was representative.

Table 3.9. Student Respondent Profile

Demographics	Survey (n=1007) #	(%)	Manchester Met University (n=33088) #	(%)
Gender				
Female	549	(54%)	19415	(59%)
Male	440	(43%)	13660	(41%)
Other	9	(1%)	5	(.02%)
Prefer not to say/unknown	9	(1%)	0	(0%)
Age				
20 and under	468	(46%)	16475	(50%)
21 - 24	344	(34%)	9515	(29%)
25 - 29	102	(10%)	2685	(8%)
30 and over	84	(8%)	4405	(13%)
Prefer not to say/unknown	9	(1%)	0	(0%)
Country of domicile				
UK	905	(89%)	30610	(93%)
Other EU	32	(3%)	970	(3%)
Non-EU (International)	70	(7%)	1500	(5%)
Ethnicity*				
White	625	(62%)	22080	(72%)
Asian	231	(23%)	4945	(16%)
Black	72	(7%)	1615	(5%)
Mixed	40	(4%)	1415	(5%)
Other	26	(3%)	440	(1%)
Prefer not to say/unknown	13	(1%)	120	(.4%)
Level of Study				
Undergraduate Degree	826	(81%)	26605	(80%)
Postgraduate Degree	181	(18%)	6475	(20%)

*HESA data for ethnicity only available for UK domiciled students

3.6.4 Procedure

Pilot

The survey was piloted with 12 volunteer students at Manchester Met, of which nine left detailed comments describing their experience of the survey. This was to ensure that the questions were correctly phrased, comprehensible, and that the online survey tool functioned as intended. Two main factors were highlighted in these comments: (1) certain questions required clarification as respondents found them confusing, and (2) the survey was slightly too long. This was corrected accordingly, re-tested and approved by the researcher's supervisory team.

Administration Phase 1

Overall, the survey ran between March 2017 and February 2018 in two phases. The online survey tool used for phase 1 was Bristol Online Survey (BOS). Leaflets with the web-link were produced to promote participation, however, the majority of responses were obtained through face-to-face recruitment as the researcher set up stands in various Manchester Met university buildings. At these stands, the survey was completed on iPads provided by the researcher. The stands had large posters and free sweets to catch attention and the researcher was actively approaching bypassing students. Students were approached with the question "are you a student currently enrolled at Manchester Met?" as this was a basic requirement before allowing them to complete the survey. Part-time students were also allowed to participate.

Administration Phase 2

After 400 responses, the researcher undertook preliminary analysis of the survey data. This revealed the need for minor changes to existing questions due to misinterpretations that were not identified in the pilot. For example, some students selected household categories that did not match their responsibility for bills or provided open comments contradicting their choice of household. Additionally, the analysis of the open-ended questions identified some interesting themes prompting a desire to add questions to the survey (see Appendix 5 for the full version of the survey. Changes are indicated).

The online survey tool SurveyMonkey (SM) allowed these changes to be made and provided a better instrument than BOS for the purpose of this research. All changes between the two versions of the survey are illustrated in Table 3.10. The administration of this survey was identical to phase one.

Table 3.10. Changes between the Two Versions of the Student Survey

BoS Version	SM Version
Accommodation and living situation was in the same choice list	Changed to first selecting accommodation category, then living situation
Options to select responsibility for bills was either yes or no with no option to provide detailed arrangements	Changed in order to separate between partial and full responsibility for bills, as well as separate option for fair usage
	Added questions regarding energy awareness and self-reported energy efficiency
	Added question regarding perceived benefits to the smart city

3.6.5 Survey Data Analysis

Quantitative Data

The Quan data from the closed-ended questions were analysed in Microsoft Excel and in IBM SPSS version 25 to examine potential relationships and differences between students. Whilst there is contesting practice within the literature on how to statistically treat Likert-type responses (Jamieson, 2004; Norman, 2010), this study was exploratory, thus the data was treated as ordinal.

The Kolmogorv-Smirnov test was used to test for normality, and thereafter non-parametric tests were undertaken (Lillefors, 1967). The Mann-Whitney U test was used to test for difference between two independent variables while the Kruskal-Wallis H test was used to test for difference between groups of more than two independent variables. If the Kruskal-Wallis H test revealed that there was a difference (p=<0.5), the post hoc one-way ANOVA Pairwise Comparisons test was used to identify which of the multiple variables were different. The Spearman's rho correlation test was used to check relationships between variables. As the sample size was large, multiple regression analysis was carried out in order to examine how well independent variables explained dependent variables (Allison, 1999). Additionally, descriptive statistics such as compare means, medians and standard deviation, and frequency distributions was used to understand the differences detected by the other tests. Unless identified in the chapters, relationships and differences between responses were not significant.

Qualitative Data

Survey responses were downloaded from the online survey tools and into to Microsoft Excel where the open-ended questions were coded and thematically analysed following the procedure illustrated in 3.5.3 (see extract of survey coding sheet in Appendix 6). However, some of the responses to open-ended comment boxes that complimented the closed questions were converted into ordinal data and given a value for the purpose of statistical analysis after being thematically coded. This quantification of the Qual data was useful to test open-ended responses against closed-ended scale questions for differences (Driscoll et al., 2007).

3.6.6 Validity and Reliability

Strengthening of the validity and reliability of the survey was accounted for through rigorous refinement of the survey design and testing in the pilot process. Reliability concerns the consistency throughout responses and validity ensures the survey achieves to gather the relevant data and measure the factors it intends to (Bryman, 2012). In order to ensure increased validity and reliability in this survey the following measures were undertaken:

- The questions were deemed appropriate based on existing research and peer reviewed literature.
- Questions were formulated to suit students of all ages with no previous background knowledge of the topics.
- Beneath all closed-ended questions (apart from demographic questions) there was a comment box provided where respondents could elaborate on their answer if they wished to do so.

As some of the questions were longer grid questions, a potential risk to reliability could be participant error in which they, for example, answer the survey without considering the questions or in a rush (Robson, 2002). To address this, the order in which these answer options appeared for each respondent was random.

3.6.7 Limitations

The nature and order of the questions could have given the respondent ideas as to what the topics were, thus potentially influence the responses. For example, questions regarding concerns about the environment and privacy were placed before those relating to the smart city, hence possibly influencing students' understanding of the concept, particularly those with no existing awareness of it. As such, the most significant limitation to this survey was the basis of self-reported answers and therefore, the risk of social desirability bias (Fowler, 2012).

Given the survey was online, respondents could experience technical issues. There was also a risk that technical inabilities could hinder respondents in participating. However, as respondents to this survey were students, the likelihood of the latter being regarded an issue was low.

Fraudulent responses from other than Manchester Met students was a possibility (Murphy, 2008). However, the researcher undertook measures to prevent this by only distributing the leaflets with the web-link to the survey within the university and by asking respondents recruited face-to-face if they were students enrolled at Manchester Met.

3.7 Strand 3 (Qual) – Innovation Challenge and Focus Groups

The strong emphasis on the need for co-creational approaches of smart city solutions in the literature provided the justification for the strategies adopted in this strand. In order to address the need of co-developing solutions in collaboration with citizens, a workshop-based 'Innovation Challenge' and focus groups were undertaken. Additionally, there was a desire to triangulate and compliment the survey findings with Qual data to increase validity.

3.7.1 Innovation Challenge

Workshops can be a powerful tool to engage stakeholders in solving societal challenges (Quist et al., 2001; Ørngreen and Levinsen, 2017). Such participatory workshops have been defined by Ørngreen and Levinsen (2017:71) as:

> "…an arrangement whereby a group of people learn, acquire new knowledge, perform creative problem-solving, or innovate in relation to a domain-specific issue".

Workshops can be used as a consultative method where stakeholders can express their opinions prior to interventions being implemented (Cornwall, and Jewkes, 1995). The workshops focus on scenarios where the goal is for the participants to propose new and creative solutions to societal challenges (Quist et al., 2001). Data collection can be a challenge when using workshops as a method, particularly if the researcher is not present at the event. However, if the researcher attends and adopts a strong note-taker role as well collects artefacts produced by the participants on the day, this can provide trustworthiness and validity of the data (Ørngreen and Levinsen, 2017).

This study adopted the workshop method contributing to Objective 3. The workshop was scenario-based by illustrating the split incentive scenario issue in BSL stated in 3.4.3. The aim of the workshop was therefore for the participants to design a potential smart solution to encourage energy conservation in the split incentive scenario in BSL.

Following the typical features of a workshop as explained by Ørngreen and Levinsen (2017), the following workshop was designed and framed as an innovation challenge as illustrated in Table 3.11.

Table 3.11. Adoption of Workshop Features for the Innovation Challenge (Adapted from: Ørngreen and Levinsen, 2017)

Workshop features	Application to the Innovation Challenge
Event with a limited duration	The event was a half a day event (6h).
Targeting participants who share a common domain	The event targeted students, but did not exclude others' that shared interest in smart solutions to energy conservation
Keeping groups small, facilitating personal attention and the chance to be heard	Participants were split into two groups of four and one with five
Active participation with influence on workshop direction, and practice relevant skills and situations	Virtual Reality bike -and existing energy conservation app demonstration
Participants and organisers expect an outcome	Participants had direct input on how the smart solution proto type should be designed

Innovation challenges (also called innovation contests) are workshop environments where organisers invite the participants to design solutions to problems. Such open innovation processes have gradually emerged in smart city contexts as governments aim to engage the public, and thus ensure democracy (Juell-Skielse et al., 2014). Similar events such as civic hackathons have also been adopted to engage citizens in co-creating solutions in smart cities, however, these tend to be IT-based and therefore require related skills such as software development (Komssi et al., 2015)

Sampling Strategy

The Innovation Challenge was hosted by Manchester Met's Environment Team in collaboration with Manchester City Council (MCC) and the small medium enterprise (SME) Clicks+Links and promoted as part of The EU Horizon 2020 smart city project Triangulum. No previous knowledge was required to participate, making it an inclusive event. Whilst the Innovation Challenge was aimed at students, other groups of people were not excluded from participating. Registration of participants was arranged through the online tool Eventbrite (2018), and recruitment was actively carried out two weeks in advance of the event. A flyer was distributed widely within the university and displayed on screens across the faculties. Participants were also recruited face-to-face when visiting the researcher's survey stand, and at the Triangulum Project's stand at Manchester Met's Go Green Week[1] 2018 celebration day. Emphasis was placed on the potential for winning prizes as the team with the best idea of the day would receive a £500 Amazon voucher, and a £250 Amazon voucher would be awarded to the team chosen for the 'people's choice prize'.

The Workshop Process

The event was held in Council Chambers in the Ormond Building at Manchester Met's All Saints campus from 12:00 – 18:00 the 21.02.2018. The room was arranged so participants could work in groups, and each table was equipped with a flip board chart, colour pens and blank post-it notes in various colours. Table 3.12 presents an overview of the Innovation Challenge participants. A total of 13 people participated, of which two were not Manchester Met students.

[1] The university's Go Green Week is a week of events that aim to educate and inspire environmental activities.

Table 3.12. Innovation Challenge Participants

Male (*n* =8)	Female (*n* =5)
Course of study/field of work	
Graphic design	Engineering
Climate change agency	Biomedical science
Microbilogy	3D design
Economics	Special needs teaching assistant
Biocomputing	Events management
Sustainability and environmental management	
Business and analytics	
Computer science	

Participants were split into three groups: two groups of four and one with five. The group sizes were ideal for a workshop environment as smaller groups give confidence to all participants to engage and interact (Patel et al., 2007). The groups were then briefed on the scoring criteria for the ideas and asked to fulfil these to the best of their abilities when developing their ideas. The participants were all presented with a participant information sheet and all signed a consent form (Appendix 2B).

First, participants were introduced the smart city concept, how Manchester is becoming a smart city, the benefits of the smart city and MCC's role in making Manchester smarter. Second, the participants were explained the challenges of climate change and energy demand, setting the context for how energy behaviours must change in order to mitigate these challenges. Additionally, participants were also introduced to the split incentive scenario and how this works as a barrier to energy conservation, particularly in environments such as student halls where the students do not pay for their energy bills. Third, participants were presented with an overview of the Birley Fields campus and its sustainable solutions. The ability to capture real-time energy data from all flats in BSL was emphasised. Finally, a Manchester Met graduate now working for Clicks+Links told his story about how his virtual reality (VR) bike idea went from being 'just' an idea to an actual working technology.

Activities

The participants were then introduced to their challenge of the day of designing a smart solution that could overcome the split incentive scenario in BSL, and encourage students living there to conserve energy. The groups were given two hours to develop their ideas. During the event, Clicks+Links demonstrated the VR bike in order to generate an innovative atmosphere to spark ideas. Clicks+Links also walked around to the groups and let them try two of their exemplar apps to give the groups better insight in the apps that had already been developed.

Presentations

At the end of the session, the groups presented their idea in a three minute elevator pitch where they were required to present their team name, a summary of their idea including relevance to the challenge, technical functionalities, implementation aspects, and scalability and replicability. The judging panel, which comprised of members of the organisers, noted down comments according to the scoring criteria. The panel and other groups also had the chance to ask questions at the end of each presentation. Thereafter, the judging panel stepped out to a separate room to discuss the teams to award the best idea first prize. When prizes had been announced, all participants were thanked for their participation.

Data Collection and Analysis

The researcher acted on advice by Ørngreen and Levinsen (2017) and was present throughout the workshop to collect data in form of notes and artefacts i.e. posters and post-it-notes produced by the participants. The notetaking was particularly useful in order to record quotes by participants that supported the rationale behind their ideas illustrated in the posters and post-it notes. The analytical approach was undertaken with inductive logic and the notes and artefacts were coded in a coding table (Appendix 7) and thematically analysed as described in Section 3.5.3.

3.7.2 App Trial and Focus Groups

Focus groups are commonly used within Qual research. A focus group is defined by Powell and Single (1996:499) as:

> "…a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research".

According to Krueger and Casey (2002), using focus groups is particularly useful when the research seeks to understand how participants perceive an issue, idea, behaviour, product, or service, or to test ideas and evaluate participants' reaction these. Additionally, focus groups are advantageous in research aiming to triangulate results as data obtained from focus groups can increase validity of findings (Powell and Single, 1996). Focus groups are recommended as a post-study qualitative method which aids the interpretation of for example survey data (Carlsen and Glenton, 2011). In contrast to one-to-one interviews, focus groups may inhibit all participants to express their opinions if other participants dominate the conversation or if participants are worried their opinions may be judged or stray from that of the majority (Acocella, 2012). However, this is when the moderator of the focus group discussion must undertake preventive actions such directing questions to all participants (Breen, 2006). Following these recommendations, this research adopted the focus group method in order to contribute to Objective 1 and 3.

Beat the Peak App

Findings from the Innovation Challenge informed the development of a smartphone application (app) entitled 'Beat the Peak'. This proto-type app was developed by Clicks+Links and was designed to prompt energy saving missions along with tips on how to conserve energy to achieve mission objectives. The missions (see Appendix 8 for full mission descriptions) ranged from energy conserving activities in the kitchen to saving energy with others. Whenever a new mission became available, a notification was sent out and the options of "yes I can help" or "no I cannot help" enabled users to accept or decline a mission. When missions were completed, another notification was displayed, and tips that were followed could be ticked off. The aim was to use the app to spark ideas about how a smart solution could encourage students to conserve energy in the split incentive scenario in BSL.

Focus Group Plan and Schedule

Prior to commencing the focus groups, a detailed plan and schedule containing questions and discussion points was developed (see Appendix 9 for the plan and schedule). Focus group plans and schedules are useful as pre-set questions help the researcher keep the conversation going and sub-questions can examine participants' views further (Powell and Single, 1996). All questions were open and questions requiring "yes" or "no" questions were avoided (Krueger and Casey, 2002). As suggested by Krueger and Casey (2002), "think back" questions were used with specific reference to the app content in order to make students think about how they experienced it. Additionally, to refresh students' memory, the app was used as a prop in the focus group.

As the aim of the focus groups was twofold and the schedule was organised into three sections:

Section 1: evaluation of the Beat the Peak app.
Section 2: evaluation of the Innovation Challenge ideas.
Section 3: perceptions of the smart city.

Section 1 sought to evaluate students' experience with testing the Beat the Peak app as well as elaborating on some preliminary findings from the survey regarding motivations and drivers for energy conservation. This contributed to Objective 3 by identifying encouraging app features and provide students with creative tips for conserving energy.

Section 2 presented the three teams' ideas from the innovation challenge. The students were then asked to discuss each idea by commenting on what they liked and did not like about them, and which parts of the ideas they believed would encourage energy conservation. This also contributed towards Objective 3.

Section 3 examined students' perceptions of the smart city by providing them with a definition of the concept and asking them about their associated challenges to implementation. The students were also asked how smart cities could make citizens aware of the concept and related benefits. More specific questions particularly focused on concerns about data collection and the new General Data Protection Regulations (GDPR) which was being implemented at the time of the research. Also happening at the time of the research was the Cambridge Analytica/Facebook scandal (Cadwalladr and Graham-Harrison, 2018) which was widely broadcasted in the news and therefore used in the focus groups to prompt discussion. This section contributed to Objective 1 and aimed to enhance and compliment findings from the survey, thus increase validity of results.

Pilot

A pilot focus group was run with four volunteer students to trial the plan and schedule designed. The pilot focus group not only sought to ensure that high quality data was being generated, it also measured the effectiveness of the researcher as a moderator (Breen, 2006). The trial focus group lasted one hour, followed by a 15 minute debrief where the students were able to provide feedback. As a result, some questions were rephrased, but overall content and structure remained the same. As a moderator, the researcher experienced appropriate involvement, but that slightly more attention should be given to keep the discussion on track. Therefore, some key words and phrases were prepared to potentially help participants answer questions.

Sampling Strategy

The participants for app trial and focus groups were recruited through Jobs4Students[2] at Manchester Met, and there were 60 places to be filled (see Appendix 10 for job advert). The only requirement was to have access to a smartphone or tablet to participate, and the roles were filled on a first come first serve basis. The successful participants were instructed to interact with the Beat the Peak app 15 minutes (0.25 hours) per day for two weeks and attend a 1.5 hour-long focus group in the following week. Participants were paid for their participation at the standard Jobs4Students pay rate which was £8.77 per hour at the time of the research. Although paying research participants can raise moral and ethical questions, Head (2009) found that it can encourage them to put more effort into the research. Given these focus groups comprised of student participants, Krueger and Casey (2002) argue that saturation usually is reached after three or four groups when the participants are from the same audience.

Procedure

Sixty students were recruited by Jobs4Students to trial the Beat the Peak app over the course of two weeks, and 49 of them were able to attend a focus group to discuss their experience with the app. The study ran eight focus groups, each of which lasted between one to one and a half hours. The focus groups ranged in size due to students' availability but did not exceed 12 participants in one group as advised by Tang and Davis (1995). Table 3.13 demonstrates the participants' demographic background.

[2] Jobs4Students provides part-time jobs on campus for students enrolled at the university.

Table 3.13. Focus Group Participants

Focus Group	Date	Gender			Age Group				Country of Domicile			Responsibility for Bills	
		(n)	Female	Male	<=20	21 - 24	25 - 29	>=30	UK	EU/EEA	International	Yes	No
FG1	Apr-18	9	6	3	5	4	0	0	8	0	1	3	6
FG2	Apr-18	6	5	1	2	4	0	0	4	0	2	2	4
FG3	May-18	7	5	2	4	2	1	0	6	0	1	0	7
FG4	May-18	8	5	3	2	2	1	3	7	0	1	2	6
FG5	May-18	3	3	0	0	3	0	0	3	0	0	2	1
FG6	May-18	8	7	1	3	5	0	0	7	1	0	4	4
FG7	May-18	6	5	1	4	1	0	1	6	0	0	3	3
FG8	May-18	2	2	0	2	0	0	0	1	1	0	2	0
Total		**49**	**38**	**11**	**22**	**21**	**2**	**4**	**42**	**2**	**5**	**18**	**31**

All focus groups took place in the same university seminar room, and all students were given sufficient time to read their provided participant information sheet, to sign a consent form (Appendix 2C) and ask any questions they may have before the focus group commenced.

Data Analysis

Each focus group was audio recorded on a Dictaphone and notes were taken throughout the focus group discussions (Dunn, 2000). Analysis was concurrent with data collection and the first six focus groups were fully transcribed. However, as only one new code emerged from focus group five and six, the researcher felt that partial transcription was sufficient for focus group seven and eight and saturation was reached at focus group seven. When the coding process was completed, the data was thematically analysed as explained in Section 3.5.3 (see Appendix 11 for full coding table).

3.8 Ethical Considerations

It is important to thoroughly consider ethics throughout the research process, both when planning and conducting the research. When collecting data from participants, ethical consideration protects their rights and eliminates unnecessary forms of harm to participants (Connelly, 2014). It is also crucial in terms of ensuring confidentiality of data and evaluating the suitability of research methodology. This research project underwent ethical approval before commencing and no significant ethical issues were identified.

In this study, participants were provided with information and gave informed consent where required. All participants were informed about their terms of involvement, their right to review and withdraw at any point without the need to provide explanation. Furthermore, they were ensured all data would be kept confidential and presented anonymously. All data collected were stored electronically on a password protected storage device only available to the researcher. No data was shared with any third parties. All research carried out after May 2018 adhered to the GDPR in terms of personal data.

3.9 Chapter Summary

Given the exploratory nature of the research problem and the aim to capture different stakeholders' perspectives, this research adopted the pragmatic philosophical paradigm. This enabled the opportunity to undertake a mixed methods approach which provided flexibility in choice of research strategies in order to best address the research objectives.

The research comprised of a multistrand design framed by the Corridor case study. The three strands included semi-structured interviews, a cross-sectional questionnaire-based survey, and an Innovation Challenge and focus groups. Data were analysed statistically and thematically.

Chapter 4. Implementers' Understandings and Perceptions of the Smart City

4.1 Introduction and Chapter Outline

There is a growing body of academic literature seeking to establish a definition of the smart city. The literature review revealed contesting differences in the understandings of the 'smart' label and in what ways this influences how citizens are framed within the smart city. In theory, implementers' understandings of the smart city should be citizen-centric, underpinned by several examples as to how their initiative's engagement with citizens has led to specific measurable practical outputs. However, previous research addressing these complexities demonstrate the paternalistic attitudes of councils and private actors towards their responsibility for producing these outputs (Cardullo and Kitchin, 2018b). It is, therefore, essential to examine what the perceived barriers to implementation of a citizen-centric smart city might be. In addition, this places greater significance on investigating what the implementers' perceived aspirations for the smart city are and how they expect to achieve those visions.

In relation to the former, it is important to consider the implementers' broader concerns regarding the 'smart' concept as this can help make sense of their understandings of 'smart' as well as elaborate on the reasoning behind these. This chapter sought to identify expert opinions in order to reveal differences between stakeholder groups, which in turn can aid the understandings of potential barriers to citizen engagement and the framing of citizens within smart city developments.

This chapter presents the results of the interviews with smart city implementers, examining their perceptions of the smart city (Objective 1), and how they frame citizens in the smart city (Objective 2). Section 4.2 revisits the interviewee profiles. Section 4.3 assesses how implementers of the smart city interpret the 'smart' label in relation to the smart city concept and smart technology. Section 4.4 evaluates the implementers' perceived benefits of the smart city whilst section 4.5 examines their broader concerns with the concept. Section 4.6 evaluates implementers' perceptions of a smart citizen. Section 4.7 assesses which approaches the implementers believe to be most effective in engaging citizens in smart city initiatives, their perceived barriers to citizen engagement in smart cities, and how citizen engagement is currently enacted in smart city developments. Section 4.8 evaluates potential barriers to the implementation of the smart city. Finally, Section 4.9 illustrates the implementers' aspirations for the concept followed by a chapter summary in Section 4.10.

4.2 Interviewee Profiles

This part of the study consisted of 12 semi-structured interviews with smart city implementers. Table 4.1 reiterates details of the interviewees alongside the interviewee ID that has been assigned to them. SCI0 acted as the pilot interviewee, but as noted in Chapter 3, Section 3.5.2, the data from a pilot interview were too valuable not to be included in the study.

Table 4.1. Interviewee Profiles

Interviewee	Role Field	Organisation	Interview Date
SCI0	Transport and Mobility	University	Jul-18
SCI1	Programme Management	Technology Developer	Aug-18
SCI2	Communications	Agency	Aug-18
SCI3	Energy Management	University	Sep-18
SCI4	Energy Management	IT Corporation	Oct-18
SCI5	Programme Management	Agency	Oct-18
SCI6	Digital Grid Strategies	IT Corporation	Oct-18
SCI7	IoT Research	Telecommunications	Oct-18
SCI8	Platforms and Sensors	Technology Developer	Oct-18
SCI9	Programme Management	Council	Oct-18
SCI10	Environmental Sustainability	University	Nov-18
SCI11	Transport and Mobility	Transport Agency	Feb-19

4.3 Understandings of 'Smart'

4.3.1 The Smart City

As previously discussed, there is currently no uniform definition of the smart city. Whilst many of the contemporary definitions are heavily influenced by the industry, all the implementers were asked what their understanding of the smart city is. This question was asked to capture expert perceptions of the smart city from various backgrounds. Data did not only inform a more representative understanding of the concept, but also helped frame the role of the citizen, specifically within smart city initiatives in the Oxford Road Corridor.

The interviews found that the understandings of the smart city varied between the implementers, with five of them actively recognising that it is an ambiguous concept, stating specifically that the term has a different meaning to different people. This notion was evident as the interviews revealed seven main themes supported by 21 sub-themes in Table 4.2, illustrating implementers' understanding of the smart city.

Table 4.2. Implementers' Understandings of the Smart City

Theme and sub-themes	Occurrences	
	Interviewee	# of interviewees
Improve citizen life		**8**
Quality of life	SCI1, SCI3, SCI5, SCI6, SCI7, SCI9, SCI11	7
Easy life	SCI10	1
Technology		**7**
ICT	SCI1, SCI6	2
Data collection -and sharing	SCI5, SCI6	2
Maximizing potential of technology	SCI0	1
Collection of technology	SCI3	1
IoT	SCI7	1
Monitoring	SCI2	1
Services		**7**
Transport	SCI1, SCI5, SCI6, SCI7, SCI10, SCI11	6
Energy grids	SCI1, SCI4, SCI6	3
Healthcare	SCI6, SCI7	2
Environment		**6**
Air quality	SCI7, SCI11	2
Energy consumption	SCI1, SCI2	2
Environmental sustainability	SCI9, SCI10	2
Connectivity		**5**
Infrastructure	SCI2, SCI5, SCI6,	3
Networked technology	SCI3, SCI8	2
Operational automation		**3**
Adaptable	SCI2	1
Intelligent	SCI10	1
Responsive	SCI11	1
Efficiency		**3**
Operational	SCI3, SCI7	2
Natural resource use	SCI10	1

The implementers clearly articulated three different service provisions that the smart city focuses upon: transport, energy and healthcare with transport being referred to by half of the implementers. All the implementers involved technology in their understanding to a greater or lesser extent. Seven of them either argued that the smart city comprises of agglomerations of technologies or expressed in-depth notions around data to address each of the other dimensions. Five of the implementers emphasised that the smart city is about connectivity in terms of infrastructure and linking together technologies in a city network. Three implementers pointed out that the smart city concept involves efficiency, with one implementer drawing a link between how the connectivity between urban technologies ensures and generates that efficiency. A more technocratic understanding was identified through the notion of automation where three of the implementers explaining that the smart city is about operating the city intelligently and a city that is responsive and adaptable.

However, one implementer specifically stated: "[…] smart city is something more abstract and is not just technology based"[SCI5]. This became salient as eight of the 12 implementers explicitly involved the citizens in their understandings of the smart city through explaining that the smart city aims to improve quality of life of citizens or make the citizens' lives easier. Half of the implementers also referred to environmental factors when describing their understandings of the smart city, with five of them stating specifically that improved environmental performance would improve the life of citizens. This was most clearly articulated by SCI7 and SCI11 who explicitly drew links between air quality and quality of life. The four implementers that did not refer to the citizen in their understanding, SCI0, SCI2, SCI4 and SCI8, focused on more technological aspects including, connectivity, energy and automation. Nevertheless, none of the implementers stated that the smart city is *only* about the citizens and therefore, did not demonstrate a pure citizen-centric view.

As demonstrated in Table 4.2, the majority of the implementers did not have a one-sided understanding of the smart city. Instead, they explained it as a multidimensional concept. Even though all the implementers identified technology as a vital component to the smart city, the majority of them linked the use of technology to a citizen focus. One implementer explicitly shed light on this multidimensional perception of the smart city:

"I think you need to take it at two levels, a technology level and a more citizen-centric level. At technology level I would say that smart city is the use of technology, often IoT, but not only IoT, to improve efficiency and effectiveness of the city so things like transport systems, improving health and social care, improving air quality. At a citizen-centric level it is to make the city a more pleasant and efficient place to live and work". [SCI7].

This captured how the majority of the implementers view the smart city holistically, and that several of the different dimensions of the smart city are interlinked. Caragliu et al. (2011:50) argue that a city can be considered 'smart' when:

"…investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance".

Overall, the understandings articulated by the implementers correlate with this definition. However, none of the implementers identified an economic aspect to their understanding of the smart city when initially asked to articulate their understanding of the concept.

4.3.2 Smart Technology

As explored in the literature review (Chapter 2, Section 2.7), the contesting notions around the 'smart' label are not only in relation to the smart city, but also smart technology. Implementers were therefore asked to describe what they believe makes a technology 'smart'. The responses were more nuanced than that of their understanding of 'smart' in relation to the city, as demonstrated by one implementer:

"It has to do something that has not been done before I'd say. So it has to be a problem there and the solution is this new technology". [SCI3].

This was, however, a standalone interpretation. The majority of the responses were centred around one factor: to what extent they believed human interaction is involved in smart technology. This linked in with the perceptions around whether they believed smart technologies should involve 'humans in, on, or off the loop' (Coletta and Kitchin, 2017). In-the-loop refers to processes where humans are in control of the technology and decision-making processes. On-the-loop allows humans to observe the automated and algorithmic decision-making process by technologies but have the opportunity to interfere. Off-the-loop requires no human interaction and humans have no way of interfering or overriding the algorithmic decision making. Table 4.3 illustrates how definitions of smart technology ranged from ‘smart’ not requiring any human interaction, to being purely focused on human interaction.

Table 4.3. Implementers’ Associations with Smart Technology

Category and themes	Occurrences	
	Interviewee	Total # interviewees
No human interaction		**3**
Operates in the background	SCI2, SCI3	2
Responsive	SCI11	1
Less human interaction		**6**
Make decisions quicker than humans	SCI0, SCI10	2
Facilitate higher efficiency	SCI5, SCI6, SCI9	3
Cover multiple user cases	SCI8	1
Human interpret information		**4**
Real-time information	SCI2,SCI8	2
Actionable information	SCI1, SCI2, SCI7	3
Human		**4**
Easy to use	SCI9, SCI10	2
Adaptable and hackable	SCI5	1
Brings value to the citizen	SCI4	1

Two of the four implementers placed within the most human-centric category explained that for a technology to be ‘smart’ it must be easy for people to use. However, those same two implementers also described smart technology as something that requires less human interaction because ‘smart’ means they can make decisions quicker than humans and therefore deliver more efficient services. One implementer who illustrated this view on what makes a technology smart was SCI5. They argued that smart technology can facilitate efficiency but is also adaptable to its user and potentially ‘hackable’ in terms of allowing the user to partake in a more collaborative approach to development of the smart city. Therefore, whilst half of the implementers placed within the category of ‘less human interaction', some of them portrayed more nuanced views by also placing closer to the human-centric category.

SCI4, whose notions were also associated with a human-centric perspective, did not specifically state the level of human interaction they believed smart technology involves. Nevertheless, they clearly articulated that humans should be at the centre of delivery for smart technology:

> *"For me, for something to be genuinely smart, it has to add more value to the inhabitants and the citizens".* [SCI4].

Contrary to this, three implementers expressed a more techno-centric description. One implementer suggested that smart technology:

> *"[…] just goes on in the background, it is not something you're having to constantly engage with".* [SCI3].

This was also explained by another implementer, although they clearly identified an interactive element in addition to this:

> *"Smart I would see as something the ley person can interpret, so there will be some crazy algorithms or technical stuff in the background, but it will be distilled so the average person on the street can understand it".* [SCI2].

This was further supported by two other implementers. They described that through interaction with a smart technology, users will be prompted to take action. As stated by one implementer "It is about informing people to take more informed action"[SCI7]. This contested the views of SCI0, SCI3, and SCI11 who argued that smart technologies do not require engagement. Nevertheless, only one implementer (SCI4) associated smart technology solely with requiring human interaction. It is noteworthy they did not elaborate on the level of human action they believed to be required for a smart technology.

Therefore, the views around exactly how much human interaction is required or desired for smart technology was nuanced, and several implementers described various levels of human interaction required depending on the type of technology.

4.4 Benefits of the Smart City

Whilst the academic literature identifies several benefits to the smart city, implementers were asked what they believe are the benefits to the smart city in order to identify a practitioner informed opinion. Table 4.4 illustrates that the benefits highlighted by implementers were articulated clearly and ranged between four benefits for: the citizens, the environment (including energy), the economy and operational efficiency.

Table 4.4. Implementers' Perceived Benefits of the Smart City

Perceived Benefits	Occurrences	
	Interviewee	# of interviewees
Wellbeing	SCI2, SCI3, SCI4, SCI6, SCI7, SCI8, SCI9, SCI10, SCI11	**9**
Environmental	SCI0, SCI1,SCI2, SCI3, SCI4, SCI6, SCI7, SCI10, SCI11	**9**
Monetary Savings	SCI0, SCI1, SCI2, SCI3, SCI4, SCI7, SCI8, SCI9	**8**
Easier life	SCI0, SCI1, SCI3, SCI6, SCI11	**5**
Operational efficiency	SCI3, SCI4, SCI7, SCI9, SCI10	**5**
Learning process	SCI1,SCI5, SCI10	**3**
Citizen empowerment	SCI1, SCI4	**2**
Safety	SCI0, SCI10	**1**

Table 4.4 shows that the majority of benefits identified by implementers centred around citizens' wellbeing, easier life, citizen empowerment and safety. However, all implementers within those four themes argued that it is the *use of technology* in the smart city context that will ensure benefits to the citizens as end-users. One implementer articulated this well:

> *"It's all about how the citizens engage with that technology and use that technology, and how it improves our life as a result".* [SCI4].

Interestingly, the implementer from whom this quote was taken did not identify the citizen as part of their understanding of the smart city. However, they did associate smart technology with human interaction. Another two of the implementers that placed within the wellbeing theme identified that the smart city will "lead to better quality of life"[SCI2] and "help citizens"[SCI8]. These two did not include the citizen within their understanding of the smart city but identified a certain level of human interaction with smart technology as seen in Table 4.3. The implementer who identified safety as a benefit did not include the citizen in either their understanding of the smart city or when considering what makes a technology smart.

The second most salient benefit noted regarded that of the environment. Implementers identified three main environmental benefits arising from the smart city: reducing energy consumption and lowering carbon emissions in turn leading to improved air quality. Some of the implementers gave examples as to how these benefits could be realised. In relation to energy, one implementer explained:

> *"[…] it's about reducing consumption, it's about air quality it's about control of that energy, decentralising that energy, balancing supply with demand".* [SCI6].

Here, they also identified decentralising energy and balancing energy supply and demand. This was reflected upon further by another two implementers - SCI1 and SCI4 - who referred to the energy grid and that implementation of smarter grids could lead to better energy management. In regards to balancing energy demand, this issue was reflected upon further by the same two implementers who stated that the use of smart city technologies could "empower people to become more carbon literate"[SCI4] which could lead to "behavioural changes"[SCI1]. However, this was contested by another implementer who stated that:

> *"If we somehow figure out how to efficiently run buildings in an automated manner, I think the energy and carbon savings can go a long way to meeting our climate change targets"*. [SCI3].

Therefore, there was a slight variance in opinion between the need for automation or citizens' interaction with technology. With respect to air quality improvements they were

- for the most part - explained in relation to how the smart city could reduce congestion and increase operational efficiencies in the city.

Economic factors were not mentioned by any of the implementers in their understandings of the concept. Nevertheless, eight of the implementers proceeded to identify monetary savings as a benefit of the smart city. This is echoed by Chourabi et al. (2012) who argue that economy is a main driver for smart city projects. Implementers identified monetary savings both for citizens and the city authorities, and more generally believed the adoption of smart concepts would fuel development.

4.5 Concerns Regarding the Smart City

Several concerns regarding the smart city have been identified from the literature review (Chapter 2, Section 2.9). However, those concerns are that of academics and have not been validated by practitioners. Implementers were asked about their concerns and worries regarding the use of smart technologies and the transition to the smart city more broadly. Table 4.5 illustrates the concerns identified, ranging from worries about current implementations, to uneasiness about the role technology may play in the future.

Table 4.5. Implementers' Perceived Concerns Regarding the Smart City

Perceived Concerns	Occurrences	
	Interviewee	# of interviewees
Data		**9**
Privacy	SCI1, SCI2, SCI3, SCI4, SCI5, SCI6, SCI7, SCI11	8
Ownership	SCI5	1
Security	SCI0, SCI3, SCI5, SCI11	4
Transparancy	SCI5	1
Technocracy		**8**
Automation	SCI2, SCI3, SCI6, SCI11	4
Dystopian futures	SCI0, SCI2, SCI4, SCI9	4
Dependency on technology	SCI0, SCI2, SCI3	3
Technical errors	SCI1, SCI3, SCI4	3
Smartification		**8**
Losing track of purpose	SCI4, SCI6, SCI7, SCI8, SCI9	5
Push for smart	SCI3, SCI5	2
Sales approach	SCI1, SCI9	2
Involvement in project	SCI8	1
Social		**8**
Exclusion	SCI1, SCI3, SCI4, SCI7, SCI8	5
Inequalities	SCI0, SCI1, SCI7, SCI9, SCI11	5
Economic		**6**
Cost	SCI2, SCI4, SCI7, SCI8, SCI10	5
Investors	SCI5	1

4.5.1 Privacy and Security

When asked about what concerns or worries they had in relation to the smart city, only five of the twelve implementers initially identified concerns in relation to privacy and two raised concerns in relation to security. However, when the implementers who did not raise concerns around those two issues themselves were asked specifically if they had any, another three expressed some level of concern regarding privacy and another two regarding security. Interestingly, it was the same implementers that expressed concerns about privacy and security, except for one. This implementer explained that: "hacking is a worry, but I'm not overly convinced by the privacy thing"[SCI0]. Nevertheless, their privacy concerns were regarded as low due to two main reasons: they were not personally concerned and did not believe the general public were either due to the purported benefits received from sharing data and engaging with smart technologies. These perceptions might align with the idea of 'false consensus' as outlined in Ross et al. (1977) where respondents project their own beliefs onto predictions for the public. In other words, the implementers' lack of concern about privacy may be due to their low personal level of concern for the matter.

Additionally, their perceptions reflected the privacy framework presented by van Zoonen (2016) describing how people's privacy concerns depend on type of data and for what purpose that data is collected. Implementers argued that as citizens receive benefits, for example in the form of public services, they would experience that as a positive trade-off. One implementer reflected upon this:

> *"It's run in exchange for your data […] some people are willing to give up more than others and that will likely unlock more services than others".* [SCI6].

Indeed, giving up more data could unlock more services; however, this begs the question whether citizens are always aware of what type of data they are giving up and what happens to that data. In relation to this, two other concerns were identified by one implementer (SCI5): ownership of data and transparency of data collection. Questions were raised and discussed as to whom owns the data and if the purpose for collecting data is always clear, especially in regard to the citizens. The implementer highlighted:

> *"…who owns data is a really important thing, and actually could all data just be open and shared for people to benefit and for people to develop solutions from? I do not know, it is really complex to try and figure out, but privacy issues I think are quite challenging".* [SCI5].

Whilst not providing a solution to this issue, the implementer stated that a transparent data collection process was crucial as:

> *"…if it is not possible to see inside the black box I think that is a danger because it can lead to mistrust"* [SCI5].

This issue has gained greater attention in the dawn of the new General Data Protection Regulation (GDPR), giving citizen end-users increased insights to this 'black box' described by SCI5, allowing them access to information such as type of data collected and purpose for that collection. Another implementer stated that:

> *"The recent GDPR laws was a wakeup call for a lot of people because I don't think they realised how their data was being used".* [SCI2].

Additionally, SCI2 expressed a particular concern regarding data collection from people classed as vulnerable within society.

However, whilst describing concerns regarding privacy to a greater or lesser extent, three implementers referred to how following privacy policies and legislation can reduce this concern. As explained by one implementer:

> *"I think anybody who are designing smart city technology and applications needs to make sure they are complying with the latest privacy legislation, especially GDPR. We carried out a privacy impact assessment where we assessed the importance and relevance of the privacy policies and legislations for that particular user case to make sure we were complying with all the relevant legislation"*. [SCI7].

Regarding security, two of the four implementers expressing a concern identified a fear of hacking as a worry, whilst the other two made references to data storage. The implementers were less concerned regarding security, explaining that they believed that sufficient procedures and protocols are in place to ensure that data is stored safely and protected and as stated by one implementer:

> *"As long as people understand the security needs for the solution they are proposing, I don't see an issue"*. [SCI8].

This was contested by another implementer who clearly stated that there is a reason for citizens to question the data security in relation to smart city technologies:

> *"There almost needs to be like a standard security system to smart city technologies to give people the reassurance that it is safe and secure. Whereas*

> *now, they're just bringing out new technology types every few days and you don't know where it's come from or whether it's secured"*. [SCI3]."

Therefore, whilst policies, legislations, procedures and protocols are implemented and followed, there are still elements in relation to privacy and security that are of concern to implementers.

4.5.2 Technocracy and Dystopian Futures

One of the foremost critiques of the smart city is that it is technocratic and represents versions of dystopian futures. Those issues were raised by nine of the implementers, who expressed a concern regarding city operations becoming too automated. Additionally, concerns regarded people and cities becoming too dependent on technology allowing for vulnerability to technical errors, and upon how the technological fetishism and solutionism witnessed in today's cities could lead to a dystopian future.

Whilst, dystopian futures were specifically raised as an issue of concern by four implementers (SCI0, 2, 4 and 9), SCI10 had a differing opinion that contested those:

> *"I always think of it as almost like Star Wars or something. Ideally, I think that's what people want cities to be like".* [SCI10].

As illustrated through the quote, SCI10 portrayed the smart city as a utopian concept that people embrace. Datta (2015) raised important questions regarding such utopian visions of the smart city, arguing that it could in some cases lead to elitist states that intuitively treasure the power of technology. Nonetheless, SCI10 associated smart technology with some level of human interaction, and the four implementers expressing a concern about dystopian futures demonstrated views of humans 'in the loop' and 'on the loop' respectively.

As demonstrated by SCI0, one of the four implementers who firmly disagreed with the former statement argued:

> *"It is almost Terminator stuff isn't it? One main frame and it is again crazy science fiction minds, but I think they are genuinely people's concerns".* [SCI0].

The latter opinion shared by the three other implementers aligns with arguments demonstrated by Vanolo (2016) who depicted the problems related to those smart dystopian imaginaries such as fear of totalitarianism and surveillance. As described in one imaginary scenario, a city without citizens or with invisible citizens. The latter was further reflected upon by one implementer who said "what is a city without people?"[SCI2], clearly expressing that they did not wish for such a future.

Drawing upon this issue, a statement from another implementer highlighted the potential social implications arising from an increasingly technocratic world:

> *"If you have all these technologies that allows you not to leave your house, to walk to the shop then the city dies, because nobody is out in the squares and shops".* [SCI11].

As noted in Section 4.3.2, their perceptions of human interaction with smart technology depended upon the type of technology. Nevertheless, one implementer differentiated between what he believed could be automated and what requires human interaction:

> *"I think if you are deploying technology that is for business users within the city or whether it is energy equipment which is automated, that doesn't require human interaction".* [SCI6].

Three implementers expressed a worry about being overly dependent on technology. Another three implementers - including one of those expressing concern regarding dependency - also pointed specifically to potential technological errors and faults that may occur. As stated by one implementer:

> *"That we become reliant on technology to do a lot of the legwork for us and we are looking at stats but the concept of big data but what do we actually do with it? We might just become blind to it".* [SCI2].

Regarding this, the implementers worried about errors and faults reported that these issues could have serious consequences for city operations. As highlighted by one implementer:

> *"…if you look at the city scale, there could be big implications if something was to go wrong with the sensors".* [SCI3].

This implementer illustrated their concerns with specific examples of street lighting and smart bins. If, they said, sensors were faulty the lights could either turn on in daytime or off at night-time, and bins not being emptied due to sensors falsely reporting empty bins to the system. Reflecting on this issue, one implementer stated that:

"We need to increase the resilience of the network to avoid any potential faults in the future". [SCI4].

Three of the implementers discussed their concerns of automation in relation loss of autonomy and freedom, referred to in Vanolo (2016) as totalitarianism. One implementer articulated this issue:

"I think it's a wider concern around smart cities that people's personal decision making just becomes redundant; you don't need to make decisions for yourself anymore. These sensors or this cloud knows what you want to do better than you know, making decisions for you. [This] can have benefits but I still feel like you should be in control of what you do and how you want to do it, not let the computers make the decisions for you". [SCI3].

The other two implementers discussing this issue correlated with this statement, and additionally emphasised that technological solutionism limited personal freedom. This is interlinked with the notions around algorithmic determination leading to uncertain and speculative futures debated in Leszczynski (2016), and further the dystopian futures described in Vanolo (2014; 2016) respectively.

4.5.3 Inequalities and Exclusions

The technocratic fetishism in urban developments is generating significant concerns regarding the smart city. Whilst technologies are implemented as a solution to specific problems, it is debated whether they consider complex underlying social issues (Grossi and Pianezzi, 2017). Three implementers reflected on this, and whilst there was some difference in opinion as to how well the smart city address these issues, there was a general agreement that the concept could contribute to solving them in one way or another. These implementers recognised that the smart city is, for example, not "a blueprint for solving urban poverty worldwide"[SCI7], but rather, as one implementer stated:

"With the right technology and the right platform, I think they can definitely help underlying issues in the city". [SCI8].

Two of those three implementers emphasised that the smart city technologies could in turn help fight urban inequalities. These claims were made with particular reference to fuel poverty as they believed it would enable greater visibility of hotspots for deprivation and fuel poverty which could then be tackled.

Whilst nine of the 12 implementers stated that the smart city would ensure improved wellbeing as seen in the previous section, eight implementers (including the three identifying technology as a problem solver) still expressed concerns regarding inequalities or exclusion in relation to implementation of the smart city concept. Two main factors fuelled the concerns regarding inequalities and exclusions in the smart city: a knowledge gap and a wealth gap, both creating challenges around access to the use of smart technologies, leading to concerns around certain groups of people not benefiting from smart technologies.

Regarding perceived benefits of the smart city, one implementer was asked who they thought the beneficiaries of the smart city were to which they answered:

> *"I don't know, because I do not know what a wholly successful implementation of a smart city agenda looks like".* [SCI5].

Despite this implementer having a more pessimistic view on the potential benefits, other implementers did share their views on whom they believed to be the main beneficiaries of the smart city. There was, however, a distinct difference between how the implementers worded those beneficiaries as the citizens were often described as those who "should be benefitting" but that local authorities and the private sector "is benefitting" from the smart city.

> *"A lot of smart tech might be hidden, […] smart technology like the central controller, the battery unit, it's not benefitting the citizens, it's benefitting the building owners and helping us reduce costs for the buildings".* [SCI3].

This 'invisibility' of benefits was also reflected on by another implementer who stated:

> *"Sometimes I think we are all benefiting from smart technology, but we don't know [it]".* [SCI11].

However, in relation to this, several implementers also provided examples of groups of people they were concerned were at increased risk of being excluded from the smart city. More than one implementer noted a concern regarding the older population being excluded from the benefits offered by smart technology due to lack of techno-literacy.

However, whilst noting a certain concern, one of those implementers was optimistic about engaging older people, drawing upon an example of using technologies familiar to the elderly such as the television in a smarter way. Yet, the implementer then proceeded to make another important observation they felt was crucial for this to succeed:

> *"I think if the application is important to them [the elderly] in their life, they will learn it, but the ability to teach them and provide them with continued training is hugely important".* [SCI8].

This was also reflected upon by another implementer (SCI0) who argued that some smart technologies - in their example the electric vehicle Nissan™LEAF - is so perfectly adapted for the older population that some one of the more advanced technical features had been trimmed down in order to fit with the older generation's skill levels. They claimed that this could in fact limit technological advancements. Another implementer (SCI2) also noted that other groups of 'unconnected' people, such as the homeless, would be harder to engage, and expressed deep worries around how these people would therefore be missing out on benefits brought forward by smart technologies.

These concerns were linked to people's financial inability to purchase the necessary technologies required for engagement with the smart city. One of the implementers noted that in addition to the perceived knowledge and educational gap, there is a financial divide as well. This was also emphasised by another implementer who expressed concerns around solutions that required owning expensive smart technologies in order to engage, which would be prohibitive for less wealthy people.

Whilst the implementers identified both people's knowledge and financial means to be a challenge in accessing the benefits of smart technologies in smart cities, two implementers stated that there were spatial challenges as well, for example in relation to Wi-Fi and broadband access:

> *"In many cases the areas and the populations where smart city technologies and applications could have the most benefit may be the least techy and maybe lower income areas, they might be areas where broadband penetration is relatively low so they are not as digitally enabled".* [SCI7].

This statement refers to the notions around how smart solutions could benefit more deprived areas as described at the start of this section. Therefore, some implementers noted that due to these challenges and considerations, there must be a requirement for smart cities to ensure inclusion and avoid enhancing inequalities:

> *"For a city to truly be smart they need a strategy around that whole area of digital inclusion and thinking about the entire demographics they are trying to reach. If otherwise, the people who have the potential to benefit the most are the ones who can afford it the least or have least access".* [SCI7].

Therefore, by undertaking a comprehensive strategy to digital inclusion, the implementers meant this would aid ensuring the smart city would "not [leave] anyone behind"[SCI4].

However, not all the implementers agreed that the smart city must facilitate engagement of everyone. One implementer stated that "to advance and move [forward], sacrifices have to be made"[SCI10], meaning someone will unfortunately, be left behind regardless. This links back to the implementer (SCI0) who felt that by interacting with elderly end-users and facilitating for them, it limited technological advancements. Therefore, whilst the majority of the implementers agreed that ensuring inclusivity and equitable access is crucial to implementations, this could indeed limit the potential of the smart city.

4.5.4 Economic Cost

As seen from the responses of what the benefits of the smart city could be, there was an agreement that improving the economy is a driver for implementing the concept. However, six implementers expressed a concern about cost in relation to the smart city, of which five were concerned about the upfront cost of implementation it required. Whilst three of these implementers were certain that this investment would be repaid over time, they were still worried about the cities' abilities to meet the initial investment requirement:

> *"Smart cities have the potential to deliver a lot of benefits, but it's like a paradox almost, which is cities haven't got any money to invest. They want to save money, but they haven't got the money to invest to save money".* [SCI7].

These concerns align with those illustrated by Chourabi et al. (2012:2294) who listed "cost of installation, operation and maintenance of information systems" as a challenge. The implementers noted that this issue in turn led to even deeper concerns about the rigour of implementation through smart city projects:

> *"Investing upfront is major requirement, whether that be the technology, the people, the training, the interviews, the citizen engagement, more of that has to be done upfront rather than trying to cut corners which happens on a lot of projects when it is under pressure"*. [SCI8].

Furthermore, worries around who would be responsible for the cost of implementation in all aspects of the smart city were raised as there was a general consensus that city authorities were not financially able too. One implementer (SCI5) reflected upon whether it would then be the responsibility of large IT co-corporations such as IBM and Cisco to "step up" or if it was going to be at the cost of the citizens.

4.5.5 Smartification and a Meaningless Buzzword

Discussing the concerns relating to the smart city concept sparked a separate debate about apprehensions associated with the 'smart' label itself for 10 of the 12 implementers. Acknowledging the ambiguity surrounding the term 'smart', there was consensus amongst those implementers that it had become an overused and meaningless buzzword that has in itself become problematic.

The implementers pointed out three particular issues driven by the smart terminologies. Firstly, they suggested it was a term designed by the industry, meaning it has become a jargon heavy term which may be alienating to the general public. Secondly, this had resulted in the private sector now using 'smart' as a marketing term more than anything. This is echoed by Söderström et al. (2014:307) who state that the smart city is "corporate story telling" in order to attract funding. Finally, they worried about the constant 'smartification' of spaces. The implementers stated that, a lot of the time, technologies were made and/or implemented without clear reasons, resulting in solutions not bringing any real benefits for the citizens.

Furthering these statements, the implementers argued that 'smart' is merely a "prefix" and that organisations and projects use 'smart' branding as a way to push their agendas. One implementer had a clear message to other smart city practitioners:

> "*Don't introduce smart tech for the sake of it being smart, so you can brand something as being smart*". [SCI3].

This was expressed as a major concern in relation to citizen engagement.

"It is not common knowledge for residents and citizens that they have smart technologies that may help them". [SCI8].

When questioned further on this matter, it was apparent that they perceived the 'smart' label to be disengaging, with several implementers believing that it directly resulted in alienating certain citizens', especially the less tech-savvy:

"I get the impression that things are just promoted as smart. That could put people off who aren't technology savvy or not know what a smart city is, or they're not interested in things being smart". [SCI3].

The 'smart' label was also identified as a potential barrier to broader engagement in the discourses around the smart city due to its jargon heavy nature. One implementer illustrated this by drawing on their own personal life:

"When I talk to friends [about] what I do for a job I never talk about doing smart cities because it sounds like Doctor Who 'fancy-land'". [SCI9]

However, whilst implementers identified that 'smart' was problematic from a citizen engagement perspective, it was also expressed that a common understanding of 'smart' in individual projects had become an important tool in order to ensure that collaborators were working towards the same goals.

"When you work in [a] sector that is associated with it, it has become a very useful 'jarganistic' shorthand, but that does not necessarily mean that it has spread into the wider world". [SCI5].

Moreover, the implementers were emphasising that the 'smart' label has driven a strong desire for companies and organisations to be involved in smart city projects. This was portrayed as an issue as several implementers argued this led to implementation of technologies that were not necessarily needed. As one implementer explained: "there is just a push to make things smart when the benefits aren't clear"[SCI3].

This led to a discussion regarding how the smartification of technologies and urban spaces can be construed as an unnecessary process:

"I think one of my concerns is that as it [smart] becomes more popular, more policies come out around smart cities with a push to make things smart where they don't

need to be smart and I'm still slightly concerned with the need to alternate everything". [SCI3].

Reflecting further on this issue, the implementers believed that this strong push for smartification led many smart city projects to lose track of their purpose. Reiterated by the other implementers as well, one implementer stated "I think we can easily forget why we are doing something"[SCI4] as the overpowering drive for smartification eclipsed the focus on benefits to the city and the citizens.

Overall, implementers agreed that 'smart' is a not a well-defined term and they frequently argued that it does not "deliver any meaningful objectives"[SCI4]. Therefore, some of the implementers suggested that perhaps 'smart' was not the optimal term, with one proposing alternative terminologies:

> *"…sometimes we hear the term future cities and sometimes I wonder if that is a better and less overloaded term that describes what smart cities are really all about*". [SCI7].

This desire for changes in terminology and futuristic interpretation was consistent with other implementers, although they believed the change in terminology was only required on a citizen level:

> *"We can still call it a smart city, but when we are talking to the general public, I think it's looking into the future, maybe more like an efficient city".* [SCI10].

However, one implementer pointed out that focusing on this futuristic element may fuel people's misconceptions about *present* smart city projects in their own cities:

> *"I think if people have a conception of smart cities it might be that it is something that is going to happen in the future or somewhere else. It is not really understanding that it could be things that are happening in Manchester".* [SCI5].

Another implementer implied divergence with this by agreeing that whilst 'smart' is happening here and now, there is a long road ahead to what they believed was true smartness:

> *"I think we are very used to listen and to think we work and live in a very smart age, which is true to some extent, but if we then look at some real case scenarios, we are a bit behind. There is a lot to do yet".* [SCI11].

Others specifically expressed notions around the ‘smart’ label in relation to the continuous change and development of technology itself.

> *“…the definition of what is actually smart will constantly change because as the technology changes what we determine as smart will always change”.* [SCI3].

This was also demonstrated by another implementer who said that “what was smart last year is no longer smart today, technology is moving on”[SCI6]. The latter reflects findings by Kitchin (2019) where interviews with smart city stakeholders highlighted the temporal link between smart and what he refers to as ‘technological acceleration’. With these statements borne in mind, it is evident that there is a strong notion of temporality attached to the ‘smart’ label which subsequently can determine how it is interpreted and engaged with.

4.6 The Smart Citizen

All implementers were asked what they understood by the term ‘smart citizen’ as debates grow around the role citizens play in developing the smart city (Shelton and Lodato, 2019). This inquiry revealed that the implementers did not use this term as part of their everyday vocabulary and consequently, the majority of responses were ‘on the spot’ guesses of who the smart citizen could be. Yet, their responses reflected their interpretation of the ‘ideal’ citizen of a smart city. Table 4.6 illustrates the array of implementers’ interpretation of a ‘smart citizen’.

Table 4.6. Implementers Understanding of a Smart Citizen

Themes	**Occurrences**	
	Interviewee	**# of interviewees**
User of technology	SCI1, SCI3, SCI6, SCI7, SCI10	**5**
Empowered	SCI2, SCI4, SCI5	**3**
Aware	SCI5, SCI8	**2**
Benefits	SCI3, SCI11	**2**
Early adopter	SCI4, SCI7	**2**
Open to change	SCI5, SCI9	**2**
Engaged	SCI6, SCI9	**2**
Co-creator	SCI3	**1**
Passive participant	SCI0	**1**

There were two overarching factors determining implementers' perceptions of whether a citizen is 'smart' or not. First and foremost, the perceptions of a smart citizen varied around how engaged with smart technology a citizen is. As demonstrated in Table 4.6, the majority of implementers believed a citizen to be smart if they actively engaged with the smart city technology available to them. Typical descriptions included: "someone who engages with smart tech"[SCI3], and "someone who is actively participating in the technology"[SCI6]. On the contrary, one implementer argued that a smart citizen plays a more unconscious role in the smart city as a passive participant:

> *"I think the smart citizen type is shaped by things like science fiction films such as going off into the future. Scurrying I think is a good word, we are all walking around as fast as we can, not paying attention to what is actually going on around".* [SCI0].

These differences in interpretation are echoed in Shelton and Lodato (2019) who argue that the typical framing of smart citizens is more repressive. Therefore, the role of the 'actual existing' smart citizen is a more ambivalent one than what is for example illustrated in the quote by SCI0.

Noteworthy were also the two implementers who specifically stated that smart citizens are "early adopters of smart technology"[SCI7]. In contrast, two further implementers noted that a smart citizen is "somebody who has a basic level or awareness and understanding of smart technology"[SCI5] and:

> *"…someone who knows what is going on in their city and how they can get access to that information".* [SCI8].

The awareness aspect was further defined by two implementers who described a smart citizen as someone who were active users of smart technology because "they understand the benefits of it"[SCI3]. The implementers expressed detailed notions around citizens' power in developing the smart city. Two implementers shared that a smart citizen was "somebody who embraces change"[SCI9]. Furthermore, a slightly vaguer description emerged where implementers said a smart citizen is "somebody who […] feels engaged enough to want to take part". This perception was supplemented by other implementers who gave specified opinions about levels of engagement. One implementer stated that:

"…a smart citizen might also be someone who has been involved in developing the technology, so they understand what the issues are, and they've helped to come up with the solution". [SCI3].

This highly co-creational perception was supported by three implementers who described smart citizens as empowered and "someone who is able to support and drive change"[SCI4]. One of these implementers also noted that a smart citizen is "someone who feels like they are able to participate in the local democracy"[SCI2].

Nonetheless, some of the implementers explicitly gave examples as to who they did not believe were smart citizens and these mainly included the elderly and the less affluent. This strongly reiterated the implementers' concerns about groups of people who they believed were potentially excluded from the smart city as seen in previous section (Section 4.5) regarding concerns surrounding the concept. One implementer pointed out that a more automated smart city could overcome this issue, however:

"…if we are talking about technology that involves human interaction then I think there is an enormous amount of training and learning that needs to be delivered as part of these projects". [SCI4].

Conversely, this could be a barrier to citizen engagement. The interpretations of a smart citizen all link to how engaged the implementers believe a citizen is with smart technology and how much power they have in developing the smart city.

4.7 Citizen Engagement

Current smart city debates question how involved citizens are in developing the smart city and critiques argue that the dominant, hegemonic top-down approach is still evolving (Shelton and Ladato, 2019). Whilst the previous section explored perceptions attached to the term smart citizen, this section focuses more specifically on how the implementers perceive the role of citizen and engagement processes. When questioned about citizen engagement, this reinforced the discussion about how involved the citizens are, and should be, in developing the smart city and in which ways.

There are ongoing debates surrounding the various levels of top-down and bottom-up approaches in urban developments, discussing to what extent these strategies are socially "just" (Cardullo and Kitchin, 2018a). The interviews identified that this was no different in a smart city context as implementers had different perceptions regarding required levels of citizen engagement. Specifically, this discussion focused on questions such as how and who should be involved in defining both urban problems and solutions to them in order to achieve a citizen-centric smart city agenda. In addition, implementers elaborated on their perceived broader issues with bottom-up approaches in smart cities.

Firstly, the implementers were all asked which approaches they believed to be the most effective in engaging citizens in smart city developments. Following this, eight of the 12 implementers referred to raising awareness as the most effective method for citizen engagement. There were several factors attached to this opinion. In particular, the implementers noted that they believed citizens did not understand their individual impact and how their behaviour influenced larger scale implementations. As stated by one implementer, the initiatives needed to be more:

> *"…instructional so people know how to use things or how their behaviour can impact on things"*. [SCI2].

Secondly, there was a concern expressed over citizens' lack of awareness of the smart city as a concept:

> *"You can see how local authorities are trying to develop smart city initiatives, but one of the biggest challenges I think they are facing is the fact that most citizens do not understand what a smart city is".* [SCI5].

However, the implementers also counted those as the main barriers to engagement and that raising awareness is not an easy task:

> *"There is a lot of noise out there, there are a lot of mixed messages and this can put off people as well, there is too much information and not enough clarity in the information that is going out"*. [SCI4].

However, another implementer (SCI8) expressed a less complicated concern about this barrier to engagement, stating that it was simply down to lack of communication about what can be accessed in a city. This was emphasised by the other implementers who noted that the key to overcome this is to "be clear on the benefits"[SCI4] suggesting citizens would only engage if it is personally beneficial to them.

Other approaches for citizen engagement deemed effective by the implementers included engaging community champions, emphasising on creating a community feeling around issues, using incentives and face-to-face interaction such as workshops and focus groups. However, as stated by one implementer; “not everyone wants to get involved [SCI5]. This rose again when another implementer argued that it was an issue in terms of equality as the citizens who do engage:

> *“…might not be the kind of people who are aware of all the issues and problems that different citizens face in a smart city context”.* [SCI7].

This emphasised the potential barriers to ‘bottom-up’ engagement.

Other grand challenges to citizen engagement included lack of awareness about smart technologies. The implementers argued that citizen engagement required implementers to “dispel rumours”[SCI0] and promote “myth busting”[SCI2] as they worried citizens may have misconceptions about smart technologies.

Co-creation was discussed with six implementers. However, it is important to note that this was an approach to which these implementers were specifically asked to express their thoughts. Nevertheless, all those six stated that co-creation would be effective. One implementer in particular

vouched strongly for a co-creational approach and followed up with an example where a smart city implementation failed as a result of not consulting with the citizens. The example was drawn on an urban cycling scheme implemented in Manchester:

> *“They [the bicycles] all got vandalised and [the company] didn’t really engage with the citizens to explain what Mobike is, how you use it and what the benefits are. Just hundreds of bikes just appeared one Monday morning!"* [SCI3].

The way in which some of the implementers described co-creation was noteworthy. More than one chose to refer to the concept as ‘stakeholder collaboration’ rather than co-creation. Additionally, the majority of comments illustrated that their interpretation of co-creation was about informing or consulting with the citizens rather than for example forming partnerships or delegating power to the citizens (Cardullo and Kitchin, 2018a).

> *“They [stakeholders] could in consultation with citizens develop the problem statements and then go to technology providers and say ‘will you help us do this’".* [SCI5].

Despite some implementers referring to citizens as part of defining the problem smart technologies must address, this was not the case in most of the interviews. Whilst listing various strategies for citizen engagement, one factor stood out among several of the articulations. The implementers strongly believed that understanding and meeting citizens' needs was the key to citizen engagement, especially self-motivated engagement. Often, implementers talked about how they needed to understand "what they [the citizens] want"[SCI7], describing them as consumers whose needs must be met, rather than co-creators of the solutions. Interestingly, one implementer specifically pointed this out as problematic:

> *"I think it is problematic because we are used to thinking of ourselves as individuals and consumers and individual consumers rather than as collective".* [SCI2].

Discussing these different levels and methods of engagement revealed differences in perceptions around engagement. There was a clear distinction between those who believed in communication and those describing direct engagement. This was also specifically raised as an issue by one of the implementers regarding misconceptions of bottom-up approaches:

> *"There is a distinction that needs to be made between engagement and 'comms'. Telling people about what is going on is not the same as getting people involved".* [SCI5].

Following this, contesting perceptions as to what a bottom up approach was became evident. For example, one implementer specifically referred to a smart city initiative in Manchester whilst stating:

> *"I think Manchester has been very grass-root as opposed to implementing solutions from the top".* [SCI9].

By grass-root, they meant citizens had been included in the process of implementation. However, another implementer involved in the same initiative countered this strongly:

> *"Citizens are referred to, but when you try and translate it into how they are actually involved, I don't think we have had, apart from us as individuals, a citizen's board advice or anything like that. So the citizen is almost a proxy it seems to me".* [SCI1].

These disagreements stressed the different notions about what truly counted as bottom-up engagement. Consequently, all the implementers were asked how they believed citizen engagement is currently enacted in developing the smart city. Several of the implementers were unable to provide examples without being probed further. Ten of the 12 interviewees did not provide any specific examples, with two arguing that citizen engagement was poorly carried out in practice. Other typical associated comments included: “I would say quite low at the moment” [SCI0], “It’s not much, it’s very patchy”[SCI11]. In contrast, other implementers reflected on efforts and attempts to engage citizens: “We always try and build it into projects”. [SCI9]. Rather than presenting narratives with specific practical outcomes, two implementers stated:

> *“When we undertake projects with end-users we will always have them at every stage of the development”.* [SCI6].

and:

> *“We did have citizen groups come in and we talked to them about all of our different user cases and tried to take a very citizen-led approach”.* [SCI7].

Only two implementers narrated detailed examples of how they believed citizen engagement had led to practical and measurable outputs. Firstly, SCI1 exemplified a group of 15-20 regular volunteers with breathing issues who gather for various activities every week. The volunteers were offered to participate in a twofold study by the implementer in question. The study involved carrying two air quality monitor devices on a daily basis: one measuring particulate matter and one nitrogen dioxide (NO_2). The device for particulate matter linked to a smart phone app whilst the NO_2 device was a standalone technology. Users were provided with visual data regarding air quality in the areas they were, allowing them to avoid areas with poor air quality. With this data the implementers were able to develop a map of local air quality for a wider audience. Secondly, SCI8 illustrated an example of how the council had implemented a citizen feedback system for road potholes. If citizens spotted potholes, they were able to complain and report this via a smartphone app to the council.

Nevertheless, looking at those two examples, neither issue nor solution were driven by the citizens themselves. In the first example, the volunteers had a health issues which poor air quality can worsen. However, they did not co-create the solution, their roles in the project were that of participant and tester. In the second example, the citizen involvement in the solution was to simply provide feedback through an app implemented by the council.

Therefore, coupled with the quotes from SCI6 and SCI7 above, yet again it could be argued that these examples were not true bottom-up approaches by referring to Cardullo and Kitchin's (2018a) reworked ladder of participation (Arnstein, 1969) (see Chapter 2, Section 2.10.1). That was reflected on by one implementer who claimed that whilst the solution should be citizen led:

> *"…it [the initiatives] needs to be led by the city otherwise things might not happen".* [SCI10].

This sparked a conversation with five of the implementers regarding who should be responsible for engagement with the citizens. Whilst academics, technology providers, and even citizens themselves were mentioned as responsible, all stated that it is the obligation of the city council to engage its citizens. Nevertheless, there were certain concerns attached to the council having the key responsibility for citizen engagement. As stated by one implementer: "it is also about where that message is coming from"[SCI0] and that it could be perceived as hegemonic if the majority of solutions were launched by public authorities. This was further supported by another implementer (SCI5) who suggested that the citizens had reservations regarding being tracked by the government in contrast to being tracked by e.g. Google. This was a common notion as another implementer argued that "people have negative perceptions […] towards the council"[SCI2]. This suggested that implementers strongly believed that citizens have distrust in government led deployments. Interestingly, five implementers directed this focus towards ownership of the smart city:

> *"The smart city is this very blurry line between public ownership, private ownership, development of solutions for public good by private companies… I am not saying everything has to be under public ownership, maybe it should, but I do not know if we can actually live in that communist kind of world or whether it is successful because enterprise innovation, that is where it happens".* [SCI5].

Additionally, another implementer (SCI2) noted that inviting citizens to co-own smart city solutions - thus 'commoning' the smart city - is essential for the engagement of *all* citizens. One implementer specifically argued that devolution could better address, and ensure, citizen engagement.

> *"It's a regional shift that needs to happen, I think we need to shift, I do think we need to centralise the smart city back to the city owners. They have got the insight as to how we can probe citizens in that city"*. [SCI6].

However, centralising power could address large-scale threats such as climate change (Harvey, 2012), countering the advice of the implementers.

Nevertheless, there was broad agreement that there was not enough citizen engagement in the smart city. Coupled with the challenges towards engagement and bottom-up approaches above, the implementers did reflect upon why that is the case which led onto the discussions around more practical barriers to implementation.

4.8 Barriers to Implementation

Throughout the interviews, it became apparent that the implementers faced several challenges to the integration of smart city solutions. These challenges varied, from financial and political, to socio-cultural and spatial as illustrated in Table 4.7.

Table 4.7. Main Barriers to Implementation of the Smart City

Themes	Occurrences	
	Interviewee	# of interviewees
Funding	SCI1, SCI3, SCI4, SCI5, SCI6, SCI7, SCI8, SCI9	8
Timeframes	SCI2, SCI5, SCI8, SCI11	4
Political realities	SCI6, SCI7, SCI10	3
Replication	SCI1, SCI3, SCI4	3
Piloting	SCI3, SCI10	2
Adaptability	SCI1, SCI9	2

When attempting to develop citizen-led approaches, one of the main implementation strategies was to pilot solutions before deploying them large scale. Despite implementers agreeing that testing solutions in smaller areas prior to city wide deployment is important, they noted that replicating smart city solutions risks ignoring local cultural and social values. One implementer declared they are "very sceptical of it"[SCI1]. Whilst one other implementer stated that “to get smart tech off the ground you need to trial it somewhere”[SCI3]. The perils of replication were specifically noted as a socio-spatial challenge in connection with the engagement debate:

> *“You can learn and evolve what different people are doing, but they’ve got different regional requirements and challenges which you need to meet to achieve similar outcomes”.* [SCI4].

Following this, more than one implementer underlined that standardisation of smart cities would be useful, but only in terms of the technologies as local challenges and cultural elements needs to be considered. As one implementer highlighted: “in terms of the detail, that’s when they [standardisations] fall down”[SCI6].

This demonstrated that although smart cities can learn from each other, there are unique socio-cultural indicators that required attention in various spaces and places. Therefore, the geographies of what is ‘smart’, is highly debatable as it may be ‘smart’ in one area, but not another.

Yet, by far, funding was identified as the grand barrier to implementation as eight implementers demonstrated several associated issues. It became evident there were significant issues linked to projects commissioning set goals and deliverables.

“You have got funding associated with that project and you’ve got tasks and deliverables associated with that project. I think that brings us some challenges". [SCI4].

Moreover, this connected with the concerns around adaptability within projects. One implementer in particular complained about this aspect:

> *“Looking back, the most frustrating thing I found through this is driven by that disconnect… And some of that is around the commission structure, I think. The ability to change and adapt is close to zero”.* [SCI1].

This frustration resonates with Cardullo and Kitchin’s (2018b) interviews with smart city initiative project managers as they found low flexibility to change and adapt project goals and outlines ultimately leading to a weakened citizen-centric smart city due to not allowing user responsiveness to trials of smart solutions.

Subsequently, the implementers articulated that initiatives were constrained by external political realities. For example, one implementer (SCI6) expressed a particular concern regarding the contemporary political climate surrounding the uncertainties of whether Britain is leaving the European Union (EU) as large amounts of funding for smart city implementations come from the EU. Another implementer (SCI7) argued that citizen-centric implementations could be limited in terms of deliverables due to them being centrally funded as they would serve the interests of central government rather than those of the local government. In relation to this, implementers also argued that efforts to engage citizens is challenging as "invariably we're in a situation where things are often funding-led". [SCI9].

Time scales were also identified as a major barrier to a citizen-centric implementation of the smart city. The implementers stated that projects are - in many cases - too short to forge lasting relationships between stakeholders and to sufficiently engage citizens.

> *"My feeling is that the timeframe to do that is much greater than funded projects allow, and the scope is much greater than funded projects allow".* [SCI9].

Therefore, it was evident that whilst implementers wished to engage citizens in the development of smart cities, there are several barriers hindering them in achieving this.

4.9 Aspirations for the Smart City

Finally, the implementers had the opportunity to express their aspirations for the concept and how they envisioned the future smart city. Whilst the implementers' responses to the other questions interlinked with their reasoning for their aspirations, further details were articulated here. As illustrated in Table 4.8, a series of themes and sub-themes emerged, ranging between the environment, citizens, transport and technology.

Table 4.8. Implementers Aspirations for the Smart City

Themes and sub-themes	Occurrences	
	Interviewee	# of interviewees
Increased citizen centric		**8**
Adapt to our needs	SCI2, SCI5, SCI9, SCI10, SCI11	5
Citizen involvement	SCI3, SCI5, SCI8	3
Social improvement	SCI3	2
Local investments	SCI7	1
Environmental improvements		**7**
Energy reduction	SCI1, SCI3, SCI6	3
Emission reduction	SCI4, SCI10, SCI11	3
Sustainability	SCI9	1
Transport and mobility		**5**
Improved efficiency	SCI4, SCI10	2
Less traffic	SCI3, SCI9, SCI11	3
Technological developments		**4**
Innovation	SCI1, SCI11	2
Increased intelligence	SCI6, SCI9	2

There were two overarching themes that were more important to the implementers. They hoped for a citizen-centric future and realisation of the environmental improvements they anticipated the smart city could bring.

Despite some implementers envisioning that increased intelligence may facilitate the broader ambitions of the smart city, eight implementers specifically made reference to wishing for a more citizen-centric smart city future. There were, however, different degrees to which they envisioned this citizen-centric smart city future. Whilst three implementers categorically exemplified that they wished for citizens to be more involved in smart city developments e.g. through participation in “management”[SCI5] and “feedback loop”[SCI8], five stated that the technologies deployed should serve a more assisting role for citizens by increasingly adapting to their needs, making citizens’ lives “easier”[SCI9] and “less stressful”[SCI10]. One implementer envisaged the smart city providing social improvements such as limiting “anti-social behaviour” and “crime”[SCI3] and promoting safety. Also noteworthy was one implementer who aspired for a more citizen-centric model of the smart city through increasing local investments, reiterating the points highlighted in the previous section. However, they noted that it was an ambitious vision as with austerity:

> "*…cities haven't got the money to invest up front to save money in the long term*". [SCI7].

This suggested that whilst devolution could ensure that the citizens' interests are appropriately addressed, austerity may counter the possible effects of this power shift.

Whilst one implementer expressed a more general aspiration of a sustainable city, the two most desired environmental outcomes for the smart city were identified as reducing energy consumption and emissions, two outcomes mirrored in the majority of academic definitions of the smart city (de Jong et al., 2015). As illustrated by two of the three implementers mentioning energy reduction, their aspirations were rooted in the improvements to energy management the smart city could potentially facilitate.

> *"I think smart cities have a big role to play in meeting climate change targets. From an energy management point of view, there is so much energy wastage that goes on across city level through poor management and the poor management is largely due to the fact it is people managing energy systems and there's sort of too much to manage".* [SCI3].

This links to the aspirations shared by two other implementers who note increased intelligence as part of the goals for the smart city. Specifically in relation to energy, one implementer stated that by increasing the intelligence of the smart city systems it could be possible to "decentralise the energy to the city level"[SCI6]. Similar to that of increased intelligence, innovation was identified as the "ultimate goal"[SCI1] in order to achieve the other aspirations:

> *"I know it's a bit of a dream but having a smart innovation plan for a city that can incorporate different actors".* [SCI11].

Three implementers focused on the emission reductions, two of whom placed substantial focus upon "lower emissions, to improve air quality"[SCI10]. These aspirations resonated with those mentioning transport and energy as the two were often interlinked, supported by comments such as "less cars"[SCI11] and "cycle lanes"[SCI9] to replace fossil fuel dependent modes of transport. Additionally, two implementers noted that they hoped the smart city will provide increased efficiency, both in relation to energy and mobility.

Based on the implementers' responses, their main aspirations to the smart city are to bring benefits to the citizens coupled with ensuring environmental improvements. However, it was evident that there are several perceived barriers to implementing solutions that would realise those aspirations. Therefore, whilst the implementers envisage several benefits to the smart city, barriers must be addressed in order to meet those.

4.10 Chapter Summary

Implementers clearly associate the 'smart' label with technology and that technology that is 'smart' require less human interaction. Although concerns around privacy were noted, these were low, and majority of implementers had to be prompted to elaborate on the issue. They believed the smart city concept could deliver benefits to the citizens, however, their perceived role of the citizen in the smart city was patchy. Implementers frequently expressed a desire for a citizen-centric smart city yet described citizens as consumers. Several implementers struggled to provide specific examples of citizen enactment in smart city developments, but adamantly argued that citizens were engaged and involved in the implementation processes. However, considering how smart citizens were referred to, it is debatable if the citizen engagement described by the implementers can be regarded as bottom-up or citizen-centric.

As illustrated in Figure 4.1 below, saturation was reached in the 11th interview. The following chapter addresses QUAN+QUAL Strand 2 and presents the results from section one in the student survey, examining students' understandings and perceptions of the smart city.

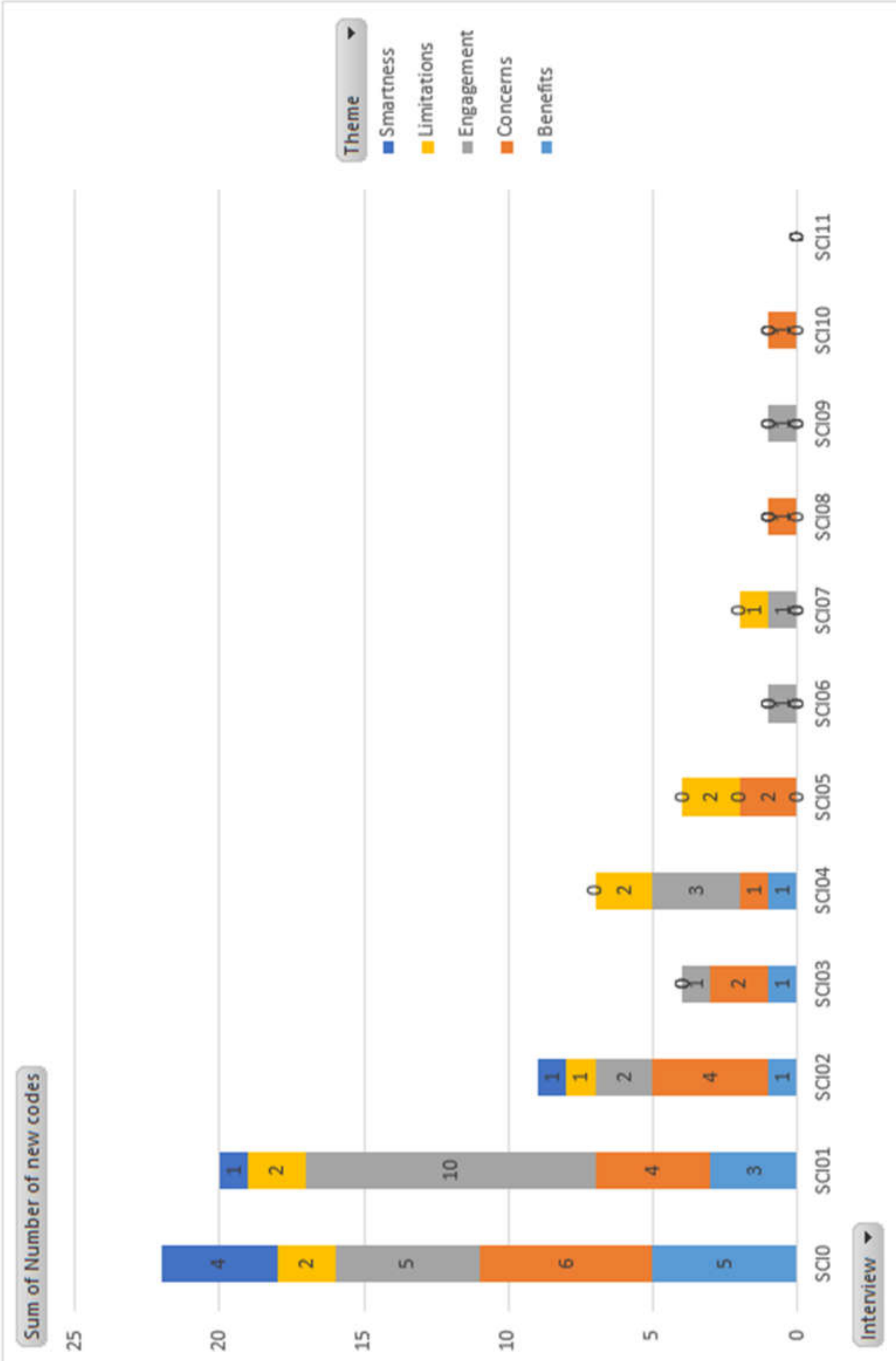

Figure 4.1. Number of New Codes Emerging from each Interview

Chapter 5. Students' Understandings and Perceptions of the Smart City

5.1 Introduction and Chapter Outline

'Smart' is an ambiguous term with no universal understanding due to mainly being defined by industry thus far. Applying the smart label in an urban context has led to the idea of 'smart cities', a concept currently heavily loaded with technocratic notions. Whilst academic literature has pursued deconstruction of the term in order to expose the technocracy driving the concept, with critical scholars such as Holland (2008) and Shelton et al. (2015) examining 'the actual existing smart city, citizens' understanding have remained largely absent. This chapter sought to capture citizens' perceptions of the smart city in order to address this gap and inform the development of a more citizen-centric meaning of the concept.

Students represent a large proportion (3.6%) of Greater Manchester's population (ONS, 2019; HESA, 2018a). Additionally, universities are becoming increasingly important actors in the urban sustainability challenge and smart cities (Trencher et al., 2014; Guan et al., 2016). As Manchester Metropolitan University (Manchester Met) is situated within the smart city district of Manchester, students attending this university are exposed to various smart city solutions, making them an interesting stakeholder group to examine.

This chapter presents the results from section one of the student survey (see Chapter 3, Section 3.6.1), examining perceptions of the smart city, specifically understandings of the 'smart' label and perceived concerns and benefits to the concept, contributing to Objective 1. Section 5.2 presents the student sample. Section 5.3 evaluates students' understandings of the smart city concept, what they believe makes a technology smart and their familiarity with the term Internet of Things (IoT). Section 5.4 assesses students' perceived benefits arising from implementing the smart city, whilst 5.5 examines students' concerns related to the smart city with specific focus on associated privacy concerns. Finally, section 5.6 provides a chapter summary.

5.2 Student Profile

The survey obtained a total of 1007 responses between February 2017 and March 2018 from students enrolled at Manchester Met. Table 5.1 demonstrates the breakdown of the students' gender, age, country of domicile, ethnicity and their level of study. Comparing the demographic ratios to that of the student population at Manchester Met (HESA, 2018b;c), the sample was representative. Whilst Thomas et al., (2016) shed light on citizens' perspective of the smart city through 22 brief on-the-street interviews, this study offers a significantly larger sample. With a cross-sectional survey, this research was able to establish a major representative sample of the student population at Manchester Met.

Table 5.1. Respondent Profile

Demographics	Survey (n=1007) #	(%)	Manchester Met University (n=33088) #	(%)
Gender				
Female	549	(54%)	19415	(59%)
Male	440	(43%)	13660	(41%)
Other	9	(1%)	5	(.02%)
Prefer not to say/unknown	9	(1%)	0	(0%)
Age				
20 and under	468	(46%)	16475	(50%)
21 - 24	344	(34%)	9515	(29%)
25 - 29	102	(10%)	2685	(8%)
30 and over	84	(8%)	4405	(13%)
Prefer not to say/unknown	9	(1%)	0	(0%)
Country of domicile				
UK	905	(89%)	30610	(93%)
Other EU	32	(3%)	970	(3%)
Non-EU (International)	70	(7%)	1500	(5%)
Ethnicity*				
White	625	(62%)	22080	(72%)
Asian	231	(23%)	4945	(16%)
Black	72	(7%)	1615	(5%)
Mixed	40	(4%)	1415	(5%)
Other	26	(3%)	440	(1%)
Prefer not to say/unknown	13	(1%)	120	(.4%)
Level of Study				
Undergraduate Degree	826	(81%)	26605	(80%)
Postgraduate Degree	181	(18%)	6475	(20%)

*HESA data for ethnicity only available for UK domiciled students

5.3 Understandings of 'Smart'

5.3.1 The Smart City

Students were asked whether they were familiar with the smart city concept and how they perceived it. Figure 5.1 illustrates students' familiarity with the smart city concept. 69% of respondents reported they had never heard of the smart city prior to responding to the survey, while 13% stated they had heard of it, but did not know what it meant. The remaining 18% indicated they were familiar with the smart city.

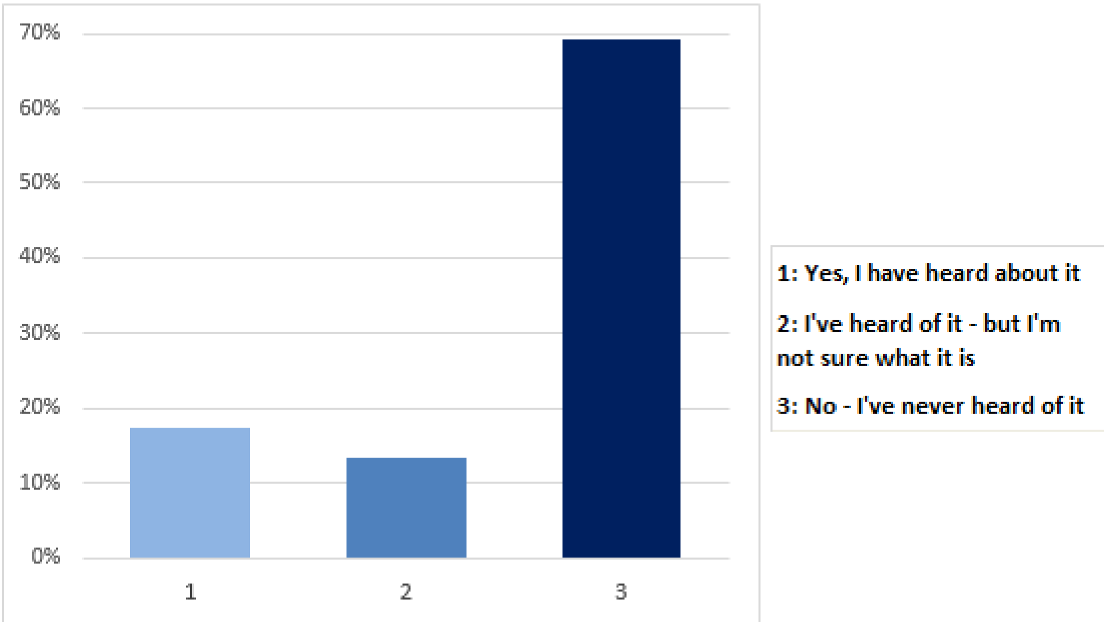

Figure 5.1. Students' Familiarity with the Smart City

Regardless of a participants' familiarity with the concept, all respondents were requested to describe what they understood by the smart city. A total of 520 meaningful comments were obtained, where the identified themes are presented in Table 5.2.

Table 5.2. Students' Understandings of the Smart City

Theme and sub-themes	All Comments (n=520)		Familiarity with the Smart City concept: Familiar with the concept (n=168)		Heard of it, but don't know what it means (n=109)		Not familiar with the concept (n=243)	
	#	(%)	#	(%)	#	(%)	#	(%)
Technology	**306**	**(59%)**	**120**	**(71%)**	**50**	**(46%)**	**136**	**(56%)**
General technology	138	(27%)	53	(32%)	17	(16%)	68	(28%)
Advanced technology	63	(12%)	15	(9%)	14	(13%)	34	(14%)
AI and automation	49	(9%)	18	(11%)	13	(12%)	18	(7%)
Connectivity	47	(9%)	26	(15%)	7	(6%)	14	(6%)
Monitoring and tracking	29	(6%)	10	(6%)	6	(6%)	13	(5%)
IoT	25	(5%)	18	(11%)	4	(4%)	3	(1%)
Data	24	(5%)	16	(10%)	3	(3%)	5	(2%)
Environment	**282**	**(54%)**	**86**	**(51%)**	**78**	**(72%)**	**118**	**(49%)**
Energy	128	(25%)	29	(17%)	41	(38%)	56	(23%)
General environment	88	(17%)	32	(19%)	22	(20%)	34	(14%)
Resources	41	(8%)	15	(9%)	13	(12%)	13	(5%)
Efficiency	36	(7%)	12	(7%)	10	(9%)	14	(6%)
Sustainability	16	(3%)	8	(5%)	4	(4%)	4	(2%)
Pollution	15	(3%)	6	(4%)	3	(3%)	6	(2%)
Citizens	**29**	**(6%)**	**16**	**(10%)**	**5**	**(5%)**	**8**	**(3%)**
Transport	**29**	**(6%)**	**16**	**(10%)**	**7**	**(6%)**	**6**	**(2%)**
General efficiency	**27**	**(5%)**	**10**	**(6%)**	**8**	**(7%)**	**9**	**(4%)**
General sustainability	**16**	**(3%)**	**5**	**(3%)**	**3**	**(3%)**	**8**	**(3%)**
Economy	**12**	**(2%)**	**6**	**(4%)**	**1**	**(1%)**	**5**	**(2%)**

Nearly two thirds (68%) of those who left a comment had either heard of the smart city, but did not know what it meant, or were not familiar with the concept at all. This means the majority of respondents adopted a terminological understanding from the phrase 'smart city' alone.

Two dominant themes emerged: technology (identified in 59% of comments) and environment (54%). The two themes were not mutually exclusive, where an overlap of 19% where respondents identified both technology and environment were evident.

Comments associated with both typically ranged from a general understanding: “a city that's technologically advanced and eco-friendly”, to specifics about how the use of technology can bring urban environmental improvements:

> *“Utilising technology to monitor [and] create devices to protect [the] environment and predict the environmental consequences”.*

Additionally, some comments illustrated the view that a smart city is a city using eco-friendly technology.

With respect to technology, survey results identified various nuances of techno-centric understandings affiliated with the smart city, ranging from a general understanding of using and integrating technology, information and communication technology (ICT) and IoT in a city context, to various aspects and connectivity of these technologies. When describing the technologies related to the smart city, words such as “futuristic”, “cutting edge” and “modern” were frequently used, clearly outlining a temporal association with the concept. Additionally, comments identified notions around technologies delivering higher levels of automation in the city, reducing the need for human involvement through increasingly relying on artificial intelligence (AI):

> *“Digital city that can almost look after itself through technology without the help of humans”.*

Subsequently, conjoined understandings highlighted that a smart city is a “city run efficiently by interconnected technology”. Respondents further referred to this in terms of the smart city providing greater operational efficiency, more specifically “a city which is automated for efficiency”, emphasising the enabling mechanisms of AI.

Efficiency was also frequently used as a descriptor within other themes, especially in relation to the environment, where 7% of respondents highlighted environmental efficiency, with the majority linking this to energy and resource efficiency. Furthermore, 8% of respondents emphasised that the smart city is “a city where everything is run by renewable resources”, whilst 25% associated the smart city with a reduction in energy consumption.

Additionally, a more general eco-centric understanding of the smart city emerged, where 17% of the comments expressed that the smart city is a city that is “environmentally friendly”, “eco-friendly” or “green”. Indeed, some respondents used alternative ‘city’ terminology to describe the smart city by re-stating it as a "green city" or "sustainable city". When addressing sustainable urbanism, there are other concepts that overlap in characteristics with those of the smart city as shown in de Jong et al. (2015). Therefore, when describing the smart city, respondents may resonate with other concepts when demonstrating their understanding.

Similar to efficiency, sustainability was used as a descriptor in a number of variations across themes. Three percent related sustainability to the environment, with typical comments describing the smart city as one that is "environmentally sustainable" or ensures "sustainable use of natural resources". An additional 3% referred to either social or economic sustainability or sustainability in a more general sense. Nevertheless, only 6% understood the smart city to be a concept designed to improve the lives of, or meet the needs of humans, including health and safety. Typical comments referred to technology as an enabler for this by stating a smart city "uses technology to improve everyday lives of the people" and:

> "*A city connected using technology […] that allows residents to understand what's going on around them digitally*".

Other respondents stated that the smart city is "a city where its citizens are safe and protected", with one comment specifically declaring this meant having "CCTV on every street". Additionally, some comments illustrated how environmental improvements such as "less pollution" brought forth by the smart city would ultimately result in improved quality of life.

Whilst a common critique within the academic literature states that citizens are not the key focus in smart city initiatives (Söderström et al., 2014), respondents reinforced this as few included citizens in their understanding of the concept. Similarly, only 2% linked the smart city to an economic context, despite it being considered as one of the concept's key domains (Giffinger and Gudrun, 2010).

Across all themes, 6% of respondents used elements of transport as tangible examples to illustrate their understanding of the various aspects of the smart city. Whilst some hinted that the smart city would better the "flow of congestion", others described the vehicles they believed to be in operation in a smart city: "autonomous cars [and] intelligent roads".

When examining the understandings of the smart city, some apparent differences emerged between those who were familiar with the concept and those who were unfamiliar, particularly with respect to the balance between technological and environmental interpretations. Those who were familiar with the concept dominantly identified technological elements (71%), with slightly over half referring to the environment (51%). In contrast, those who had heard of the concept, but did not know what it means dominantly identified environmental (72%) aspects, with just under half referring to technology (46%). In comparison, those who had never heard of the smart city made broadly comparable reference to both environment (49%) and technology (56%). In adopting a terminological understanding, those who had heard of the smart city identified a broader environmental context and were linking it to other ‘city’ concepts such as those noted earlier in this section. The respondents who had heard about the smart city but did not know what it means or those who had never heard of the concept typically pointed out specific environmental aspects such as energy. Interestingly, whilst the respondents familiar with the concept did cite citizens more frequently than those who were unfamiliar, a citizen-centric understanding remained low as only 6% of all comments referred to citizens.

5.3.2 Smart Technology

In order to fully capture the perceptions of the ‘smart’ label, the students were also asked what they believed makes a technology smart. This enabled a holistic understanding of what ‘smart’ means to citizens, both on a technology and a city level as understandings of the two may not be interchangeable.

Firstly, it became evident that ‘smart’ in relation to individual technologies was significantly more relatable to the students as this question obtained a total of 904 meaningful responses. Secondly, the range of themes was considerably broader, yet less ambiguous than those of the understandings attached to the smart city. Table 5.3 illustrates the overarching themes identified.

Table 5.3. Students' Associations with Smart Technology

Theme and sub-themes	All Comments (n=904) #	(%)
Value to the user	**198**	**(22%)**
Technological aspects	**186**	**(21%)**
Technological abilities	**166**	**(18%)**
Connectivity	**120**	**(13%)**
Level of human interaction	**111**	**(12%)**
Functionality	**105**	**(12%)**
Tangible examples	**97**	**(11%)**
Efficiency	**93**	**(10%)**
Environmental friendliness	**84**	**(9%)**
Data and information displayed	**54**	**(6%)**
Time and money savings	**22**	**(2%)**

A Citizen Focus: in, on or off the loop?

A clear citizen-centric view of what makes a technology smart emerged from the analysis, as 22% of respondents expressed various notions of how it adds value to the user. These interpretations were categorised into four sub-themes: easy to use, makes life easier, improves quality of life, and provides ease of access.

Within this theme, respondents identified that smart technology is easy to use, with some comments referring specifically to less techno-literate people: "ease of use and making things easier for none technology minded people [sic]", "technology capable to enhance everyday life, but simple enough for anyone to use". Words such as "convenient", "useful" and "helpful" were frequently used to describe their understandings of the smart label in relation to technology with some stating it runs as "almost like a personal assistant". Noteworthy comments included that a smart technology is easy to use, despite being "high tech" due to its "intuitive" abilities. The majority of these respondents described intuitive qualities as a positive enabler, linking the level of intuition to generally improving quality of life for people and "enhances your life", although some also identified concerns related to this: “technology is easing human life by being smart however intrusive”. Additionally, respondents explained that a smart technology enables increased accessibility when compared to traditional technologies:

> “*Easy to access things that wouldn’t normally be easy to access i.e. you would have to log onto the computer etc.”*

Whilst respondents agreed that intuitive abilities could make life easier, there was a strong disagreement between respondents regarding how much human interaction smart technology required. Twelve percent of comments expressed a view reflecting the level of human interaction they believed smart technology requires. These views ranged from smart technology being purely human operated, to no human interaction required, including the extreme outlier of virtual humans and robots taking over operations. Figure 5.2 illustrates these perceptions linking smart technology to the idea of human in, on or off the loop (Coletta and Kitchin, 2017).

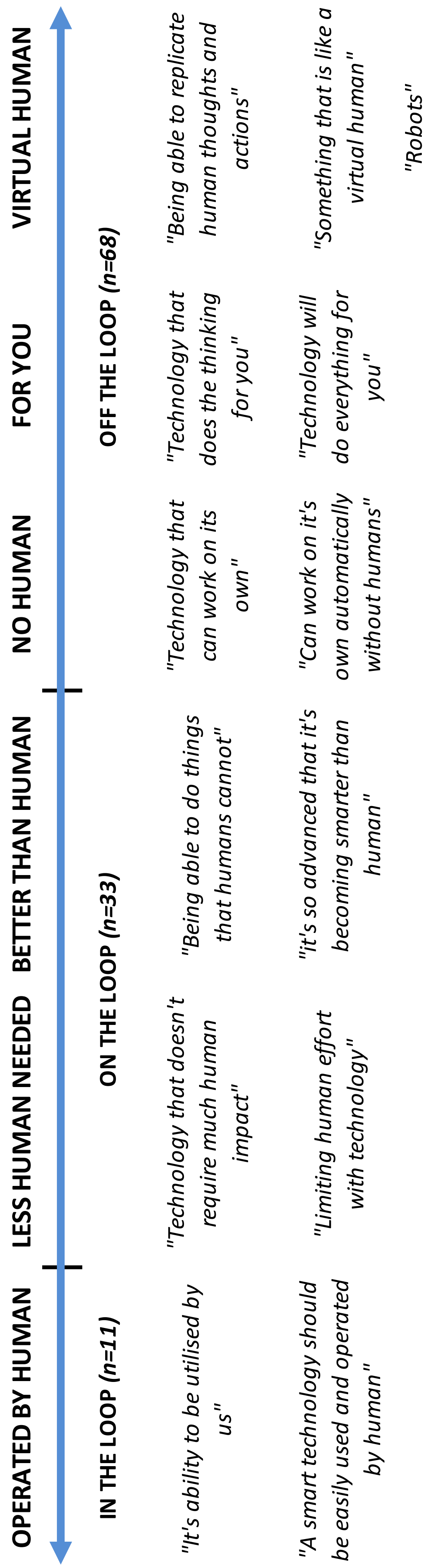

Figure 5.2. Perceived Level of Interaction Required for Smart Technology

As seen in Figure 5.2, the majority of respondents talking about levels of human interaction believed smart technology required no interaction, thus falling within the category of human-off-the-loop. Off-the-loop disables the opportunity to interfere in an automated process, and decision making is fully based on algorithms. The students' notions around this frequently referred to the technologies performing tasks on behalf of humans, with some noting "robots" and "virtual humans". On-the-loop provides automated processes where humans observe but have the opportunity to interfere or override the system when necessary. Comments associated with the on-the-loop perspective noted that smart technology requires less human interaction, and that it was 'smarter' than humans. However, there was still an element of human interaction present within these notions. Whilst on-the-loop comments addressed 'smart' as only requiring significantly less human interaction, off-the-loop comments referred to technology completely taking over for humans. Only 11 respondents resonated with the human-in-the-loop category where humans use technology to make informed decisions. These comments emphasised that technology should adapt to humans and that it should operable by humans. Together, these notions contextualise the concerns that 'smart' facilitates algorithmic governmentalities, giving citizens lesser control over decisions in the smart city (Leszczynski, 2016). It also aids in understanding what triggers the worry about dystopian futures (Vanolo, 2014; 2016).

Technological Aspects and Abilities: Complex and Futuristic

Whilst not specifying levels of human interaction required for smart technology, 21% of comments identified various aspects of technologies they believed makes them 'smart'. Six percent of comments associated smart technology with automation and AI, which facilitates, as one comment remarked:

> *"…capacity for the technological instrument to make decisions based on robust evaluations of its environment".*

When referring to a broader understanding of automation and use of AI as an aspect of smart technology, 18% of comments talked about various technological abilities they associated with smart. Firstly, the ability to monitor and learn behavioural patterns of the user. Secondly, that the technology is interactive, adaptable, predictive and responsive to its user and surrounding environment based on this monitoring and learning process. There were, however, strong contesting perceptions of levels of human interaction required within these themes. Whilst comments referring to interactivity specifically emphasised human interaction with technology and users' "capacity to customise", comments linked to the predictive abilities and responsiveness stressed that it "makes decisions for the user" and "predicts your needs". Respondents noting abilities of adaptability made remarks such as "technology that will adapt to your behaviour" and "smart means it's adaptable to your needs". Whilst, this is associated with a certain level of automation, there was a stronger sense of the human overseeing the decision making within this theme. One comment in particular illustrated this: "technology that changes according to the persons likes and dislikes".

Coupled with comments illustrated in Figure 5.2, these responses are strongly interlinked with the perceptions of control. Whilst some perceived smart technology as a device to control other devices with, several responses also related to remote control. The strong temporal notions surrounding 'smart' were noteworthy. These were particularly evident in the responses that referred to smart technology as "advanced" and "can do more than basic tech". Responses within this theme also specifically referred to time through comments such as "technology is smart because it is so up to date" and "being ahead of time and innovative e.g. a new form of technology" while using words such as "futuristic", "modern", "evolving" and "progressive" as descriptors. In addition to this, some respondents made references to temporality through stating that smart technology saves time. Ten percent of comments referred to efficiency in terms of "increasing productivity" as in "the ability to shorten the time it takes to perform tasks" as well as that the technology itself is "fast". Time was also evident within the theme focusing on data as some comments stated that smart technology "provides information regularly or in real time". These findings align with Kitchin (2019), who - through interviews with smart city stakeholders - identified similar temporal aspects of the smart technology and the smart city.

Connected and Multifunctional: Reinforcing the Temporalities of Smart

There was also a strong sense of 'smart' relating to connectivity as 13% of respondents stated that a smart technology was connected to the internet, to other technologies, and enabled increased communication through connectivity between people. Additionally, a group of comments related to the interconnectedness of smart technologies in a more general sense. With regards to connectivity between people, comments such as "the socialising it offers” and “technology that enables us to connect with one another” truly emphasised the social change smart technology offers. This links to a socio-temporal aspect of the smart city as discussed in Kitchin (2019). Whilst more mundane aspects were identified within the connection to the internet such as “the ability to access the internet”, some more robust techno-centric notions of connectivity arose from the links to other technologies:

> *“Primarily I think that if something is smart it has to be able to 'talk' to other devices, not necessarily via the internet, but they are smarter if it is. So Bluetooth to Bluetooth controls etc. could make a coffee machine turn on when you're home, but you could turn on your heating when you're away from home using your phone and an internet connection”.*

These quotes not only clearly outline the complexity of the interpretations, but they also identify the spatial aspects of the ‘smart’ label through the ability to shrink distances between people, and between humans and tasks (Castells, 2010; Kitchin, 2019).

In order to more accurately describe smart technologies, 11% of respondents chose to use tangible examples of technologies they were familiar with and classed as ‘smart’ or why they were ‘smart’. Typical examples included various interactions with household objects such as “boil the kettle from your iPhone”. Others with recently launched technologies with “voice recognition and AI – e.g. Amazon robot, Alexa, Siri, etc.” However, other responses specifically remarked aspects of the temporalities:

> *“If it has features that haven’t existed before in the past, for e.g. like touch screens”.*

and:

> *“Has many uses not just one, for example the old phones were only used to call sometimes text but with modern phones, you basically have the world in your pocket e.g. phone, watch, TV, computer”.*

These temporal notions regarding smart technology being multifunctional were clearly outlined as respondents emphasised the ability to operate multiple tasks through one device:

"Smart technology is technology that enables us to do many things [and] is forever evolving".

or, as another comment highlighted:

"Technology that brings everyday things such as banking together into one device, so that you don't have to own various devices to do different things".

Collectively, these quotes demonstrate how temporalities are harnessed in the understandings of smart. However, some comments stated disbelief in the label as a whole:

"Smart seems to just be a catch all term for anything with multiple functions or the ability to use internet connectivity to function".

and:

"Being new and connectable to other things. It's basically a marketing thing at this point".

Environmentally Friendly Technology: Smart Saves the Environment

Mirroring the comments from understandings of the smart city, 'smart' is indeed associated with the technology itself being environmentally friendly and eco-efficient, while enabling energy saving. Technology was identified as 'smart' "when it has the ability to tell you how much energy you are using", with particular emphasis placed on the technologies' energy usage and ability to help improve users' energy behaviours.

"I think smart technology is tech that is green, clean, uses little amount of energy, helps to manage energy use".

"Technology that can help you make smart decisions such as smart energy monitors to reduce waste".

Additionally, other helpful aspects were highlighted:

"Technology that enables us to control certain aspects of our lives, such as measuring/timing things in relation to energy consumption for example".

Whilst majority of respondents stated positive notions within this theme such as "using very less resources and have no consequences on nature [sic]", some expressed scepticism:

"It's described as tech that works in conjunction with the planet, to lower emissions and energy whilst still using it. However, I think this is just a marketing tool"

5.3.3 Internet of Things

In order to capture the students' awareness of different elements of the smart city, they were asked to state their familiarity with IoT and to describe what they understood by the term. Figure 5.3 shows that the vast majority of students had never heard of the IoT prior to responding the survey and only 17% stated they were familiar with the term.

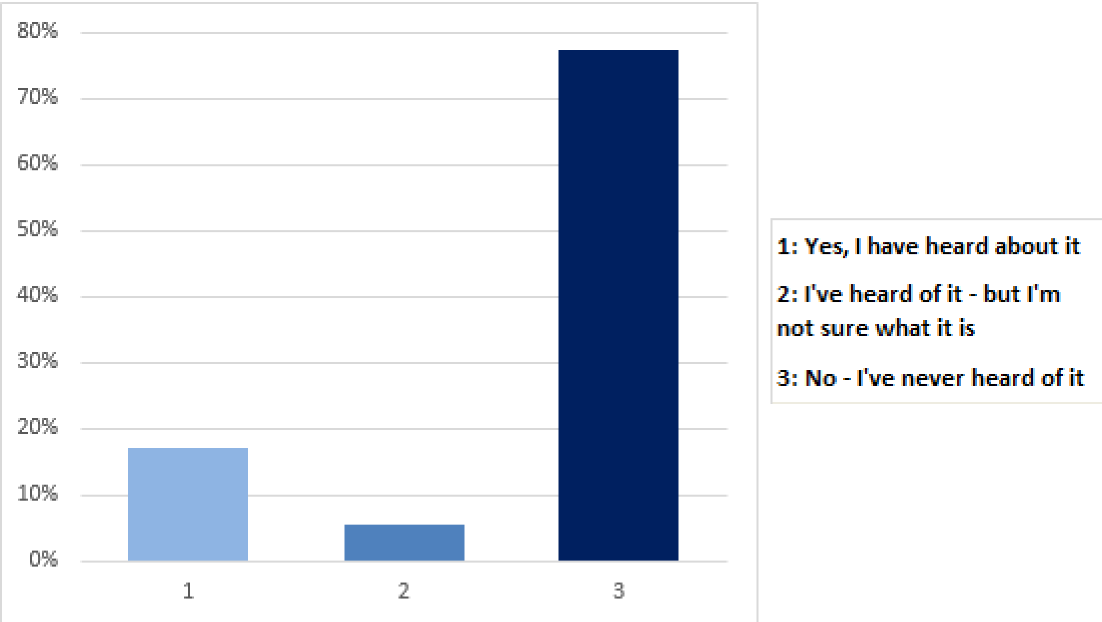

Figure 5.3. Students' Familiarity with the Term IoT

When asked what they understood by the term IoT in an open comment box (Table 5.4), a total of 282 meaningful responses were obtained. Table 5.4 presents the themes identified in relation to students' understandings of the IoT.

Table 5.4. Understandings of IoT

Theme and sub-themes	All Comments (n=282)		Familiarity with the term "IoT": Familiar with the concept (n=149)		Heard of it, but not sure what it is (n=28)		Not familiar with the concept (n=105)	
	#	(%)	#	(%)	#	(%)	#	(%)
Connectivity	**111**	**(39%)**	**92**	**(62%)**	**7**	**(25%)**	**12**	**(11%)**
To the internet	60	(21%)	49	(33%)	4	(14%)	7	(7%)
To other technologies	53	(19%)	48	(32%)	3	(11%)	2	(2%)
General connectivity	18	(6%)	14	(9%)	1	(4%)	2	(2%)
Internet	**90**	**(32%)**	**14**	**(9%)**	**14**	**(50%)**	**62**	**(59%)**
Information on the internet	25	(5%)	2	(1%)	5	(18%)	18	(17%)
Things on the internet	23	(4%)	1	(1%)	5	(18%)	17	(16%)
General internet	21	(4%)	4	(3%)	1	(4%)	16	(15%)
Use of the internet	12	(2%)	4	(3%)	1	(4%)	7	(7%)
The internet (WWW)	10	(2%)	3	(2%)	2	(7%)	5	(5%)
Tangible examples	**38**	**(13%)**	**24**	**(16%)**	**2**	**(7%)**	**12**	**(11%)**
Physical	23	(8%)	23	(15%)	0	(.0%)	0	(.0%)
Online	15	(5%)	1	(1%)	2	(7%)	12	(11%)
Accessibility and control	**22**	**(8%)**	**15**	**(10%)**	**2**	**(7%)**	**5**	**(5%)**
Data	**20**	**(7%)**	**17**	**(11%)**	**1**	**(4%)**	**2**	**(2%)**
AI and automation	**14**	**(5%)**	**13**	**(9%)**	**0**	**(.0%)**	**1**	**(1%)**
Technology	**12**	**(4%)**	**6**	**(4%)**	**2**	**(7%)**	**4**	**(4%)**

As Table 5.4 illustrates, the majority of comments were obtained from students stating they were familiar with the term. The main theme identified was connectivity in relation to IoTs connection to other technologies and devices, and the internet. However, it is noteworthy that most respondents referring to connectivity reported that they were familiar with the term, and that those associating it with the internet were not.

The broadest and most ambiguous theme emerged from those talking about IoT's specific relationships to the internet in various ways. Whilst one group of respondents stated that IoT is information found on the internet, another thought it is 'things' found or purchased from the internet. Two smaller groups of respondents referred to IoT in a more general sense and the use of the internet, whilst another stated IoT *is* the internet/world wide web. However, it has to be noted that the majority within this theme stated they were not familiar with the term IoT; hence their responses were likely guesses.

Thirteen percent of respondents gave tangible examples, both on and offline, that they believed to be classed as IoT. These included various 'smart' household objects as well as other more specific technologies: Alexa, cars, phones, watches, search engines, Google, websites, Reddit, browsers and social media. The majority of respondents providing tangible examples were familiar with the term IoT.

The bottom four themes of Table 5.4 were broadly similar to those identified within understandings of smart technologies. Whilst 4% of responses linked IoT to the everyday use of technology, 8% of responses reported that they believed IoT to be related to people's ability to access and control equipment, with several responses referring specifically to doing so remotely via the internet: "where devices are interconnected via the internet and can also be controlled remotely". Responses regarding the latter closely related to those associating AI and automation with IoT, describing it as: "every device which have senses and operate without human interference". More specific comments also emphasised sensors as part of IoT, with some pointing to the use of sensors to share data: "every device that have sensors [and] communicates their reading to other devices". This was also mentioned in relation to IoTs collecting, monitoring, and producing data for various purposes, with some referring to "big data".

5.4 Perceived Benefits of the Smart City

Smart city initiatives are clear on what the benefits of the concept are as reviewed in Chapter 2, Section 2.8.1. Whilst a range of academic literature discusses these benefits (cf. Neirotti et al., 2014; Belanche et al., 2016), it is strongly debated who these benefits are for (Winters, 2011). Additionally, there is little understanding of citizens' perceived benefits to the smart city. Therefore, students were invited to reflect on what benefits they believed could be associated with the concept in an open comment box (Table 5.5).

Of the 612[3] students presented with this question, 351 meaningful comments were obtained. Table 5.5 illustrates the themes identified. These included benefits for: the environment, efficiency, the citizens, technological advancements, and transport.

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[3] Question only included in the SurveyMonkey version of the survey, thus *n*=612.

Table 5.5. Students' Perceived Benefits of the Smart City

Theme and sub-themes	All Comments *(n=351)* #	*(%)*
Environment	**224**	**(64%)**
Energy and resources	112	(32%)
General environment	107	(30%)
Pollution	37	(11%)
Efficiency	**70**	**(20%)**
General efficiency	33	(9%)
Time and money	23	(7%)
Energy efficiency	18	(5%)
Citizens	**55**	**(16%)**
Better and easier life	27	(8%)
Technology	**26**	**(7%)**
Transport	**14**	**(4%)**

The main benefit associated with the smart city was environmental improvements (64%). Half of these comments stated that the smart city would lead to increased conservation of energy and resources, and more efficient utilisation of both. Comments frequently referred to these changes in regards to the concept facilitating the ability to monitor and control energy and resources. Additionally, respondents associated the smart city with the use of sustainable, green and renewable energy and resources which in turn linked to the perceived benefit of lower consumption. Some responses drew these links down from a city level to an individual level as the concept could also "encourage people to be smarter by providing them with knowledge on energy saving".

Efficiency was not only a prevalent theme in relation to energy. Nine percent of responses identified general efficiency as a benefit, with several comments strongly relating to operational efficiency where "things may run more smoothly" and that "it'd allow the city to run excessively efficient", whilst 7% thought the smart city could save both people and councils money. Another 7% associated smart city benefits with improved transport both in relation to more efficient traffic flows and vehicles running on renewable fuels, thus reducing pollution. However, transport related comments tended to capture a holistic perception of the benefits smart cities could potentially bring by including technological aspects:

> *"Connectivity in terms of being able to collect traffic data to optimise traffic flow, which would in theory reduce pollution".*

Use of technology and increased connectivity were also identified as a benefit in relation to replacing human operations as the smart city provides "highly efficient automated systems, which can help set back basic tasks with[in] areas". Interestingly, comments associated automation and the inclusion of AI as a benefit to people through:

> *"Reducing the number of errors in daily issues and replacing it with AI to help humans evolve"*.

Although citizens were mentioned more frequently than when respondents were asked to elaborate on their understanding of the smart city, citizen specific benefits only accounted for 16% of the comments. Benefits highlighted ranged from smart cities providing a generally better and easier life to improving health and equality. It was evident that they were not mutually exclusive as the respondents in this category often identified more than one benefit to the citizens. Moreover, comments also frequently noted that citizens would benefit from environmental improvements: "less harmful to the environment and better for the planet and people".

5.5 Concerns Regarding the Smart City

From contemporary academic literature, concerns such as privacy and security, inclusion/exclusion, and inequalities, have been identified in relation to the smart city (Vanolo, 2016; Cardullo and Kitchin, 2018a). Additional concerns regarding barriers to implementation have also been identified such as cost and citizen engagement (Cardullo and Kitchin, 2018a; b). However, none of these concerns rose from empirical inquiries with *citizens* in a smart city. Therefore, the students were asked what concerns or worries they had about the smart city in an open comment box (Table 5.6).

Table 5.6 illustrates the concerns identified by the students and three main areas of concerns arose: data and security, dystopian futures and barriers to implementation of the concept. Additionally, three other topics of concerns emerged, stating that the smart city would not deliver environmentally, that it will fuel inequalities and exclusions, and students doubted the overall effectiveness of the concept. However, these were not as prevalent, and responses categorised within these themes were broader.

Table 5.6. Students' Perceived Concerns Regarding the Smart City

			Familiarity with the Smart City concept					
Theme and sub-themes	**All Comments** *(n=496)*		**Familiar with the concept** *(n=152)*		**Heard of it, but don't know what it means** *(n=81)*		**Not familiar with the concept** *(n=263)*	
	#	*(%)*	*#*	*(%)*	*#*	*(%)*	*#*	*(%)*
Data and security	**133**	**(27%)**	**63**	**(41%)**	**22**	**(27%)**	**48**	**(18%)**
Privacy	67	(14%)	30	(20%)	14	(17%)	23	(9%)
Security	60	(12%)	31	(20%)	7	(9%)	22	(8%)
Data collection -and regulation	32	(6%)	11	(7%)	8	(10%)	13	(5%)
Dystopian futures	**97**	**(20%)**	**29**	**(19%)**	**14**	**(17%)**	**54**	**(21%)**
Dependency on technology	27	(5%)	6	(4%)	3	(4%)	18	(7%)
Disruption from errors	25	(5%)	7	(5%)	4	(5%)	14	(5%)
Losing sight of the human	20	(4%)	3	(2%)	4	(5%)	13	(5%)
Rise of the machines	15	(3%)	5	(3%)	1	(1%)	9	(3%)
Less jobs	12	(2%)	6	(4%)	1	(1%)	5	(2%)
Less human control	8	(2%)	5	(3%)	0	(.0%)	3	(1%)
Less physical activity	6	(1%)	4	(3%)	1	(1%)	1	(%)
Barriers to implementation	**96**	**(19%)**	**34**	**(22%)**	**22**	**(27%)**	**40**	**(15%)**
Cost and time	53	(11%)	20	(13%)	14	(17%)	19	(7%)
Citizen engagement	29	(6%)	6	(4%)	6	(7%)	17	(6%)
Unrealistic concept	15	(3%)	8	(5%)	2	(2%)	5	(2%)
Not delivering environmentally	**51**	**(10%)**	**13**	**(9%)**	**13**	**(16%)**	**25**	**(10%)**
Exclusion and inequalities	**22**	**(4%)**	**9**	**(6%)**	**3**	**(4%)**	**8**	**(3%)**
Effectiveness of concept	**19**	**(4%)**	**1**	**(1%)**	**5**	**(6%)**	**13**	**(5%)**

5.5.1 Privacy and Security

Data and security related concerns (27%) were by far the most prevalent throughout responses. Fourteen percent of comments explicitly referred to worries around privacy, whilst 12% expressed concerns around security. However, privacy and security concerns were not mutually exclusive as 3% of these responses mentioned both.

Typical comments within the theme of privacy expressed worries around “lack of privacy” and “privacy invasion”, with several respondents stating that the smart city “sounds a bit 'Big-Brother'”. Other comments with respect to the latter voiced concerns that the concept would lead to “constant monitoring” and “surveillance” where “everything [is] controlled by the government or a company”. Additionally, respondents were concerned about “what parts of […] life it has access to” and “the way private data will be used”.

A group of respondents (6%) articulated concerns regarding data collection and regulation, where several comments questioned how data would be controlled and who owned the data. Some stated that “corruption could increase within companies” or that:

> *“That it [data] will be exploitable by business and used for advertising or charge for "premium" services”*.

Moreover, the fear of being exploited for data was clearly articulated by several respondents:

> *“With so many apps and technologies connected to "the cloud", it leaves so much data at risk of falling into the wrong hands. We can't always be sure our data is secure and encrypted with the most protective technology”.*

Consequently, respondents were worried about data security. Typical comments expressed uneasiness around “hacking” and “data protection”, specifically regarding data that respondents identified as personal, such as payment information and bank details. Whilst the majority of comments referred to data on a personal level, some made reference to worries around urban data platforms:

> *“Hacking if it's the case. Consolidation of everything to one system makes it easy to disrupt”.*

> *“It would make a hackers paradise, given that already it is feasible to hack cars, it would concern me that the system is unreliable”.*

Due to the extensive academic literature discussing privacy concerns related to the smart city (Chapter 2, Section 2.9.2), all students were also specifically asked about their personal level of privacy concern when using smartphones and downloading apps (Figure 5.4). The students were only asked this question if they stated they owned a smartphone.

The smartphone prevalence among the surveyed students was 98.5%. Students with a smartphone reported having an average of 27 apps installed (SD=27.8).

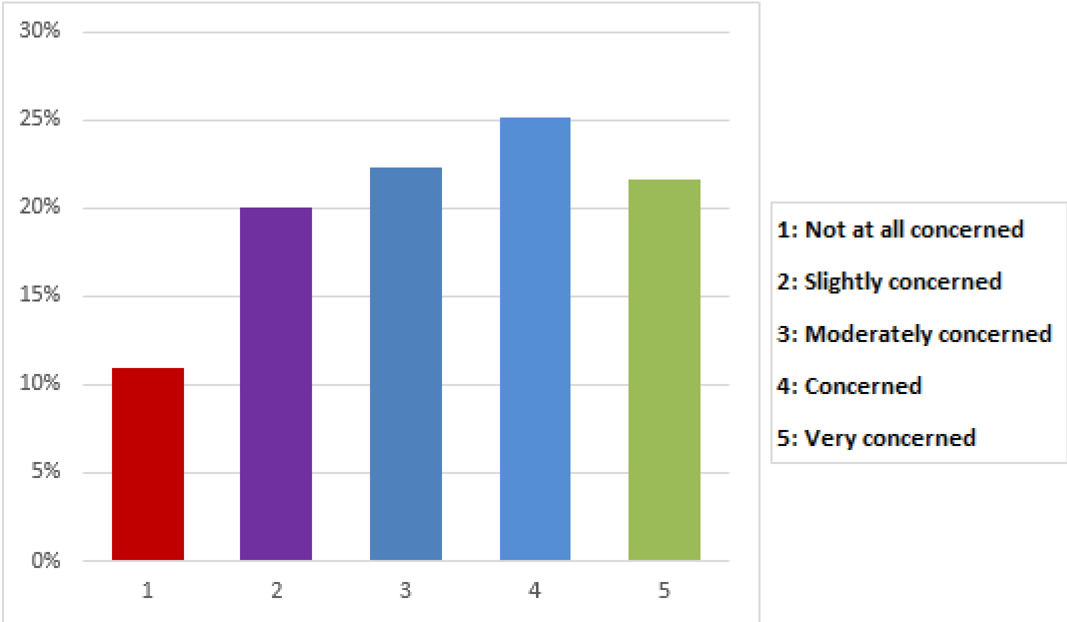

Figure 5.4. Students' Level of Privacy Concern

As seen in Figure 5.4, 89% of respondents expressed some level of concern about privacy. A greater proportion of students was "moderately concerned" or "concerned" than "very concerned". In an open comment box (Table 5.7) allowing students to elaborate on why they were or were not concerned about their privacy, 540 meaningful responses were obtained, with a representative response rate over 50% from each level of concern. Two overarching categories arose: concerns in relation to privacy and/or security. Table 5.7 illustrates the privacy themes that emerged, whilst Table 5.8 shows those in regards to security.

Table 5.7. Privacy Related Concerns with Smartphone Usage

Theme and sub-themes	Privacy Concerns (n=217) #	(%)	All comments (n=540) (%)
General invasion of privacy	**138**	**(64%)**	**(26%)**
Data	**57**	**(26%)**	**(11%)**
Collection and sharing	35	(16%)	(6%)
Purpose of use	9	(4%)	(2%)
Lack of trust	19	(9%)	(4%)
Surveillance	**31**	**(14%)**	**(6%)**
Targeted advertisement	**9**	**(4%)**	**(2%)**

Forty percent of all comments related to a variety of privacy concerns. As seen in Table 5.7, the majority of privacy related comments referred to general invasion of privacy (64%), with typical comments stating "I don't want other parties to access my private information" and "I don't want too much of my personal info shared". Some respondents followed up on this by stating "I believe I'm entitled to absolute privacy". However, a noteworthy number of comments (14%) articulated strong surveillance concerns by stating that "I feel that society is sleepwalking into a controlling age" and "the government is spying on us". This was often rooted in perceptions about possibilities of tracking of, and access to, personal devices.

Furthermore, 26% highlighted specific issues with data, emphasising on collection and sharing, as well lack of trust in the companies receiving the data. This was coupled with a frustration over targeted advertisement.

> *"Because I don't want my private data to be stored away in some server waiting to be sold to companies and sell me ads based on my internet research".*

Whilst several comments articulated worries about their data leaking to third party companies, several respondents questioned the purpose for collecting that data in the first place on which they based their level of concern:

> *"Not sure why they need so much personal information. What do they use it for?"*

Additionally, respondents felt that the data collection process was not transparent, and that companies often tried to avoid disclosing information about data collection: "companies often hide the fact they are harvesting data".

Twenty-five percent of comments related to security concerns. As seen in Table 5.8, the majority of these comments noted various worries about how their data is protected (39%) whilst others specifically referred to hacking (35%). Whilst data protection concerns were often rooted in general security concerns of devices, others questioned whether their data were safely stored. Few respondents feared malware and viruses, with a greater worry about having data stolen:

> *"If it gets stolen, I might be at some potential risk such as identity fraud".*

Whilst fraud was referred to in several cases, noting issues such as identity theft, financial information was highlighted as the type of data students perceived as most personal.

> *"The only things that concern me are when using finance apps, PayPal, banking etc. In case of fraud or hacking".*

Table 5.8. Security Related Concerns with Smartphone Usage

	Security Concerns *(n=136)*		All comments *(n=540)*
Theme and sub-themes	**#**	***(%)***	***(%)***
Data protection	**53**	**(39%)**	**(10%)**
General security	21	(15%)	(4%)
Stolen data	17	(13%)	(3%)
Data storage	12	(9%)	(2%)
Virus and malware	9	(7%)	(2%)
Hacking	**48**	**(35%)**	**(9%)**
Fraud	**45**	**(33%)**	**(8%)**
Financial information	27	(20%)	(5%)
Phishing	12	(9%)	(2%)
Bad intentions	11	(8%)	(2%)

Interestingly, 18% of comments explicitly stated that they had no concerns about their privacy, with majority either explaining "I don't have anything to hide" or "I don't really care about my privacy”. This strongly contributed to understanding the lower levels of concern (moderately concerned or less). Three percent of respondents appeared to succumb to having their data collected:

> *“[I] Worry sometimes about how my data is used but ultimately accept it’s the world we live in and my data could be obtained whether or not I provided it to apps”.*

On the contrary, 5% of comments voiced trust in where they downloaded apps from and their operative system, with several stating: “I only download apps from trusted sources such as the App Store” and:

> *“iOS is heavily encoded, and I've never had any problems with my privacy when using my phone”.*

Additionally, 4% referred to measures undertaking by the students to protect their own privacy and security, thus lowering their level of concern:

> *“Most of my social media is on private settings and I feel my passwords are secure enough to avoid hackers”.*

> *“The Android OS has to give applications permissions to access personal data etc. before it can use them so I can select what I want them to access”.*

The students were also asked about what operating system their smartphone run on. Of the 992 students who owned a smartphone, iOS accounted for 64% of respondents and Android for 35%, whilst the remaining 1% used another type of operating system such as Windows and Google. No significant statistical difference in levels of concern were found between the operative systems (U=101680.50, p=0.087).

Subsequently, students were asked to report whether they read the terms and conditions (T&C) before downloading an app, and in an open comment box they were invited to explain why or why not. The survey revealed that 90% of respondents do not read T&C before downloading an app. Figure 5.5 illustrates the typical reasons given by the 544 who students elaborated on their response.

Reasons for not reading T&Cs	Reasons for reading T&Cs
"Too long to read, time consuming". *"I believe it won't affect me".* *Little point [sic] - companies do what they want".* *"Way too much information and jargon".* *"...usually just want the app to download straight away".* *"As consumers we always assume that nothing bad will happen to us if we download certain apps because we trust the AppStore".*	*"To see the terms and conditions of use and the app permissions being requested".* *"I want to know what will be accessed whilst I use the app".* *"Need to make sure your details are safe".* *"I value my privacy".* *"I really don't want an application to be tracking me".* *"I look at main points on what data they'll get access to".*

Figure 5.5. Reasons for Reading, or Not Reading T&C

Three quarters of respondents stated that the lengthy text and time it takes to read were the main reasons for not engaging with the T&C. Others referred to the content of the T&C being complicated and jargon heavy to understand for end users. Interestingly, some respondents also specifically stated that they felt unaffected by potential consequences due to trusting the apps and their operative system, whilst others had given up attempting to prevent companies from obtaining their data. The 10% of students who stated that they do in fact read the T&C expressed a common interest in maintaining their privacy and data security, and desire to know exactly what data the app required them to allow access to.

5.5.2 Dystopian Futures

An array of comments (20%) referred to concerns around level of human interaction with technology. Students described various dystopian futures, where humans play a lesser role in controlling technology as well as technology performing tasks without humans.

The majority of these responses expressed strong concerns around an over-reliance on technology, with a future in which “the city will become increasingly dependent upon the new technologies of the smart city”. Concerns surrounding dependency on technology in a city closely correlated with those expressing worries about technological errors and disruptions. Several comments discussed a strong uneasiness around scenarios where technologies malfunction, stating that “if there's a system failure the city may become obsolete” or experience a “total black out when everything goes wrong”.

Others stated specifically that relying heavily on technology increases chances of cyber-attacks, thus making the city systems vulnerable.

> *“That it [the city] becomes over dependent on technology and setbacks could occur with system failures, also more vulnerable to hacking from people with bad intentions”.*

On the contrary, some comments drew links to societal consequences where they explained that people were becoming addicted to technology and were worried about “urban populations becoming too engrossed in technological lifestyles”. This interlinked with the 4% of comments that expressed a strong concern about losing sight of the human. Some comments described that the smart city would “potentially further the use of disconnecting technology”, with one comment expressing explicit concerns about the consequences of technology usage for human to human relationships:

> *“Psychological impact of people who are connected to each other but who feel no interpersonal connection”.*

Additionally, respondents believed that “too modern means humans could get carried away and disconnect from nature and purpose” and that in turn, “technology will overpower nature”.

Describing futures where humans play a lesser role, 2% of comments defined more specific worries about increased automation by being “worried that humans will have no control”. Some also drew links back to the societal consequences outlined above, expressing particularly strong beliefs about the smart city:

> *“Limited flexibility due to lack of human personnel. The infinite psychological issues that lack of physical and emotional connection between individual will bring to its inhabitants. I am against the concept”.*

Further to this, an additional theme emerged from 3% of respondents making references to concerns around machines taking over, with associated comments stating: “I’ve seen terminator” and that they had worries about a “robot rebellion”. Other negative connotations included futures where "AI dominates humans" and where "things [are] too automated, jobs taken by robots [and] hobbies destroyed". Additional comments (2%) referred to worries about the smart city resulting in loss of employment. This was especially in relation to practical professions where machines would be able to do the job faster and better than humans, whilst some even expressed that the smart city would create a future where "human labour being redundant" was a possibility.

Whilst the concerns outlined above comprise of great changes to present reality, other apprehensions around the concept were less radical as a small group of comments (1%) referred to futures where "humans would become lazier".

5.5.3 Barriers to Implementation

Despite several respondents feeling uneasy about the outcomes of the smart city concept being implemented, 19% of responses expressed a range of perceived barriers to the implementation process. Eleven percent of comments were associated with the financial cost and time of implementing the smart city. Respondents felt "that it will take a long amount of time to build" the smart city and that it would "cost a lot of money to put in place". Some comments also progressed to question this in greater detail:

> *"Will people be willing to invest? Will it be too little too late? Will advanced technology start to impede on culture and social life more and more? Become difficult to escape tech. A.I may replace many human jobs, how will current economic systems cope?"*

These questions strongly correlated with the broader concerns identified in the above sections, whilst additionally pointing out the socio-cultural implications of the smart city. Another comment also drew links to this by stating that the concept would make "cities lose uniqueness". Likewise, another comment conveyed the opinion that the smart city "could cause human disputes".

Nevertheless, not all comments expressed high levels of worry, rather, their concerns were rooted in potential lack of citizen engagement with the concept, both from a bottom-up and a top-down perspective:

> *"It is brilliant and works for everyone. However, the acceptance of such technologies depends on sociological factors and this will be the weakest point in Manchester".*

“That citizen participation is key in the development of a smart city, but these is not always shared by politicians, or policy-makers”.

Moreover, in relation to the quote provided above, some comments stated that the main barrier for bottom-up engagement and the resistance of smart technologies would be a result of lack of awareness:

“I’m afraid that the smart city will be very confusing for the people at first and not many people will be happy to be a part of it”.

In contrast, some respondents stated that “some politicians are in denial of the need for smart cities”, creating a barrier to a top down implementation of the concept.

Despite some of these comments expressing the need for smart cities and thus concerns over how they may not be implemented, others remained sceptical and apprehensive, stating that “the objectives of such cities are hardly realised”. This scepticism was shared by several other respondents, declaring that “we will never get there” and that it is “not easy to develop”. Whilst some comments questioned “would it work? Would it actually be feasible? How far would it go?”, others firmly stated that it “can't be applied to a real city. Only a good concept”.

5.5.4 Other Concerns

The first of the broader concerns identified by respondents stated that the smart city would not deliver against its environmental targets and promises. The majority expressed worries that the smart city solution would only results in worsening the issue. Whilst the smart city aspires to facilitate energy conservation and environmental improvements, some students felt uneasy about the increased use of technology to reach these goals. Comments argued it could result in increased energy usage and cause environmental harm instead:

“People are just technology obsessed. It uses so much energy and harms our environment even without [us] realising”.

Some students highlighted that the developments of the smart city could also lead to impactful redevelopment:

“To build these cities, they either need to be new or a redevelopment of an old city. […] and building them (production) would create emissions”.

Additionally, some comments emphasised that the high technology usage would disturb the balance with nature and that the concept could lead to “disregard for nature and the natural world”. Further comments expressed a disbelief in the effectiveness of the concept by questioning how and if it would work, whilst others explicitly referred to effectiveness in terms of the environment:

> *“I worry that it won't have a big enough effect on energy saving to be worthwhile”.*

Other respondents highlighted doubt in the long-term results of the implementation of the concept, stating that “the time of change could take a while and not pay off in the end”.

Students also outlined a range of concerns in regards to equality and inequality. The students firstly stated that certain groups are excluded from the benefits of the smart city, fostering greater inequalities. Responses specified that the concept could potentially widen the wealth gap and that “rich people are very rich poor people might be very poor”. This was due to perceiving smart technology as costly, and therefore, some questioned the affordability for all. Additionally, one comment stated that the smart city would lead to “higher deindividuation and feeling of being lorded over by the higher up”.

5.6 Chapter Summary

The students demonstrated extremely low awareness about the smart city and the term IoT. However, their perceptions about the concept clearly revolved around how technology could enable environmental sustainability and protection and facilitate energy conservation. Nevertheless, they argued that a smart *technology* should provide value to the user. Moreover, their perceptions of the ‘smart’ label illustrated temporal aspects through their descriptions of advanced, futuristic and new technologies.

These temporal notions did, however, prompt concerns in regards to dystopian futures that lose sight of the human and where smart technologies require next to no human interaction. Privacy and security concerns were prevalent, however, very few read the T&C due to its bulky and long content. Additionally, students worried about the cost of implementation with some deeming the concept not viable.

The following chapter also addresses QUAN+QUAL Strand 2 but presents the results from section two and three of the student survey: students’ environmental attitudes and perceptions.

Chapter 6. Students' Attitudes and Perceptions of the Environment

6.1 Introduction and Chapter Outline

The energy demand for university buildings is significant, leading to major environmental impacts emerging from energy consumption on university campuses (Petersen et al., 2007). For several students, moving to university is their first experience of living away from home, and therefore, habits have not yet been shaped (Verplanken and Wood, 2006), making their energy behaviours more pliable. Life changing events such as relocating has also proven to make people more open to changing their energy behaviours (Schäfer et al., 2012). Students living in university halls do not pay for their energy bills, removing all financial motivations for energy conservation (Petersen et al., 2007). Studies suggest that being able to see real-time energy data can reduce consumption (Chiang et al., 2014). However, Stern et al. (1987; 1993) identified several barriers to pro-environmental behaviour including household background, beliefs, value orientations, knowledge and worldviews.

As the literature review (Chapter 2, Section 2.10.2) revealed that perceptions about the environment vary, the students were asked a series of question that aimed to detect certain factors potentially influencing their environmental perceptions in order to identify any barriers to engagement with pro-environmental behaviours. Therefore, this chapter aimed to explore the underlying potentials to encourage students to save energy in student halls by examining their attitudes perceptions and potential barriers.

This chapter presents results from sections two and three of the student survey (see Chapter 3, Section 3.6.1), identifying students' perceptions and concerns about the environment, drivers for energy conservation and attitudes towards real-time energy information, contributing to Objective 3. This chapter first presents a characterisation of the respondents' worldviews and value orientations in in Section 6.2. It then outlines students' household background in Section 6.3. Section 6.4 examines students' concerns about climate change and their motivations for pro-environmental behaviours, whilst Section 6.5 outlines the actors motivating students to behave environmentally friendly. Section 6.6 assesses drivers for energy conservation and explores potential differences in drivers between household backgrounds. Section 6.7 investigates students' perceptions of real-time energy information and how seeing this information can encourage energy conservation in split incentive scenarios (not responsible for bills). Section 6.8 then examines the relationships between students' worldviews and value orientations, and the factors identified in the above sections. Finally, section 6.9 provides a summary of the findings in this chapter.

6.2 Worldviews and Value Orientations

In order to determine students' environmental and technological attitudes and values that may relate to their perceptions of the smart city, the New Ecological Paradigm (hereafter 'NEP') (Dunlap et al., 2000) and the Value Scale based on Schwartz's Value Theory (Schwartz, 1992; de Groot and Steg, 2008) were utilised.

6.2.1 The New Ecological Paradigm

The NEP scale comprises a set of 15 items that can be categorised into two sub-scales or dimensions: Pro-NEP and Pro-Dominance Social Paradigm (Pro-DSP). Agreement with the odd numbered items (Pro-NEP items) and disagreement with the even numbered items (Pro-DSP items) indicates an ecological worldview, whilst disagreement with odd numbered items and agreement with even numbered items indicates an anthropocentric worldview. A pro-ecological orientation is believed to result in pro-environmental attitudes and beliefs towards a variety of problems. Additionally, the NEP scale can be further categorised into five facets relating to environmental attitudes: reality of limits to growth, anti-anthropocentrism, fragility of nature's balance, rejection of exceptionalism, and possibility of an eco-crisis.

Table 6.1 presents the frequency distribution of the students' worldviews according to the individual NEP items on a 5-point scale (SA = Strongly agree, MA = Mildly agree, U = Unsure, MD = Mildly disagree, SD = Strongly disagree). Overall, students tended to agree with the Pro-NEP items and disagree with the Pro-DSP items, with the exception of three Pro-DSP items (4, 6, and 14). With respect to item 6, the majority of students agreed (69.1%) that 'the earth has plenty of natural resources if we just learn how to develop them'. With respect to item 4, around three quarters of students either agreed (34.0%) or were unsure (42.8%) whether or not 'human ingenuity will insure that we do NOT make the world unliveable'. Likewise, for item 14, the majority of students either agreed

(41.3%) or were unsure (31.1%) whether or not 'humans will eventually learn enough about how nature works to be able to control it'.

The total NEP score, Pro-NEP and Pro-DSP scores, and facet scores were calculated for each participant across all scores for the individual scale items as illustrated in Table 6.2. For data analysis, all even numbered questions (Pro-DSP items) were reverse coded. A Cronbach's alpha greater than 0.7 showed that the NEP scale (a=0.75), the Pro-NEP (a=0.77) and Pro-DSP (a=0.73) sub-scales, and the five facets (a=0.70), were internally consistent.

The boundary between an eco-centric and anthropocentric worldview is set at a mean NEP score of 3 (Rideout et al. 2005). A mean total NEP score of 3.50 for the full sample, with scores for all sub-scales and facets greater than or equal to 3.0, indicates that the students leaned towards an eco-centric worldview. Examination of the facet scores indicates that the students most strongly agreed with the possibility of an eco-crisis (*M*=3.91), with weakest agreement with the reality of limitations to growth (*M*=3.08).

Table 6.1. Frequency Distributions for New Ecological Paradigm Scale Items

Sub-scale	Facet	Do you agree or disagree that:		SA	MA	U	MD	SD
Pro-NEP	Limits	**1.**	We are approaching the limit of the number of people the earth can support	23.1%	33.4%	26.5%	10.8%	6.2%
Pro-DSP	Anti-antrho	**2.**	Humans have the right to modify the natural environment to suit their needs	9.0%	27.6%	20.1%	29.7%	13.6%
Pro-NEP	Balance	**3.**	When humans interfere with nature it often produces disastrous consequences	28.7%	41.1%	18.4%	9.1%	2.7%
Pro-DSP	Anti-exempt	**4.**	Human ingenuity will insure that we do NOT make the earth unlivable	8.4%	25.6%	42.8%	16.5%	6.7%
Pro-NEP	Eco-crisis	**5.**	Humans are seriously abusing the environment	47.5%	34.6%	9.5%	5.3%	3.2%
Pro-DSP	Limits	**6.**	The earth has plenty of natural resources if we just learn how to develop them	30.7%	38.4%	16.9%	10.1%	3.9%
Pro-NEP	Anti-anthro	**7.**	Plants and animals have as much right as humans to exist	49.8%	29.4%	10.3%	7.2%	3.3%
Pro-DSP	Balance	**8.**	The balance of nature is strong enough to cope with the impacts of modern industrial nations	6.0%	18.1%	24.6%	28.4%	22.9%
Pro-NEP	Anti-exempt	**9.**	Despite our special abilities, humans are still subject to the laws of nature	34.1%	39.4%	20.4%	5.1%	1.1%
Pro-DSP	Eco-crisis	**10.**	The so-called "ecological crisis" facing humankind has been greatly exaggerated	5.4%	14.9%	28.9%	26.5%	24.3%
Pro-NEP	Limits	**11.**	The earth is like a spaceship with very limited room and resources	19.9%	36.8%	21.9%	15.7%	5.7%
Pro-DSP	Anti-anthro	**12.**	Humans were meant to rule over the rest of nature	8.7%	16.4%	20.2%	24.9%	29.8%
Pro-NEP	Balance	**13.**	The balance of nature is very delicate and easily upset	24.6%	43.7%	21.2%	8.1%	2.4%
Pro-DSP	Anti-exempt	**14.**	Humans will eventually learn enough about how nature works to be able to control it	11.1%	30.2%	31.1%	17.5%	10.1%
Pro-NEP	Eco-crisis	**15.**	If things continue on their present course, we will soon experience a major ecological catastrophe	38.2%	36.2%	19.8%	3.6%	2.2%

Table 6.2. Total Sample Scores of Dimensions and Facets of the NEP Scale

Element	Min	Q1	Median	Q3	Max	Mean	Std. Dev
Full NEP Score	1.73	3.13	3.47	3.87	4.87	3.50	0.52
Dimensions							
Pro-NEP	1.00	3.50	4.00	4.38	5.00	3.88	0.64
Pro-DSP	1.00	2.57	3.00	3.57	5.00	3.07	0.72
Facets							
Limits	1.00	2.70	3.00	3.70	5.00	3.08	0.75
Anti-anthro	1.00	3.00	3.70	4.30	5.00	3.59	0.87
Balance	1.00	3.30	3.70	4.30	5.00	3.69	0.72
Anti-exempt	1.00	2.70	3.00	3.70	5.00	3.24	0.67
Eco-crisis	1.00	3.30	4.00	4.70	5.00	3.91	0.77

Differences in NEP Scores between Demographic Variables

The students' individual total mean NEP scores were tested against demographic data in order to identify any differences in environmental perceptions between demographic groups. As the total NEP scores were not normally distributed (1-sample Kolmogorov-Smirnov test), the non-parametric Mann-Whitney U test (2 groups) and Kruskal Wallis test combined with 1-way ANOVA pairwise comparisons (3 or more groups) were used to test for difference. Small and undetermined groups (e.g. "other" genders and "prefer not to say" were excluded from the analysis). Table 6.3 presents the NEP score comparisons across the demographic variables utilised in this analysis.

Table 6.3. NEP Score Comparisons across Demographic Variables

	TOTAL NEP SCORE						Significantly different to
	(n)	Mean	Std. Dev	Min	Median	Max	
Gender	**989**						
1 Female	549	3.55	0.53	2.00	3.53	4.87	2
2 Male	440	3.44	0.50	1.73	3.40	4.60	1
Age	**998**						
1 <=20	468	3.41	0.47	2.00	3.33	4.80	2,3,4
2 21 - 24	344	3.54	0.54	1.73	3.53	4.87	4
3 25 - 29	102	3.58	0.55	2.33	3.57	4.73	1
4 30=<	84	3.76	0.55	2.27	3.73	4.87	1,2
Ethnicity	**994**						
1 White	625	3.61	0.53	1.73	3.60	4.87	2,3
2 Asian	231	3.31	0.41	2.13	3.20	4.40	1
3 Black	72	3.28	0.46	2.27	3.20	4.53	1
4 Mixed	40	3.46	0.55	2.53	3.40	4.87	No differences
5 Other	26	3.43	0.62	2.33	3.37	4.53	No differences
Academic Discipline	**953**						
F Physical Sciences	105	3.69	0.54	2.07	3.73	4.80	B,G,K,N,X,H
C Biological Sciences	121	3.60	0.51	2.27	3.60	4.67	G,K,N,X,H
J Combined Disciplines	59	3.60	0.52	2.47	3.53	4.67	N,X,H
L Humanities, Languages and Social Science	79	3.57	0.49	2.47	3.53	4.60	X,H
B Subjects Allied to Medicine	85	3.50	0.49	2.53	3.40	4.40	F,H
G Maths and Computer Sciences	85	3.45	0.55	1.73	3.47	4.80	F,C,H
K Architecture, Creative Arts & Design	48	3.45	0.57	2.07	3.33	4.80	F,C,H
N Law, Business & Administrative Studies	157	3.44	0.52	2.13	3.33	4.87	F,C,J,H
X Education	157	3.39	0.44	2.00	3.33	4.67	F,C,J,L,H
H Engineering	57	3.20	0.43	2.33	3.13	4.13	F,C,J,L,B,G,K,N,X,H

Significant differences were observed between genders (*U*=107691.00, *p*=0.003), between age groups (*H*=38.07, *p*<0.001), and between ethnic groups (*H*=77.18, *p*<0.001).

With respect to gender, females held a slightly higher mean NEP score (*M*=3.55), indicating higher pro-environmental beliefs, than males (*M*=3.44).

With respect to age, pairwise comparisons indicated no significant difference between the 21-24 and 25-29 year age groups (*p*=0.395). When these groups were combined, significant differences were observed between all age groups, 20 years or under (*M*=3.41, p<0.001 against all other groups), 21-29 years (*M*=3.55, *p*<0.001 against ≤20y, *p*=0.003 against ≥30y), and 30 years or older (*M*=3.76) with a trend of NEP score increasing with age.

With respect to ethnicity, pairwise comparisons revealed significant differences between white (*M*=3.61) and Asian (*M*=3.31) students (*p*<0.001), and white and black (*M*=3.28) students (*p*<0.001), with white students acquiring the higher mean NEP score.

Statistical differences were also found between academic disciplines (*H*=54.953, *p*<0.001). Whilst Table 6.3 presents a summary of which degrees are significantly different to each other, the detailed p-values for the pairwise comparison are shown in Table 6.4 below.

Table 6.4. Pairwise Comparison of Mean NEP score for Academic Disciplines

	Physical Sciences	Biological Sciences	Combined	Humanities, Languages & Social Science	Subjects allied to Medicine	Maths & Computer Sciences	Architecture, Creative Arts & Design	Law, Business & Administrative Studies	Education
Engineering	0.000	0.000	0.000	0.000	0.000	0.004	0.017	0.003	0.012
Education	0.000	0.001	0.013	0.014	0.097	0.429	0.626	0.533	
Law, Business & Administrative Studies	0.000	0.004	0.044	0.053	0.257	0.789	0.951		
Architecture, Creative Arts & Design	0.003	0.048	0.126	0.160	0.429	0.886			
Maths & Computer Sciences	0.001	0.028	0.109	0.139	0.447				
Subjects allied to Medicine	0.012	0.171	0.362	0.463					
Humanities, Languages & Social Science	0.091	0.584	0.817						
Combined	0.193	0.804							
Biological Sciences	0.196								

As seen in these two tables, engineering students (*M*=3.20) were significantly different to all other academic disciplines and respondents within this group demonstrated the lowest NEP score, indicating weakest eco-centric worldview. On the contrary, students studying physical sciences (*M*=3.69) scored highest on the NEP scale and this group indicated differences to all academic disciplines except humanities, languages and social science, combined subjects, and biological sciences, demonstrating the strongest eco-centric worldview.

6.2.2 Value Orientations

Based on Schwartz's Value Theory (1992; 1994), de Groot and Steg (2007; 2008) developed an instrument to measure how value orientations explain environmental perceptions and behaviour. This was utilised to identify background characteristics of the students' attitudes and perceptions towards the environment and general social views. The instrument comprises of three sets of orientations: (1) altruistic values identify moral concern for others, (2) biospheric values demonstrate concern for the ecosystem and the environment and (3) egoistic values detect concerns for self (de Groot and Steg, 2008). The altruistic and biospheric value orientations included four items whilst the egoistic value orientation used here included one extra item "ambitious (hard-working, aspiring)" due to the sample being students (Howell, 2013). Respondents were asked to rate each item on a 9-point scale where: "-1 (opposed to my values), 0 (not important), 3 (important), to 7 (of supreme importance)" (de Groot and Steg, 2007:322). Following de Groot and Steg's (2008) advice, students were encouraged to vary their scores and rank a maximum of two values at 7. Ascribing to altruistic and biospheric values has previously been shown to relate to pro-environmental behaviour (de Groot and Steg, 2008; Howell, 2013), whilst individuals ascribing to an egoistic value orientation tend to base their decisions on whether or not the benefits of behaving in an environmentally friendly manner outweigh the personal costs (de Groot and Steg, 2008).

Table 6.5 presents the total score, mean score, and rank for each item, and the mean score for each value orientation. A Cronbach's alpha greater than 0.7 indicated that the responses for all three value orientations were internally consistent. Overall, students ascribed most strongly to an altruistic value orientation (*M*=5.69) and least to an egoistic value orientation (*M*=4.00). Considering individual items, students rated the altruistic value item "equality" as most important to them (*M*=6.04), followed by "a world at peace" (*M*=5.94), and the biospheric value item "protecting the environment" (*M*=5.59), whilst the egoistic value item "social power" (*M*=2.57) was rated as least important. Although the students did not ascribe strongly to an egoistic value orientation, the value item "ambitious" was ranked fourth.

Table 6.5. Value Scores Totalled for All Respondents

Value Item	Rank	Total Score (max = 7049)	Mean Score
Altruistic Values			**5.69**
Equality (equal opportunity for all)	1	6086	6.04
A world at peace (free of war and conflict)	2	5985	5.94
Social justice (correcting injustice, care for the weak)	7	5443	5.41
Helpful (working for the welfare of others)	8	5411	5.37
Cronbach's alpha = 0.79			
Biospheric Values			**5.32**
Protecting the environment (preserving nature)	3	5633	5.59
Preventing pollution (protecting natural resources)	5	5539	5.50
Respecting the earth (harmony with other species)	6	5507	5.47
Unity with nature (fitting into nature)	9	4751	4.72
Cronbach's alpha = 0.86			
Egoistic Values			**4.00**
Ambitious (hard-working, aspiring)	4	5608	5.57
Influential (having an impact on people and events)	10	4648	4.62
Wealth (material possessions, money)	11	3790	3.76
Authority (the right to lead or command)	12	3492	3.47
Social power (control over others, dominance)	13	2587	2.57
Cronbach's alpha = 0.76			

Differences in Value Orientations between Demographic Variables

The students' individual mean value ratings for the three value orientations were tested against demographic data in order to detect potential differences in attitudes and perceptions between demographic groups (Table 6.6). As none of the three value orientations were normally distributed (1-sample Kolmogorov-Smirnov test), the non-parametric Mann-Whitney U test (2 groups) and Kruskal Wallis test combined with 1-way ANOVA pairwise comparisons (3 or more groups) were used to test for difference between demographic groups. Small and undetermined groups (e.g. "other" genders and "prefer not to say") were also excluded from this analysis.

Table 6.6. Value Score Comparisons across Demographic Variables

	(n)	Egoistic Values Mean	Egoistic Values Std. Dev	Egoistic Values Median	Significantly different to	Altruistic Values Mean	Altruistic Values Std. Dev	Altruistic Values Median	Significantly different to	Biospheric Values Mean	Biospheric Values Std. Dev	Biospheric Values Median	Significantly different to
Gender	**989**												
1 Female	549	3.97	1.44	4.00	No differences	5.90	1.19	6.25	2	5.41	1.41	5.75	2
2 Male	440	4.05	1.39	4.00		5.44	1.27	5.75	1	5.21	1.35	5.50	1
Age	**998**												
1 <=20	468	4.13	1.36	4.20	3,4	5.67	1.24	6.00		5.12	1.43	5.25	2,3,4
2 21 - 24	344	4.08	1.39	4.00	4	5.65	1.30	6.00	No differences	5.39	1.37	5.50	1
3 25 - 29	102	3.80	1.56	3.80	1,4	5.82	1.14	6.25		5.71	1.09	6.00	1
4 30=<	84	3.19	1.45	3.00	1,2,3	5.80	1.28	6.00		5.65	1.37	6.00	1
Ethnicity	**994**												
1 White	625	3.71	1.39	3.80	2,3,4,5	5.65	1.22	6.00		5.34	1.34	5.50	
2 Asian	231	4.40	1.36	4.40	1	5.72	1.34	6.00		5.30	1.46	5.50	
3 Black	72	4.78	1.10	4.80	1	5.96	1.19	6.25	No differences	5.32	1.53	5.75	No differences
4 Mixed	40	4.45	1.28	4.40	1	5.62	1.19	5.88		5.14	1.37	5.25	
5 Other	26	4.28	1.65	4.40	1	5.65	1.39	5.88		5.29	1.66	5.75	
Academic Discipline	**953**												
F Physical Sciences	105	3.50	1.50	3.60	B,K,N,X,H	5.51	1.04	5.75	C,B,L,N,X	5.45	1.23	5.50	No differences
C Biological Sciences	121	3.82	1.24	4.00	N	5.79	1.27	6.00	F,L,G,H	5.18	1.43	5.50	K
J Combined Disciplines	59	3.84	1.36	4.00	N	5.68	1.09	6.00	L	5.27	1.28	5.25	No differences
L Humanities, Languages and Social Science	79	3.83	1.34	3.80	N	6.04	1.20	6.25	F,C,J,G,K,N,H	5.45	1.49	5.75	X
B Subjects Allied to Medicine	85	4.16	1.27	4.40	F,N	5.91	1.12	6.25	F,G,K,H	5.57	1.12	5.75	X
G Maths and Computer Sciences	85	3.81	1.33	3.80	N	5.36	1.47	5.75	C,B,L,X	5.14	1.45	5.25	K
K Architecture, Creative Arts & Design	48	4.18	1.31	4.10	F,N	5.45	1.33	6.00	B,L,X	5.68	1.29	6.00	C,G,X,H
N Law, Business & Administrative Studies	157	4.61	1.50	4.80	F,C,J,L,B,G,K,N, X,H	5.71	1.25	6.00	F,L,H	5.41	1.44	5.75	X
X Education	157	4.12	1.32	4.00	F,N	5.90	1.20	6.25	F,G,K,H	5.07	1.52	5.50	B,K,N,L
H Engineering	57	4.09	1.43	4.00	F,N	5.10	1.51	5.50	C,B,L,N,X	5.12	1.35	5.25	K

Whilst no differences were found in egoistic values between males and females (*U*= 117696.00, *p*=0.489), significant differences in both altruistic (*U*= 90520.50, *p*<0.001) and biospheric (*U*= 107580.00, *p*=0.003) value orientations were demonstrated, with female students (Alt. *M*=5.90, Bio. *M*=5.41) ascribing more strongly to these orientations than males (Alt. *M*=5.44, Bio. *M*=5.21).

With respect to age groups, there were significant differences in egoistic (*H*=32.14, *p*<0.001) and biospheric (*H*=25.07, *p*<0.001) orientations, but none were found within altruistic values (*H*=2.21, *p*=0.531). Students 20 and under (Bio. *M*=5.12) ranked lowest on the biospheric values and were statistically different to all other age groups. Students 20 and under also ascribed strongest to the egoistic values (Ego. *M*=4.13). On the contrary, students 30 and over (Ego. *M*=3.19) were statistically different from all groups within the egoistic value orientation as they rated these value items lowest of all age groups.

In relation to ethnicity, only the egoistic value orientation illustrated significant differences (*H*=79.15, *p*<0.001), where white students were different from all other ethnic groups by ascribing the least to the egoistic value orientation (*M*=3.71).

Significant statistical differences were found between disciplines across all three value orientations: egoistic: (*H*=52.72, *p*<0.001), altruistic (*H*=44.14, *p*<0.001), and biospheric (*H*=18.06, *p*=0.035). As seen in Table 6.6, law, business and administration studies students ascribed most strongly to the egoistic value orientation (Ego. *M*=4.61) and were significantly different from all other disciplines. On the contrary, physical science students had the lowest mean egoistic value score (Ego. *M*=3.50). With respect to altruistic values, differences were seen between humanities, languages and social science students (Alt. *M*=6.04) and all other disciplines except subjects allied to medicine (*p*=0.193) and education (*p*=0.209), where the former ascribed most strongly to the altruistic value orientation. Fewer differences were identified within the biospheric value orientation. However, architecture, creative arts & design students (Bio. *M*=5.68) ascribed the most strongly to a biospheric value orientation and were different to engineering (Bio. *M*=5.12, *p*=0.017), education (Bio. *M*=5.07, *p*=0.007), maths and computer sciences (Bio. *M*=5.14, *p*=0.019), and biological sciences (Bio. *M*=5.18, *p*=0.019). Education students ascribed the weakest to biospheric values, resulting in significant differences to business, law and administrative studies (Bio. *M*=5.41, *p*=0.026), subjects allied to medicine (Bio. *M*=5.57,

p=0.028), humanities, languages and social science (Bio. M=5.45, p=0.031), and as mentioned, architecture, creative arts and design.

6.2.3 Relationships between Students' Value Orientations and NEP Score

Multiple regression analysis (Table 6.7) was conducted to investigate if there was a relationship between the students' value orientations and their NEP score (de Groot and Steg, 2008). Students' total mean NEP score was used as the dependent variable and their mean rating of each of the value orientations was selected as the independent variable.

Table 6.7. Relationships between Value Orientations and NEP

	β	*t*	*p*	R^2	*df*	*F*
Dependent variable: NEP				0.26	3, 1003	114.75*
Egoistic	-0.14	-13.51	0.000			
Altruistic	0.03	2.09	0.037			
Biospheric	0.16	12.73	0.000			

*p <0.001

As shown in Table 6.7, value orientations explained 26% of the variance in NEP and all three value orientations significantly contributed to explain students NEP score. The biospheric value orientation was most strongly related to NEP (β=0.16, p<0.001), where the more students ascribed to a biospheric value orientation, the higher their NEP score. On the contrary, the more students ascribed to an egoistic value orientation, the lower their NEP score (β=–0.14, p<0.001). This means that students that ascribed to a biospheric value orientation were most concerned about the environment and those that ascribed to an egoistic value orientation were less concerned. Whilst the altruistic value orientation significantly contributed to explaining the students' NEP score (p=0.037), the increase in NEP score when ascribing strongly to an altruistic value orientation was low (β=0.03).

6.3 Household Background

In order to understand the complex drivers for energy conservation, students were asked closed questions about their living situation in order to establish a profile of students' household background (Table 6.8). This was useful as previous studies suggest that people living in split incentive scenarios may be differently motivated to conserve energy than those with responsibility for bills (McMakin et al., 2002; Gillingham et al., 2010).

Table 6.8. Students' Household Background

Family home & Privately Owned Accommodation *(n=506)*	**All students *(n=1001)***		**Responsible for bills *(n=155)***		**Split Incentive *(n=351)***	
	#	***(%)***	**#**	***(%)***	**#**	***(%)***
Family home	473	*(47%)*	131	*(85%)*	342	*(97%)*
Shared privately owned	18	*(2%)*	14	*(9%)*	4	*(1%)*
Sole occupier privately owned	15	*(1%)*	10	*(6%)*	5	*(1%)*
Rented Accommodation *(n=495)*	**All students *(n=1001)***		**Responsible for bills *(n=225)***		**Split Incentive *(n=270)***	
	#	***(%)***	**#**	***(%)***	**#**	***(%)***
University halls	189	*(19%)*	5	*(2%)*	184	*(68%)*
Shared privately rented	253	*(25%)*	180	*(80%)*	73	*(27%)*
Sole occupier privately rented	53	*(5%)*	40	*(18%)*	13	*(5%)*

Overall, 62% of the students lived in a split incentive scenario and as seen in Table 6.8, the divide between students living in family and privately owned homes and rented accommodation was even[4]. More students lived in a split incentive scenario in family and privately owned homes due to living with parents or other relatives. The majority of students living in a split incentive scenario in rented accommodation were living in university halls where energy bills are typically included in accommodation fees. Note that 15 students indicated that their accommodation cost included a fair usage agreement for energy bills. These students have been categorised as living in a split incentive scenario.

6.4 Concerns about Climate Change

All students were asked about their level of concern about climate change (Figure 6.1), a factor that has been found to influence environmental perceptions (Steg and Vlek, 2009;

[4] Please note that household background could not be determined for six students due to inconsistency in their responses to establish this information. Therefore *n*=1001 when analysing household background.

Abrahamse and Steg, 2011). The students were also presented with the option to provide a comment to elaborate on their level of concern (Table 6.9).

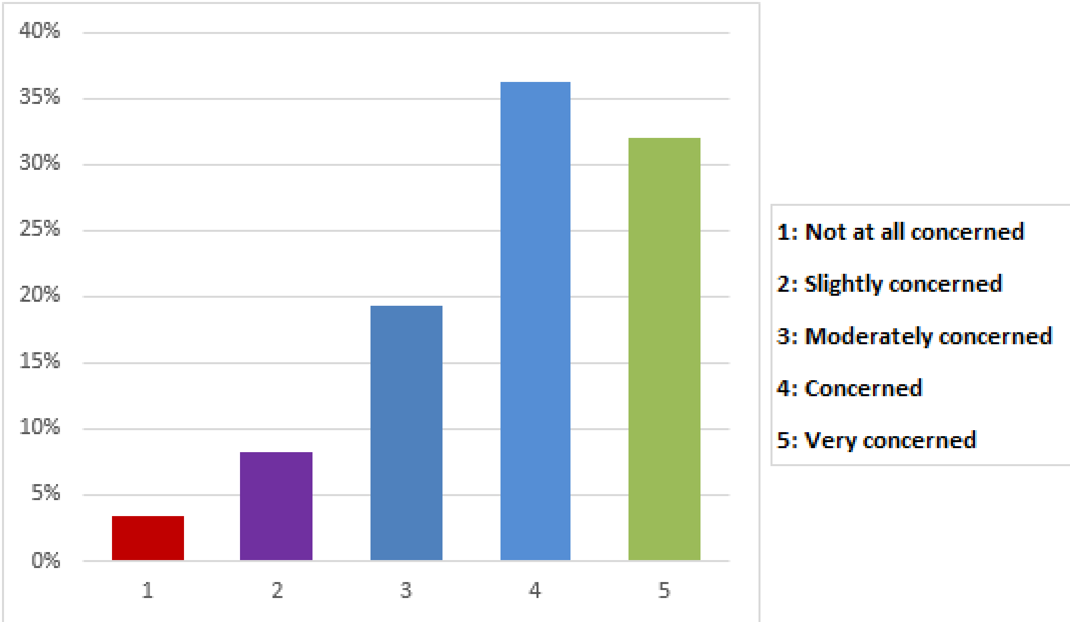

Figure 6.1. Students' Level of Concern about Climate Change

Overall, 97% of students reported some degree of concern regarding climate change, where 69% stated they were either concerned or very concerned. However, as seen in Figure 6.1, "very concerned" was not the dominant response group, rather, more students were "concerned", and the mean level of concern was 3.9.

Table 6.9. Reasons for Concerns about Climate Change

Theme and sub-themes	All comments (*n=573*) #	(%)
Environmental reasons	**218**	**(38%)**
Effects on eco-system and wildlife	89	(16%)
Global warming	67	(12%)
Threat to the planet	53	(9%)
Extreme weather	30	(5%)
Food and water resources	30	(5%)
Pollution	19	(3%)
Awareness	**129**	**(23%)**
Aware of changes	58	(10%)
Other people not aware	49	(9%)
Personal lack of awareness	30	(5%)
Future generations	**88**	**(15%)**
Collective issue	**78**	**(14%)**
Adverse effects	**65**	**(11%)**
Lack of political will	**20**	**(3%)**

In the associated comments (*n*=573) presented in Table 6.9, the majority of responses related to environmental concerns (38%), highlighting the threat posed by rising temperatures and weather extremes, and provided various examples of associated environmental impacts. The threat posed to eco-systems and wildlife was the concern identified by most students (16%). Whilst related concerns included deforestation and general effects on the natural environment, the majority of these comments referred to worries about a variety of animal species and loss of habitats.

> "*Climate change is happening rapidly. Seeing the polar caps melting and our animals such as polar bears and others dying off is quite upsetting. We need to be doing more about it*".

Five percent of comments noted concerns around the increased frequency of extreme weather events and "the effect they will have on society". Several comments highlighted that this was a visible threat they had already witnessed, hence describing these events as a more tangible and real concern. Similarly, 5% stated that these extreme weather events pose great concerns about resources such as food and water. Respondents also depict a concerning future without oil and the urgent need to develop sustainable and renewable energy sources as “there is not enough fossil fuels to sustain energy consumption at its current rate”.

This interlinked with the 3% of comments signifying a broad array of concerns about pollution. Whilst the majority of comments associated pollution with CO_2 and other greenhouse gas emissions from transport, others related pollution to social concerns by stating that “it's the poorest countries that are hit the worst”. In addition, pollution was a worry in regards to population growth.

> “*As the human pop increases so do the amount of greenhouse gases which effect the climate negatively [sic]*”.

Nearly a quarter of respondents (23%) related their level of concern regarding climate change to either their own awareness or the awareness of others. Whilst being personally aware of the effects of climate change caused concern (10%), so did the lack of awareness and not understanding the threat climate change poses to people and the planet on a personal level (5%). The latter made students concerned as they felt uneasy about “what can happen” and that the issue was “not broadcasted enough to people”. Additionally, 9% announced their worries about other people not being aware of climate change.

> *“We can already see the effects of climate change, and it's scary. It will ultimately also affect us, and most people don't seem to realise how important it is”.*

Moreover, 14% stated that climate change is a collective issue, but felt that many failed to acknowledge it, especially those in positions of power such as politicians, where this also related to the 3% of respondents that referred to lack of political will to address climate change matters.

> *“The signs are obvious and it's scary that countries like the USA are saying it doesn't exist”.*

Additionally, 11% reported deep concerns about the pace of climate change and extent of impacts, with comments referring to the “alarming rate” of climate change and how it will “only get worse”, with 15% of the comments stating a concern regarding the future and future generations.

"So far we know that our generation and generations after us will deal with bigger climate issues if we do not act now. However, at the moment no one in power makes big enough deal of it and not expressing to people around the globe how important our actions are for future generations".

"It will be a big issue in my life as I grow older, and for my children, at the moment people are to selfish and only thinking of themselves"

The latter quote reflects one of the main reasons cited for not being concerned. Overall, 14% of respondents stated various reasons for low levels of concern regarding climate change. These included a lack of immediacy ("I feel as though it doesn't impact me enough") where climate change was viewed as an abstract concept hard to relate to, low prioritisation in comparison to other concerns ("I have a lot of other things I am worried about"), and a lack of agency, with respondents saying their actions have no impact.

6.5 Motivational Actors

The literature recognises several motivational actors that influence people to behave in a more environmentally friendly manner (Kollmuss and Agyeman, 2002; McMakin et al., 2002; Whitmarsh and O'Neill, 2010; Gadenne et al., 2011). In order to identify the main actors that encourage students to adopt environmentally friendly behaviour, a multiple-choice question allowed students to select one or more motivators (Figure 6.2). Students were also invited to elaborate on their answer in an open comment box (Table 6.10).

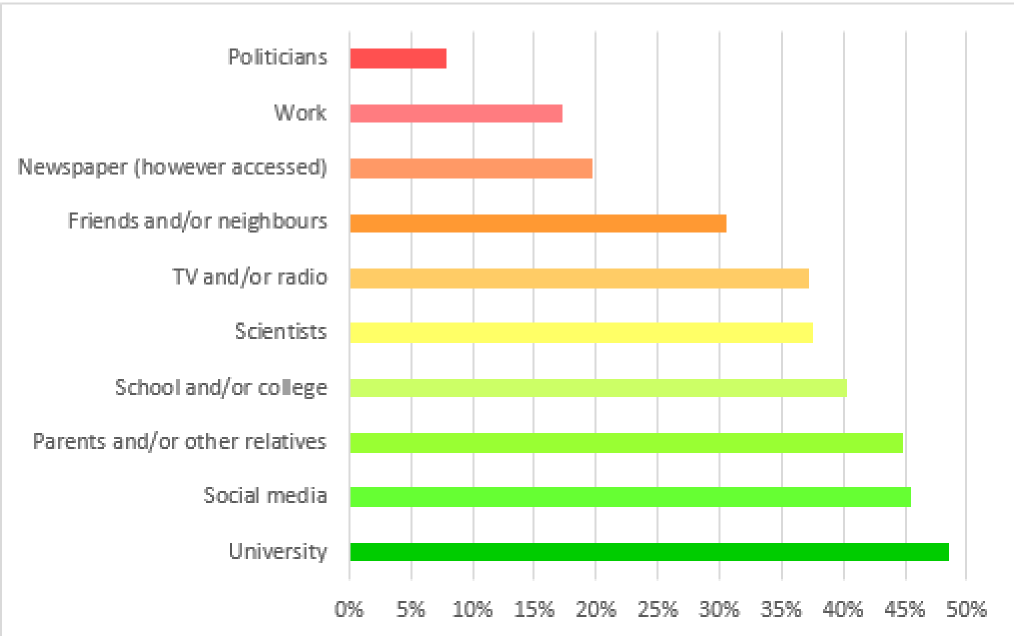

Figure 6.2. Motivational Actors for Pro-Environmental behaviours

While 5% of students reported that nobody had motivated them to adopt environmentally friendly behaviours, 95% identified at least one actor, with 79% identifying multiple motivational actors (between 2 and 10 actors).

As seen in Figure 6.2, university (49%) was the most frequently identified motivator for environmentally friendly behaviour for students, whilst politicians (8%) motivated the least number of students. Social media (45%) was ranked higher than traditional media such as TV and/or Radio (37%), and Newspapers (20%). Parents and/or other relatives were also ranked highly (45%), followed by school and/or college (40%), and scientists (38%), whilst friends and/or neighbours were identified by around one third of respondents (30%). While work was only identified by 17% of students, it is noted that not all students will be in employment.

In the associated comments (*n*=589) presented in Table 6.10, it was evident that awareness about climate change (37%) was an important motivational factor. Around a quarter (24%) of the comments stated that those who had motivated them had made them aware of how their individual behaviour contributed to both cause and combat against climate change and how they as a single person had an impact: "Being informed of the consequences our actions have on the environment".

"I [have] seen what saving on energy use could do to help people and the planet".

Table 6.10. Reasons for being Motivated Towards More Environmentally Friendly Behaviours

Theme and sub-themes	All Comments (n=589) #	(%)
Awareness	**220**	**(37%)**
Impact of (individual) behaviour	143	(24%)
Impact of climate change	102	(17%)
Own values and activities	**127**	**(22%)**
Parents and other people	**111**	**(19%)**
Work and educational institutions	**98**	**(17%)**
(Social) media and documentaries	**86**	**(15%)**
Money	**54**	**(9%)**
Scientific facts and evidence	**48**	**(8%)**
Help the planet and future generations	**37**	**(6%)**
Workshops and campaigns	**23**	**(4%)**

Likewise, 17% of comments stated that being aware of the impact of climate change on the planet affected the students' behaviour.

> *"I have been motivated due to learning about the actual damage caused and it certainly shocked me".*

Twenty-two percent of students identified their own values and activities undertaken as a driver for pro-environmental behaviour. Whilst several comments highlighted that these values have been engrained in them from an early age stating "I have always been motivated", others noted reasons they had been self-motivated to learn more about environmentally friendly behaviour.

> *"I am more conscious of my own impact on the environment after learning through others and have begun to seek out more information in the area".*

Further comments emphasised the specifics around how other people (19%), work and educational institutions (17%) and (social) media and documentaries (15%) motivated students to adopt more environmentally friendly behaviours. Parents were found to enforce pro-environmental behaviours in the family home, whilst peers, and work and educational intuitions raised awareness. The latter was comparable to (social) media and documentaries, where related comments identified motivation by influential people (e.g. Brian Cox and David Attenborough). Awareness was also closely linked to comments explaining they were motivated by workshops and campaigns (4%).

Interestingly, only 9% of students identified a financial incentive for environmentally friendly behaviours, whilst a further 8% were motivated by scientific facts and evidence. Comments related to the latter stated that climate change became a more tangible and relatable concept through evidence and that with “facts and figures” it was easier to understand the positive as well as negative impact of individual behaviour. A further 6% stressed that environmentally friendly behaviours would help “save the planet”, with several respondents expressing they were “concerned for the future for my kids”.

Nevertheless, 7% of students highlighted reasons for not being motivated to behave in an environmentally friendly way. The most frequent reason given was “never affected me” followed by “laziness”. However, some respondents gave more politically directed reasons such as “countries that leave the environmental agreement for example” and:

> *“The ways in which politicians constantly lie about how they're going to invest in renewable resources but end up helping corporations and their needs”.*
>
> *“When I was younger (and more neoliberal) I thought individual actions had a bigger effect. Now I'm more scientifically literate I realise that emotional campaigns do not mean something is an effective plan and I'm more interested in holding multinational corporations to account for their energy use than switching off a few lights”.*

Comments such as these contrasted with those given by the students who felt that their individual impacts do indeed have an effect on combatting climate change.

6.6 Motivations for Energy Conservation

6.6.1 Drivers for Energy Conservation

Importance and Drivers

The study sought to identify drivers for conserving energy for students and detect potential differences in drivers between their household backgrounds. Students were first asked to select how important they believe saving energy is (Figure 6.3) as positive attitudes towards energy conservation have been found to influence energy consumption (Abrahamse and Steg, 2011). They were also invited to explain why in an open comment box (Table 6.11).

As seen in Figure 6.3, 98% of all students placed an importance on saving energy to a greater or lesser degree (*M*=4.2), with 45% stating it is “very important” and 38% “important”. There was a significant relationship between students’ level of concern about climate change and how important they thought it was to save energy (r_s=0.527, *p*<0.001). The more concerned students were about climate change, the more important they believed it is to save energy.

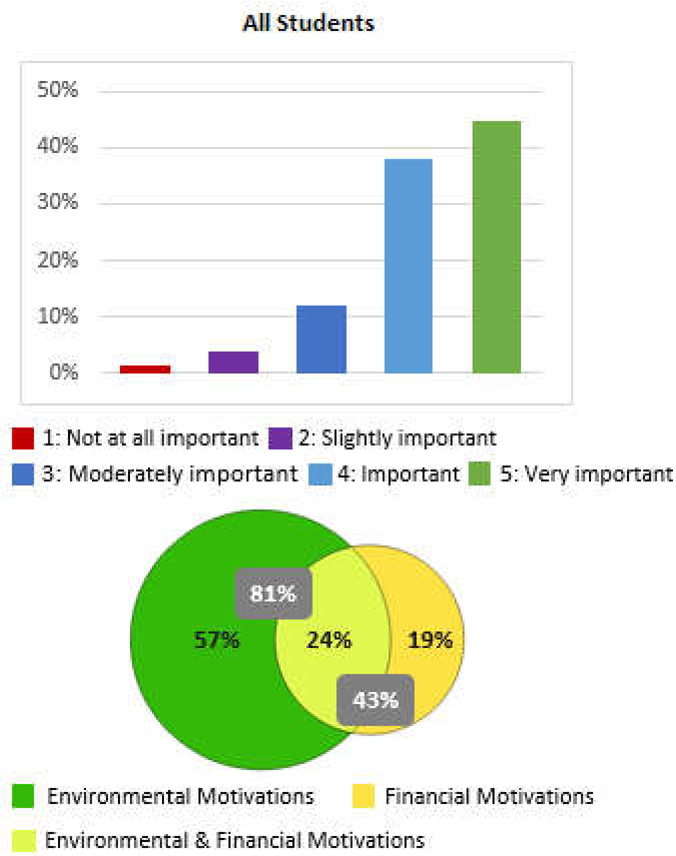

Figure 6.3. Energy Importance and Drivers for All Students

In the associated comments illustrated in Table 6.11 (*n*=609), it became evident that there were two main drivers for energy conservation: environmental factors and financial factors. Considering only the comments that identified one or both of these factors, 81% identified environmental factors, whilst 43% identified financial motivations. The two were not mutually exclusive as 24% of these comments highlighted both, whilst 57% stated only environmental motivations and 19% only financial motivations (Figure 6.3).

Table 6.11. Motivations for Energy Conservation

Theme and sub-themes	All comments (n=609) #	(%)
Environmental reasons	**448**	**(74%)**
Help the environment	205	(34%)
Resource preservation	174	(29%)
Pollution	94	(15%)
Sustainability	29	(5%)
Financial reasons	**241**	**(40%)**
Collective responsibility	**33**	**(5%)**
Security of supply	**10**	**(2%)**

Overall, 40% of students stated financial motivations to save energy, in comparison to 74% identifying environmental motivations. A general desire to help the environment (34%) was the main environmental driver, closely followed by preserving resources (29%) and reducing pollution (15%). Interestingly, 2% of comments also related their motivation for saving energy to maintain the security of supply.

> *"We take it [energy] for granted and soon be harder to acquire in the near future".*

> *"Overconsumption is running rampant and people often use more energy than is needed. Considering energy crises all over the world, especially those without access to it as we have, it is very important concerning the longevity of the human race".*

A number of students made reference to sustainability, with the majority referring to environmental sustainability: "I think we have a very wasteful society that could become more sustainable". Other reasons for saving energy included improved health and a broader and more general sense that saving energy is important.

Three reasons for placing low importance on energy conservation were identified. Two percent of students felt that their individual energy behaviours have no impact on addressing climate change or that not enough people are taking action to combat climate change. Another 2% stated they have no time or interest in saving energy, and a further 1% expressed low importance due to lack of agency as they are not responsible for paying energy bills.

Awareness and Self-Reported Efficiency

Figure 6.4 illustrates students’ awareness of how to conserve energy and their self-perceived energy efficiency in households.

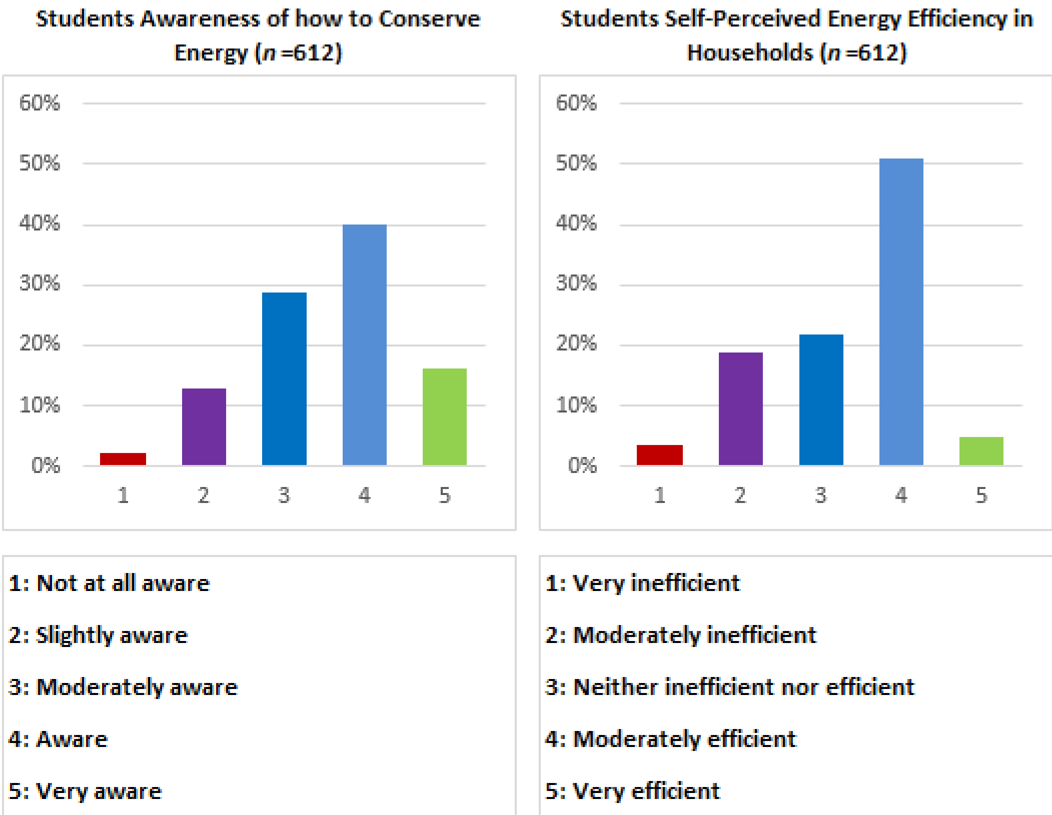

Figure 6.4. Students' Awareness and Self-Reported Efficiency of Energy Conservation[5]

In contrast to the 45% of students identifying that saving energy is very important, only 5% stated that their energy behaviour is “very efficient”, with 51% reporting that they were moderately efficient, and 45% of students reporting they are “neither inefficient nor efficient”, “moderately inefficient” or “very inefficient”, (*M*=3.4). This could be explained by the significant relationship between efficiency and awareness of how to conserve energy (r_s=0.514, p<0.001). The less efficient students reported their energy behaviours were, the less aware they were about how to conserve energy. As seen in Figure 6.4, only 16% of students were “very aware” of how to conserve energy (*M*=3.6).

[5] Note that *n*=612 as these questions were only asked in the SurveyMonkey version of the survey. Therefore, when analysing awareness and efficiency, the sample size is lower.

6.6.2 Differences between Household Backgrounds

Rented Accommodation

Of the 495 students living in rented accommodation, 98% (*M*=4.3) placed an importance on saving energy, and as seen in Figure 6.5, students in a split incentive scenario placed slightly lower importance on conserving energy than those with responsibility for bills. However, environmental motivations were identified as the main driver for energy conservation amongst both students with responsibility for bills (80%) and those in a split incentive scenario (86%). Interestingly, 33% of comments from students in a split incentive scenario also identified financial drivers for energy conservation.

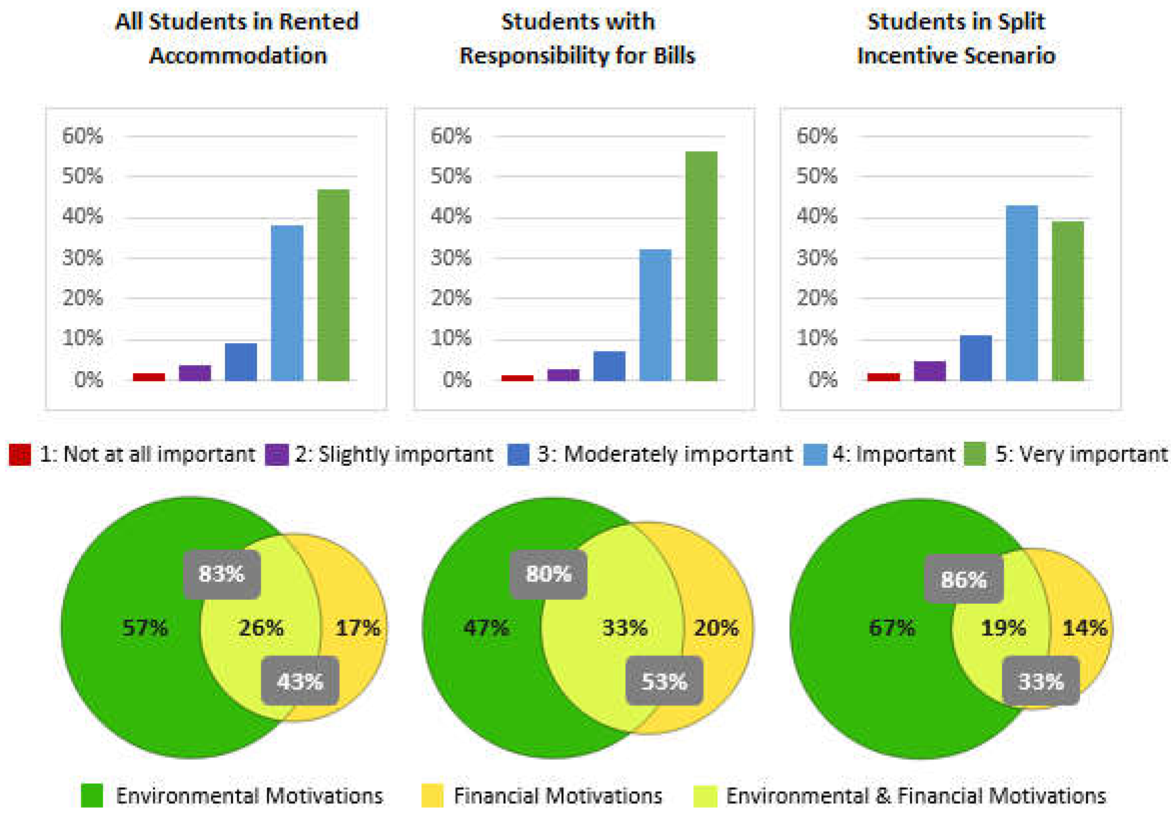

Figure 6.5. Drivers for Energy Conservation for Students in Rented Accommodation

Family and Privately Rented Homes

Of the 506 students living in family and privately owned homes, 99% (*M*=4.3) placed an importance on saving energy as seen in Figure 6.6, and students with responsibility for bills placed a higher level of importance on saving energy than those living in split incentive scenario. Similarly, to students in rented accommodation, environmental motivations was identified as the main driver for energy conservation, both for those with responsibility for bills (81%) and for those living in a split incentive scenario (76%). Interestingly, as with the students living in rented accommodation, 38% of comments from students living in a split incentive scenario referred to financial motivations as a driver to conserve energy.

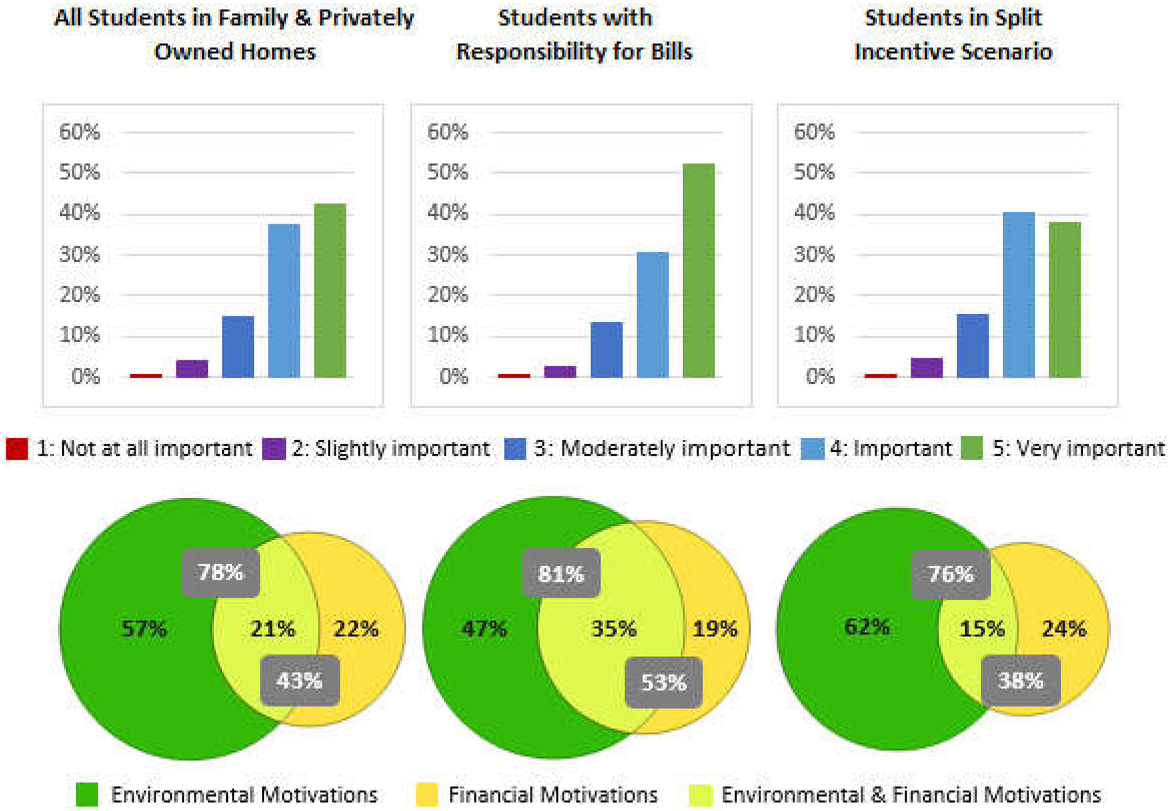

Figure 6.6. Drivers for Energy Conservation for Students in Family and Privately Owned Homes

Differences

Statistical differences in level of importance students placed on energy conservation were found between the household backgrounds (H=24.720, p<0.001). As seen in Table 6.12, there was no difference between the forms of home ownership when both were responsible for bills (p=0.269) or when both were living in split incentive scenario (p=0.555). This indicates that with respect to household type, responsibility for bills was the dominant factor in determining the importance placed on saving energy.

Table 6.12. Differences in Perceived Importance of Energy Conservation between Household Backgrounds

	Family and Privately Owned Resposible for Bills	Family and Privately Owned Split Incentive Scenario	Rented Accommodation Responsible for Bills
Family and Privately Owned Split Incentive Scenario	0.006		
Rented Accommodation Responsible for Bills	0.269	0.000	
Rented Accommodation Split Incentive Scenario	0.030	0.555	0.000

6.7 Perceptions of Real-time Energy Devices and Information

6.7.1 Previous Experience with Real-time Energy Devices

This study sought to identify students' perceptions of real-time energy information and to what extent seeing their real-time energy consumption might encourage them to conserve energy (Chiang et al., 2014).

Four hundred and sixty-two students stated they had experience with either a smart meter, smart monitor and/or smart thermostat. However, only 58% of these students reported that these devices had encouraged them to conserve energy. Notably, as seen in Figure 6.7, the majority of the students stating that the smart devices had not encouraged them to conserve energy also reported to interact with them less frequently than those who had been encouraged.

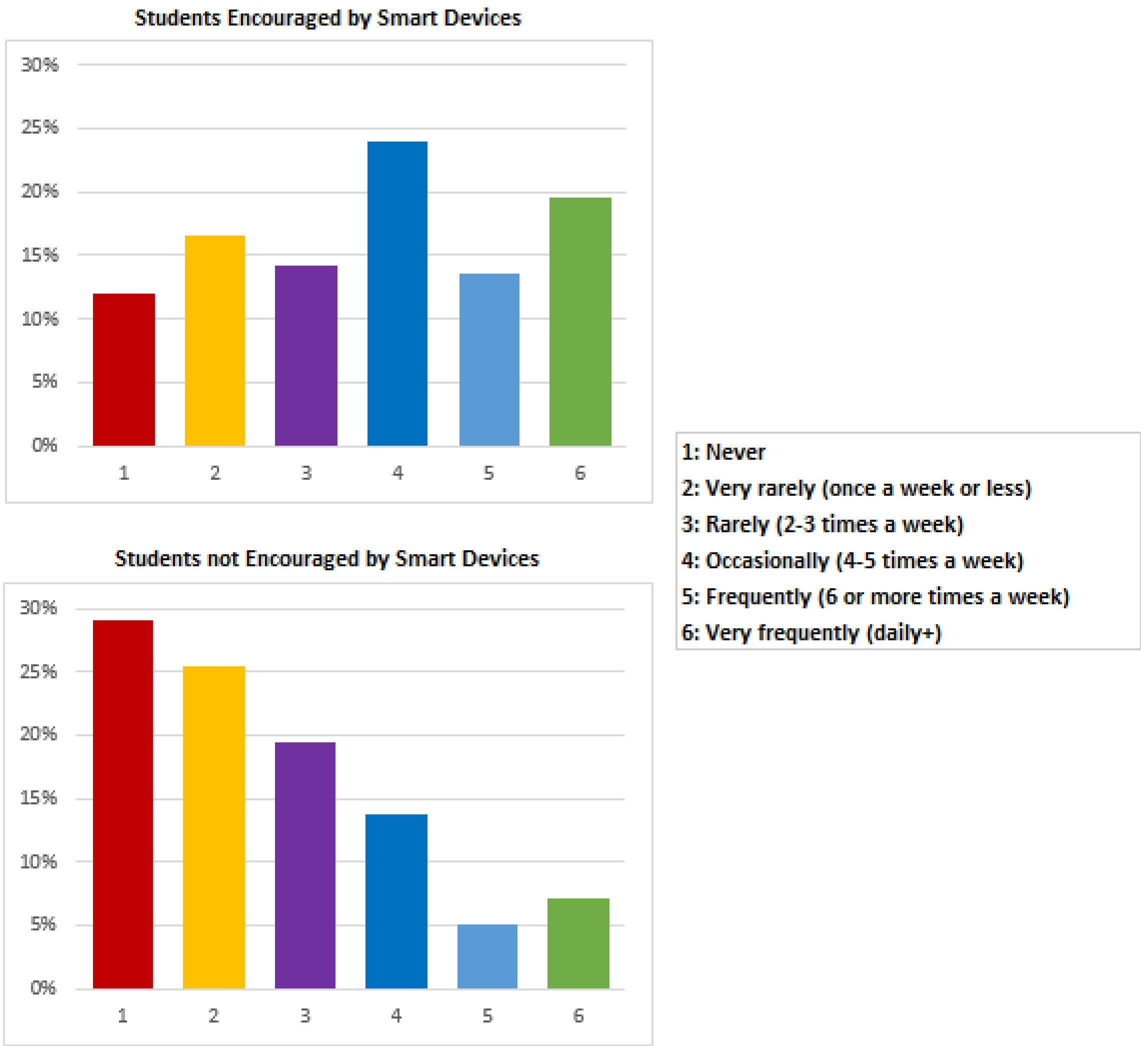

Figure 6.7. Frequency of Looking at Smart Device

In the associated comments (*n*=143), students identified factors that influenced whether or not they had been encouraged (Table 6.13). Of these, 35% of comments regarded reasons why the students were not encouraged, while 65% related to how the smart devices had encouraged them. Whilst 15% identified a lack of contextual information ("just because it displays numbers doesn't mean anything"), 31% explained that being able to see real time usage enabled them to not only monitor consumption, but make changes and identify specific appliances that used a lot of energy. Additionally, 6% of comments valued broader contextual information because it "puts it [usage] into perspective". Twenty percent placed importance on visual cues prompted by the devices, for example colours were highlighted as very helpful.

> *"Red light = High usage - encourages me to check if lights/appliances etc. are on unnecessarily".*

“Goes red when you're using a lot, makes you feel like you are using tonnes and wasting money”.

Table 6.13. Factors Influencing Encouragement by Real-time Energy Devices

Themes and sub-themes	**All Comments** ***(n=143)*** **#**	***(%)***
Encouraged	**93**	**(65%)**
Being able to see usage	44	(31%)
Visual cues	28	(20%)
Lowering bills	25	(17%)
Contextual information	9	(6%)
Challenge	1	(1%)
Not Encouraged	**50**	**(35%)**
Lack of contextual information	22	(15%)
Low Priority	13	(9%)
Living at home	8	(6%)
Not responsible for bills	4	(3%)
Poor visual cues	2	(1%)
House of multiple occupancy	1	(1%)

Seventeen percent of comments were encouraged by the devices to save energy as they enabled them to see what their energy consumption cost, thus providing motivation to lower their bills.

“As it tells you in pennies how much energy you're using and if you use less you save money”.

However, 6% of comments specifically stated that they were not encouraged to conserve energy due to living at home, thus not paying bills, and a further 3% explained that they were not responsible for bills in their household and were therefore not encouraged. Interestingly, one comment stated issues around energy conservation in multiple occupancy housing: “I forget to look and live with so many people that it feels futile”.

6.7.2 Perceptions of Real-time Energy Information

As seen in Figure 6.8, 98% of students thought that seeing their real-time energy consumption would be useful to a greater or lesser extent (*M*=4.1). Similarly, 96% of students stated that seeing their real-time energy consumption would encourage them to conserve energy to some degree (*M*=4.0).

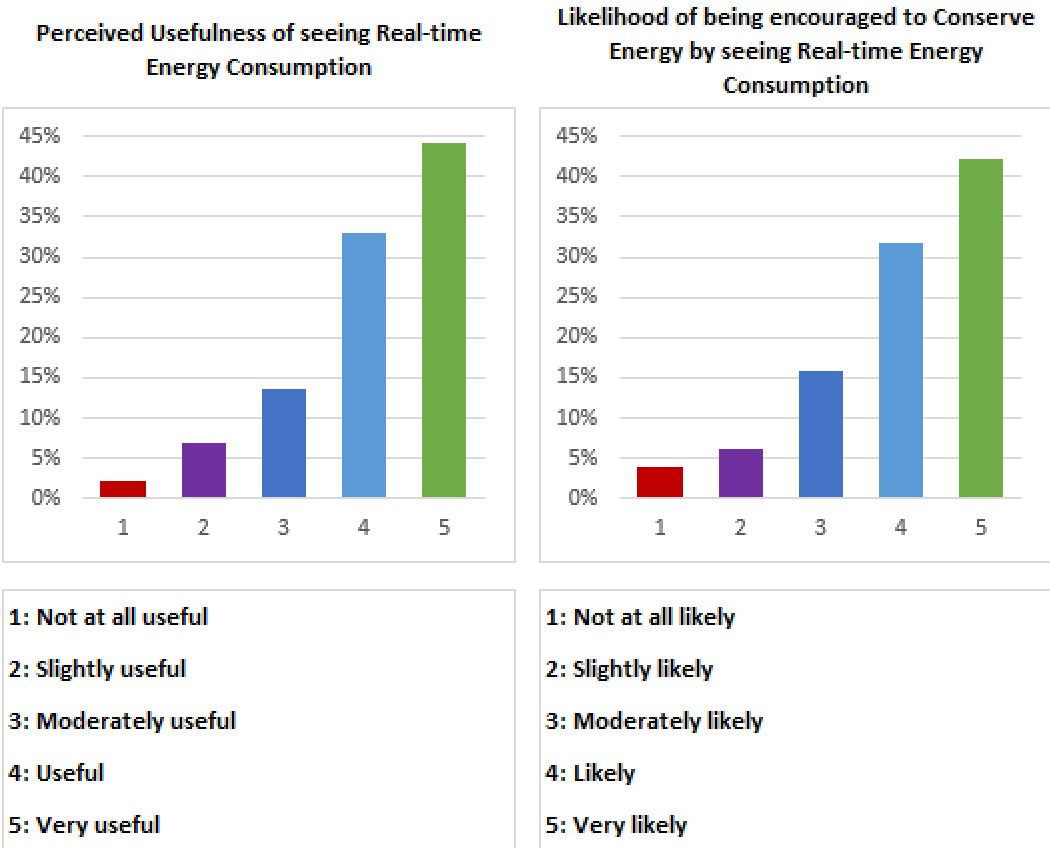

Figure 6.8. Perceptions of Real-time Energy Information

No statistical differences were found between perceived usefulness of seeing real-time energy information or perceived likelihood of being encouraged to conserve energy by this information and household backgrounds or responsibility for bills.

Significant positive relationships were found between the importance placed on energy conservation, awareness of how to conserve energy, and current energy efficient behaviours and both the perceived usefulness of real-time energy information (Importance r_s=0.368, *p*<0.001; Awareness *H*=26.924, *p*<0.001; Behaviours *H*=20.984, *p*<0.001) and the likelihood of this encouraging energy conservation (Importance r_s=0.329, *p*<0.001; Awareness *H*=30.144, *p*<0.001; Behaviours *H*=27.655, *p*<0.001).

Table 6.14 illustrates the associated comments (*n*=601) elaborating on why they would find seeing their real-time energy consumption useful.

Table 6.14. Reasons for Finding Real-time Energy Information Useful

Themes	All Comments (*n=601*) #	(%)
Monitoring and managing consumption	**270**	**(45%)**
General reduce consumption	**214**	**(36%)**
Reduce bills	**151**	**(25%)**
Environmental impact and resources	**63**	**(10%)**
Challenge	**15**	**(2%)**

Forty-five percent of comments stated that it would be useful for monitoring and managing their consumption. Thirty six percent made a more explicit reference to enabling them to make immediate changes and reduce their consumption, while 25% referred to helping them reduce their bills, and 10% to reducing their environmental impact. Interestingly, 2% of comments referred to how they would find it useful in order to challenge themselves to reduce consumption. Some referred to turning it into a game in order to better understand energy conservation:

> *“'Gamification' of energy saving like this would make it easy to turn the abstract concept of saving energy into a tangible concept and remind you how much you should/shouldn't be using”.*
>
> *“An objective value would allow a set of aims to be made and tracked instead of the current "use less" mantra which is completely subjective”.*

In addition, similar comments highlighted how it would be useful in order to compare themselves with others and be motivated to use less than them.

On the contrary, 6% of comments highlighted various reasons as to why seeing real-time energy consumption would not be useful. Firstly, the majority of these comments stated that they are not interested in saving energy, that it is not a priority and that they refused to change their habits. Secondly, and in contrast, some of the comments explained that they are already doing everything they can to conserve energy and did not think they can do more. Finally, students stated that constantly engaging with this information would only cause worry and that “it could be highly distracting and a source of stress”.

Table 6.15 shows the associated comments (*n*=479) explaining why and how seeing real-time energy information would encourage them to use less.

Table 6.15. Reasons for Likelihood of being Encouraged by Real-time Information

Themes	**All Comments *(n=479)*** #	***(%)***
Visual cues and contextual Information	**237**	**(49%)**
Reduce bills	**121**	**(25%)**
Environmental impact and resources	**39**	**(8%)**
General save energy	**34**	**(7%)**
Challenge	**20**	**(4%)**

Although 7% of comments stated it would encourage them to save energy in more general sense, 49% of comments reported that by seeing their real-time energy consumption they would be more aware of their usage and thereby turn energy consumption into an understandable and more tangible concept. They stated this was due to the intuitive visual cues on the device and contextual information. Frequently, comments referred to being able to ‘see’ energy being wasted and over-consumed.

> *“If I had a little progress bar that told me how much I was using, I’d be much more aware of and able to prevent my energy wastage”.*
>
> *“I'm always interested in reducing my consumption so knowing when usage spikes would allow me to modify my behaviour”.*

Additionally, 25% referred to being encouraged to conserve energy in order to reduce their bills, whilst 8% stated it would help them lower their environmental impact and resource usage. As first identified in Table 6.14, students also stated here that seeing their real-time energy consumption would encourage them to use less as “it would make it more engaging and almost like a game or a challenge”.

"I'm quite competitive so I'd probably be trying to beat my daily best for less consumption".

"If I knew the average amount that a person was using and I was using more, I would want to cut down".

However, 9% of comments related to reasons why being able to see real-time consumption would not be encouraging. Similar to the reasons for not finding real-time energy information useful, students stated that "I don't think we really waste much in our house" and could therefore not use less than they already do. Other comments stated that: "[energy is] pre-paid with rent, does not affect me" and that reducing consumption: "... could negatively impact my lifestyle".

6.8 Differences in NEP & Value Orientations between Responses

6.8.1 The NEP Scale

The study sought to identify whether there were differences between students' NEP scores and their responses to the climate change and energy related questions. Significant differences (p<0.001) were found in NEP scores amongst all the questions, as presented in Table 6.16.

Table 6.16. Differences in NEP Scores as per other Perceptions

Likert Scale Response	Climate Change Concern*		Energy Importance*		Usefulness of Real-time Energy Information*		Likelihood for encouragement by Real-time Energy Information*	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
1	3.10	0.52	2.91	0.56	3.49	0.44	3.39	0.58
2	3.18	0.40	3.12	0.48	3.38	0.46	3.35	0.42
3	3.26	0.39	3.30	0.45	3.30	0.46	3.29	0.49
4	3.49	0.43	3.45	0.44	3.50	0.48	3.49	0.48
5	3.80	0.54	3.65	0.54	3.59	0.55	3.62	0.53

*p <0.001

Students' NEP scores increased with their level of concern about climate change. Those stating they were "not at all concerned" (Likert Scale Response 1) had a lower NEP score than those that were "very concerned" (Likert Scale Response 5), meaning that students with an eco-centric worldview were more concerned about climate change than those with a more anthropocentric worldview. This was also true for how important students believed it was to conserve energy. As seen in Table 6.17, students stating that conserving energy was “not at all important” (Likert Scale Response 1) had a much lower NEP score than those believing it was “very important” (Likert Scale Response 5).

Interestingly, students stating that seeing their real-time energy consumption was “moderately useful” (Likert Scale Response 3) scored lower on the NEP score than the students stating it would be “not at all useful” (Likert Scale Response 1) or “slightly useful” (Likert Scale Response 2). This could be explained by the comments identified in 6.7.2 where students explained that they would not find it useful as they were already doing everything they possibly can to conserve energy. This was also true for those students reporting it would be “not at all likely” (Likert Scale Response 1) or “slightly likely” (Likert Scale Response 2) for them to be encouraged to conserve energy by seeing their real-time energy consumption, as they scored higher on the NEP scale than those stating the possibility for encouragement as “moderately likely” (Likert Scale Response 3).

6.8.2 Value Orientations

Table 6.17 illustrates the relationships between students’ value orientations and their perceptions about climate change, importance of energy conservation and real-time energy information.

Table 6.17. Relationships between Value Orientations and Perceptions

	β	*t*	*p*	R^2	*df*	*F*
Dependent variable: Concern				0.29	3, 1003	136.58*
Egoistic	-0.22	-7.84	0.000			
Altruistic	-0.03	-0.79	0.429			
Biospheric	0.57	17.73	0.000			
Dependent variable: Importance				0.19	3, 1003	75.91*
Egoistic	-0.13	-4.28	0.000			
Altruistic	0.01	0.16	0.872			
Biospheric	0.45	12.96	0.000			
Dependent variable: Usefulness				0.06	3, 1003	19.83*
Egoistic	-0.08	-2.31	0.021			
Altruistic	0.01	0.33	0.744			
Biospheric	0.24	6.49	0.000			
Dependent variable: Likelihood				0.06	3, 1003	29.96*
Egoistic	-0.06	-1.75	0.081			
Altruistic	0.05	1.38	0.167			
Biospheric	0.23	6.19	0.000			

*$p<0.001$

Firstly, value orientations significantly contributed to the explanation of students' concern about climate change, $R^2=0.29$, $F(3, 1003)=136.58$, $p<0.001$. The more students ascribed to a biospheric value orientation, the more concerned they were about climate change ($\beta=0.57$, $p<0.001$). Egoistic values significantly contributed to explaining students' level of concern about climate change in the other direction ($\beta=–0.22$, $p<0.001$). Altruistic values did not significantly contribute to the explanation of students' level of concern about climate change ($p=0.429$).

Secondly, value orientations significantly contributed to the explanation of how important students believed it is to conserve energy, $R^2=0.19$, $F(3, 1003)$=, 75.91, $p<0.001$. The more students ascribed to a biospheric value orientation, the more important they believed it was to conserve energy ($\beta=0.45$, $p<0.001$). In contrast, the more students ascribed to egoistic values, the less concerned they were ($\beta=–0.13$, $p<0.001$). Altruistic values did not significantly contribute to the explanation of students' perceived importance of energy conservation ($p=0.872$).

Thirdly, value orientations significantly contributed to the explanation of students' perceived usefulness of seeing their real-time energy consumption, R^2=0.06, $F(3, 1003)$=19.83, p<0.001. The more students ascribed to a biospheric value orientation, the more useful they believed it would be to see their real-time energy consumption (β=0.24, p<0.001). On the contrary, the more students ascribed to egoistic values, the less useful they thought it would be (β=–0.06, p=0.021). Altruistic values did not significantly contribute to explaining students' perceived usefulness of real-time energy information (p=0.774).

Finally, value orientations also significantly contributed to explaining the likelihood for students to be encouraged to conserve energy due to seeing their real-time energy consumption, R^2=0.06, $F(3, 1003)$=, 29.96, p<0.001. However, *only* the biospheric value orientation contributed to this explanation as the more students ascribed to biospheric values, the more likely they reported it would be that real-time energy information could encourage them to conserve energy (β=0.23, p<0.001).

6.9 Chapter Summary

The survey revealed that majority of students are concerned about climate change and placed high importance on energy conservation. Environmental motivations were the main driver for energy conservation amongst all students, both for those with responsibility for bills and in a split incentive scenario. Additionally, the majority of students gave positive indications that seeing their real-time energy information would lower their consumption.

Overall, the students demonstrated an eco-centric worldview, although interesting differences were identified between demographic groups and academic disciplines. Firstly, NEP score increased with age. Secondly, engineering students had a more anthropocentric worldview (lowest NEP score), whilst physical sciences students placed highest on the eco-centric side of the scale. There were also significant differences found between NEP scores and their other perceptions measured in this survey. The more eco-centric the students' worldviews were, the more concerned they were about climate change and the higher the importance they placed on energy conservation.

The survey also found that students ascribed strongest to an altruistic value orientation. However, throughout, biospheric values significantly contributed to the explanation of their perceptions. The more students ascribed to biospheric values, the more concerned they were about climate change and the more important they believed it was to save energy. Additionally, the more students ascribed to a biospheric value orientation also made them more positive towards real-time energy information. On the contrary ascribing to egoistic values demonstrated negative perceptions towards the above statements.

The following chapter addresses QUAL Strand 3 of this research which further examines the potential for a smart solution to overcome the barriers to energy conservation in Birley Student Living, and elaborates on students perceptions of the smart city, complementing the findings from the survey.

Chapter 7. Exploring Smart City Innovation

7.1 Introduction and Chapter Outline

Campus greening is becoming increasingly important in the urban sustainability challenge (Evans et al., 2015). However, student halls of residence demonstrate a particular difficult energy conservation challenge as energy bills are included in accommodation cost, thus students have no financial drivers to conserve energy. In addition to living in a split incentive scenario, these students live in multiple occupancy housing (MOH), providing a further barrier to energy conservation. Universities are emerging as popular test beds for smart city technologies to overcome such social dimensions to energy conservation in smart cities (Evans and Karvonen, 2014). Although, in order for a smart technology to tackle challenges such as these, students must engage with them. Research suggest that co-creational approaches can ensure higher engagement with the technology as it meets the needs of the users if co-developed and co-designed with them (Voytenko et al., 2016). Manchester Metropolitan University's (Manchester Met) Birley Student Living (BSL) is an example of such a scenario. The campus has recently fitted a battery for electricity storage with an aim to charge the battery through rooftop solar panels and discharge the electricity during peak hours (5pm – 7pm) when the demand is high. This would take the campus off the national grid whilst using the battery (Karvonen et al., 2018). However, this requires electricity consumption to be reduced. Therefore, there is a need to involve students in co-creating a solution that could overcome the split incentive scenario energy challenge in BSL and identify features and elements that meets their requirements for engagement.

This chapter presents the results from the Innovation Challenge and app trial focus groups with students and the chapter's aim is twofold. First, it explores ideas for a potential smart solution to encourage students to save energy in the split incentive scenario in BSL described in Chapter 3, Section 3.4.3 (Objective 3). Second, it further examines students' perceptions and concerns with the smart city to compliment the student survey findings (Objective 1). Section 7.2 outlines in detail each of the ideas from the teams attending the Innovation Challenge. Section 7.3 presents the results from the focus groups that evaluated students' experience with the Beat the Peak app and their ideas and perceptions of a potential smart solution for energy conservation in BSL.

Section 7.4 examines students' perceptions, challenges and concerns with the smart city whilst 7.5 provides a chapter summary.

7.2 The Innovation Challenge

A total of 13 participants divided into three teams participated in the Innovation Challenge, all presenting a different concept and idea to solve the energy conservation barriers in BSL. Table 7.1 reiterates the participant profile.

Table 7.1. Participant Profile Innovation Challenge

Male (*n* =8)	**Female (*n* =5)**
Course of study/field of work	
Graphic design	Engineering
Climate change agency	Biomedical science
Microbilogy	3D design
Economics	Special needs teaching assistant
Biocomputing	Events management
Sustainability and environmental management	
Business and analytics	
Computer science	

All the teams illustrated their ideas on large flip board charts which was collected and analysed afterwards. An illustration of each team's idea is included in this chapter.

7.2.1 Team 1 'Energy Savers'

Team 1 who called themselves 'Energy Savers' presented an idea that revolved around an open data source and smart tablet the team named the 'G-Hub' as seen in Figure 7.1.

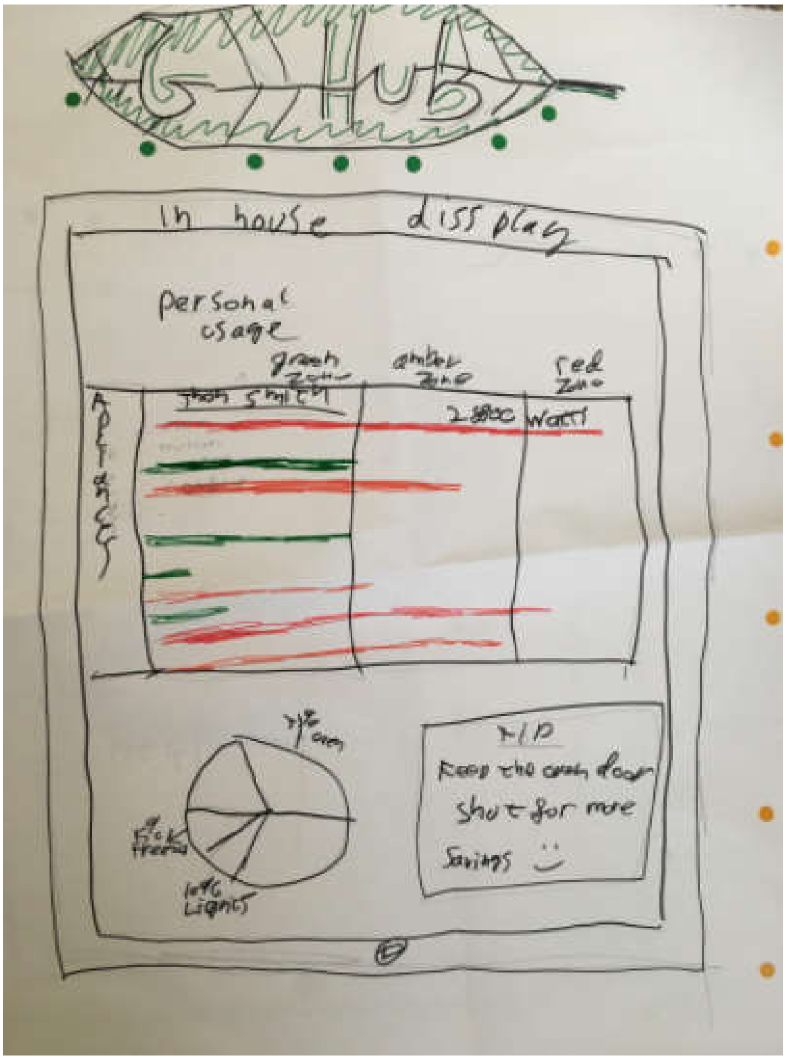

Figure 7.1. Illustration of Team Energy Savers' Idea

One G-Hub screen would be mounted on the wall in each flat's kitchen, displaying real-time electricity consumption in kWh. As seen in the illustration, it also showed whether the electricity usage of appliances was low (green), medium (amber) or high (red) in real-time to visually alert excessive levels of consumption. The device was designed to display energy saving tips adapted to the individual flat's consumption. The G-Hub would also have a scanner for student cards, where each student would be able to view their individual consumption of their rooms and which appliances they could use more efficiently and how. A separate screen in the tablet would display an overall live league table of the flats, showing the flats that consumed the least and most energy. There would be inter-house, block and campus wide competitions to encourage conservation. At the end of each term, there would be a prize for the best performing flat in form of free entry to events on campus with societies that promote green living or monetary prizes such as vouchers, reduced accommodation fee or money on students' 'Met Cards';

a card with pre-paid credit that students can spend around the university campus and on other university services.

7.2.2 Team 2 ‘OMIE’

The second idea presented by team ‘OMIE’ was a smart energy app-based concept, integrated within the existing Manchester Met app ‘MyMMU’ as seen in Figure 7.2.

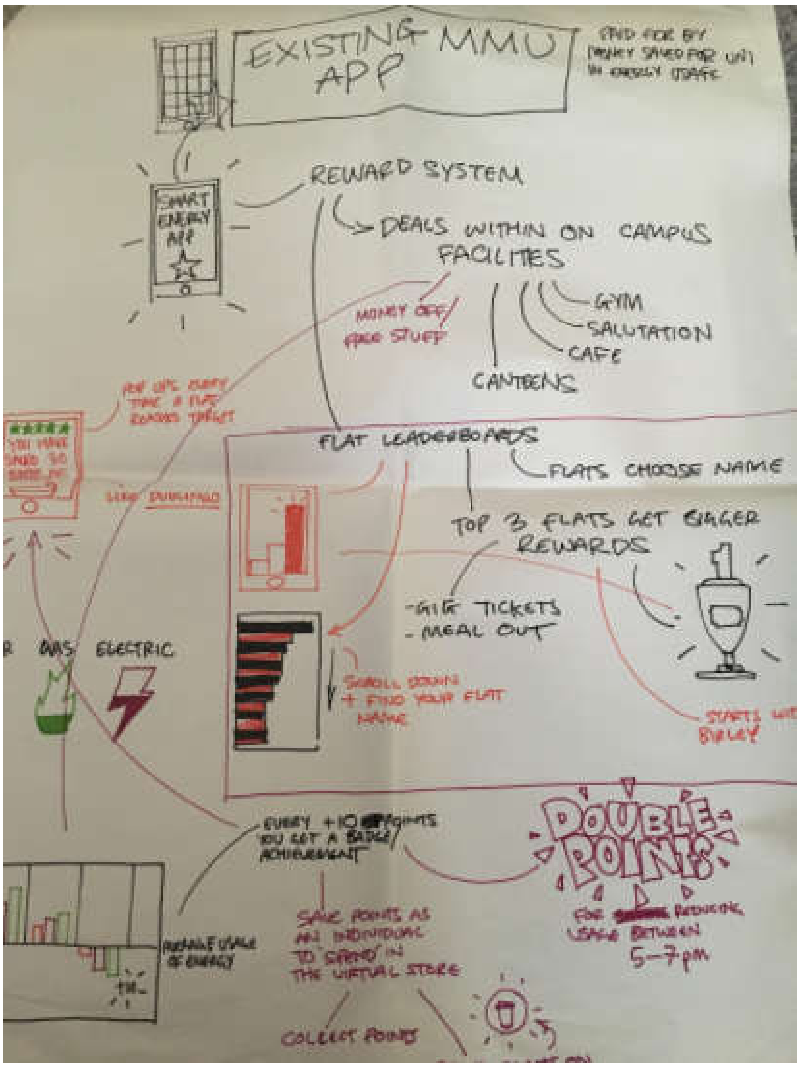

Figure 7.2. Illustration of Team OMIE’s Idea

Inside the MyMMU app there would be a button for the smart energy app with different sections and functions. There would be a section displaying real-time energy consumption for each flat comparable to an average of the same flat last year. As seen in the illustration in Figure 7.2, the idea also entailed a point system where the flats’ energy conservation would reward points, including double points during peak time (5pm – 7pm). Targets and goals would be set, and whenever a flat achieved these, students would get a notification with an achievement badge explaining in relatable information what their savings equaled to, e.g. ‘you have saved a kettle of water’ or ‘you have saved enough to fill a car with fuel’. There would also be log in reminders to remind students to engage with the app. There would be a section with an overall league table available for all to see where each flat got to choose their team name.

Rewards were given on a flat level, but each student in the flat got a share of the points into their own account to purchase rewards from a virtual points store. The rewards ranged from small prizes such as a free coffee or food on campus to bigger prizes costing more points such as a free gym session. The top three flats on the league table at the end of the year would receive a grand prize collectively as a flat such as a free meal out or gig tickets. The absolute best flat would receive a trophy for their efforts.

7.2.3 Team 3 ‘Eco Students’

The third idea presented by team ‘Eco Students’ was also an app-based concept and the team named it ‘Eco Reward’ as seen in Figure 7.3.

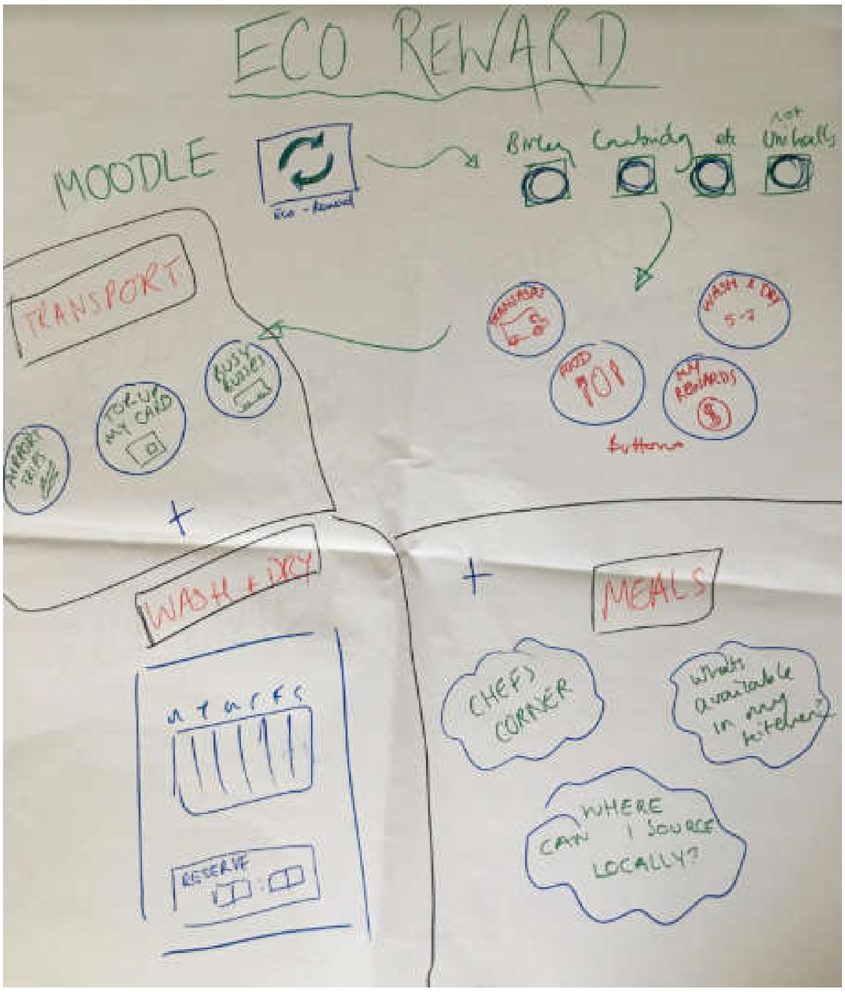

Figure 7.3. Illustration of Team Eco Students’ Idea

The app would be integrated with the MyMMU app with a button leading to Eco Reward. Unlike the other two ideas, Eco Reward focused on elements outside of campus as well and worked on an individual level rather than collective flat level. The app would have three sections: transport, wash + dry and chef's corner. The transport section was designed to encourage students to take public rather than private transport. A type of smart card would be available to scan on e.g. the bus, rewarding points for taking the bus. The transport section would include a sign-up page for collective transport to the airport as there are several international students at Manchester Met. The second section 'wash + dry' revolved around a booking system for the campus washing machines. This enabled the university to control the best times for washing and drying, preferably outside the peak time hours. This in turn could reduce the strain on the energy grid within these hours, allowing the battery to last and thus reduce costs. Students washing clothes outside peak hours would be awarded points. The last section 'chef's corner' would include a system where students could arrange over a forum in the app to cook together. For example, a student would write a post in the forum saying 'cooking curry tonight', which then other students could sign up to join. Additionally, the app would include tips on where to purchase locally sourced foods.

Using the app would award points. There were monetary rewards exchangeable for points or they could also grant access to sustainability events on campus. Moreover, every student had to deposit £50 at the beginning of the year. Through interaction with the app they could earn this deposit back by gaining points. If their behaviours were more pro-environmental than their peers, they could potentially earn the others students' deposit as well as their own. An overall league table with students' usernames would be available in order to compare performance to others.

7.2.4 Collective Summary

Whilst Energy Savers proposed an idea based on a dashboard screen displayed within each student flat, both OMIE and Eco Students suggested app-based ideas. Both these app ideas would be integrated as part of the MyMMU app, creating a collective platform for the solution for practical reasons. Ease of use of the solution was regarded as important and a participant in the team OMIE stated that: "the information needs to be simple, fun and competitive". They followed up with: "students won't engage if it's tiny writing. Design is key". Another participant on the same team agreed that the app "needs to be very straight forward". There were different opinions regarding how much students should be required to engage with the smart solution. One participant on the team Energy Savers stated: "with our idea we wanted to move away from the app as that requires more effort". There was, however, slight disagreement between the teams as some argued that with simplicity the solution lost some of the technical complexities and opportunities which undermined the usefulness of the solution overall. One participant on the team Eco Students stated specifically that they disagreed with team OMIE saying: "if it is complicated, it can do more". Therefore, coupled with how all three teams demonstrated their ideas, cues, context and challenge were identified as the three most important drivers for engagement with the app/smart solution itself.

When addressing potential broader engagement challenges, the participants unanimously highlighted the barrier of being in a flat where one may end up being the only one caring about saving energy. One participant from OMIE raised the question in their group discussion:

> *"How do we overcome people who won't engage? Because it can be discouraging if you are the only one using it [the app/smart solution]".*

This led to OMIE identifying "team spirit" as one of their key points for engaging entire flats with their app idea. Whilst Eco Students focused slightly more on individual energy reduction commitment in their solution, the other two teams demonstrated that the main prize would be won together as a flat in order to encourage collective participation.

Nevertheless, one of the main perceived barriers to engage with the energy saving potential of the solutions were the students' perceptions and concerns about climate change. There was a clear worry demonstrated around perceptions of personal impact on climate change and how relatable environmental impact of climate change is on individuals. One participant stated that the solution for BSL needed to: "shift the focus from the North pole, to your doorstep", turning it into a tangible concept for students to relate to. Another participant argued that: "climate change is so abstract, it needs to affect you directly", whilst it was also said that the solutions: "need to romanticise sustainability again; it used to be cool". All three teams decided to integrate a reward system with prizes as incentives into their solutions, identifying it as a factor to overcome the potential lack of concern about climate change.

7.3 App Trial and Evaluation

7.3.1 The Beat the Peak App

After the Triangulum Innovation Challenge had finished, Clicks+Links, an app development company tied to the Manchester Smart City project developed a prototype app called Beat the Peak. The aim was to explore a smart solution that can encourage students to save energy in the split incentive scenario in BSL. The app was trialled over a two-week period with 60 students. The app allowed students to sign up and receive energy saving missions which they could either accept or reject (see Appendix 8 for illustration of missions). Each mission was accompanied by tips on how to achieve the mission objective. At the end of a mission, students were able to tick off which tips they had followed. The app is illustrated in Figure 7.4 below.

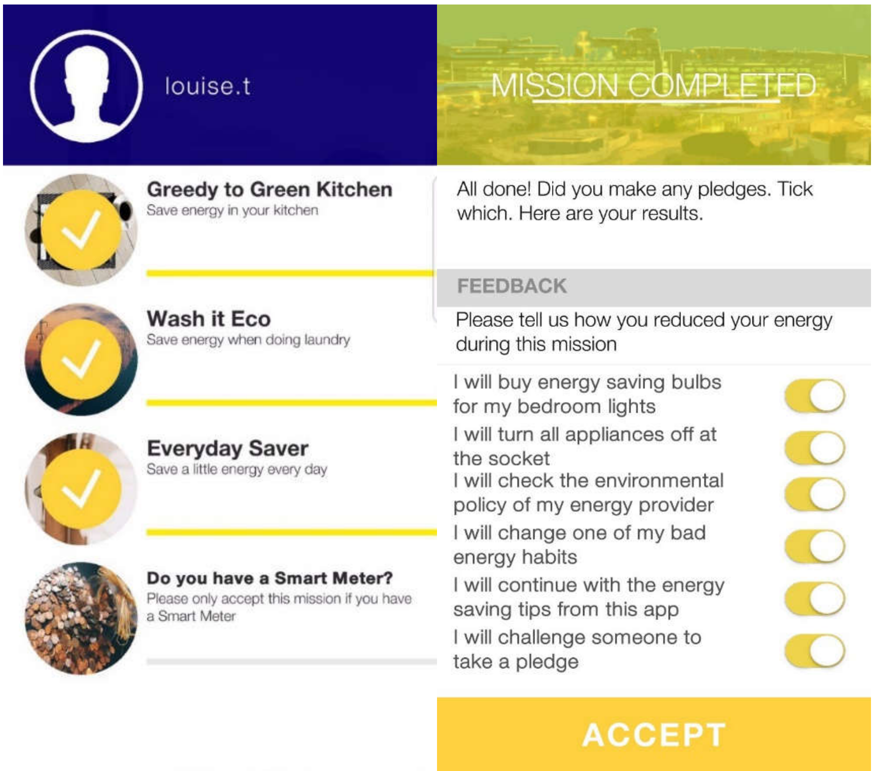

Figure 7.4. The Beat the Peak App Illustration

7.3.2 Participant Profile

A total of 49 students agreed to participate in the post app-trial focus groups, and they were divided into eight focus groups. There were significantly more females than males that attended the focus groups and the majority of participants were from the UK. All the students were either living in university halls, at home with parents or other relatives or in rented accommodation. There was a skewed split in responsibility for bills, as seen in Table 7.2, where most participants did not have responsibility for bills, thus living in a split incentive scenario.

Table 7.2. Participant Profile Focus Groups

Focus Group	Date	Gender			Age Group				Country of Domicile			Responsibility for Bills	
		(n)	Female	Male	<=20	21 - 24	25 - 29	>=30	UK	EU/EEA	International	Yes	No
FG1	Apr-18	9	6	3	5	4	0	0	8	0	1	3	6
FG2	Apr-18	6	5	1	2	4	0	0	4	0	2	2	4
FG3	May-18	7	5	2	4	2	1	0	6	0	1	0	7
FG4	May-18	8	5	3	2	2	1	3	7	0	1	2	6
FG5	May-18	3	3	0	0	3	0	0	3	0	0	2	1
FG6	May-18	8	7	1	3	5	0	0	7	1	0	4	4
FG7	May-18	6	5	1	4	1	0	1	6	0	0	3	3
FG8	May-18	2	2	0	2	0	0	0	1	1	0	2	0
Total		**49**	**38**	**11**	**22**	**21**	**2**	**4**	**42**	**2**	**5**	**18**	**31**

7.3.3 App Evaluation

App Features

To begin with, the students were asked what they liked and disliked about the app as an introductory topic to the discussion. Thereafter, the discussion evolved into app features that would encourage them to conserve energy. Table 7.3 illustrates the themes and sub-themes that related to these app features, and in which and how many focus groups they were discussed. Specific emphasis was placed on visual cues, contextualised information and challenge, with the students giving several examples as to what they would prefer to see in future versions of the app.

Table 7.3. Motivational App Features

Theme and sub-themes	Occurrences	
	Focus Group	# of Focus Groups
Cues		**8**
Interactive	FG1, FG2, FG4, FG5, FG6, FG7, FG8	7
Ease of use	FG1, FG2, FG3, FG4, FG5, FG6	6
Nudging	FG1, FG3, FG4, FG6, FG7, FG8	6
Overall design	FG2, FG3, FG4, FG6, FG7	5
Colours	FG1, FG2, FG4, FG5, FG7	5
Language	FG2, FG4, FG7	3
Context		**8**
Tips	FG1, FG2, FG4, FG5, FG6, FG7, FG8	7
Savings	FG1, FG2, FG3, FG4, FG5, FG7	6
Real-time consumption	FG1, FG2, FG3, FG5, FG6	5
Environmental consequences	FG1, FG2, FG3, FG4, FG8	5
General information	FG2, FG4, FG5, FG6	4
Personalise	FG2, FG4, FG7, FG8	4
Personal impact	FG2, FG3, FG7	3
Challenge		**8**
Points system	FG1, FG2, FG3, FG5, FG6, FG7, FG8	7
Competition	FG1, FG2, FG3, FG4, FG6, FG7, FG8	7
Reward system	FG1, FG2, FG3, FG4, FG5, FG6, FG7	7
Gamification	FG1, FG2, FG3, FG4, FG5, FG6	6
Leader board	FG1, FG3, FG4, FG5, FG6	5
Goal setting	FG1, FG2, FG4, FG7	4
Comparison to others	FG2, FG4, FG6	3

The comments from the students revealed that intuitive visual cues, coupled with the use of contextualised information and various elements of challenge and competition were crucial for engagement with the app and for it to encourage energy savings. The level of interactive features was recognised as the key factor for engagement. Typical comments stated: "I think it would have been more interactive"[FG4]. Therefore, students were asked to suggest features that could potentially be added to the app in order to make it more interactive and engaging.

Six sub-themes were identified as imperative regarding cues, ranging from factors relevant to the use of the app to the various elements of design. Colours, language and structure of the app itself were recognised as important as it "gets you interested"[FG4]. Several students stated that the app's colours were "visually stimulating"[FG1], and that "the language that was used was quite user friendly and quite engaging"[FG2]. All but 2 focus groups also placed high importance on the ease of use of the app: "I liked that it was quite easy to follow. It wasn't loads of data or anything"[FG5].

Furthering this, students argued that placing the information within the app in a comprehendible and relatable context was vital for them to understand the challenges of energy conservation, and to be encouraged to save energy. Eight sub-themes were identified in relation to context, with all but one focus group placing high importance on the tips on how to save energy. The students argued that the tips had to be achievable as some would give up if they required them to alter their routines too much:

> *"They do make you change your routines, but not to a scale where people think 'I can't do that' and give up"*. [FG7].

As the app sent notifications, 'nudging' in the form of reminders through notifications were highlighted as important as students emphasised they had busy lives and that without reminders it was easy to forget about the tasks set in the app. However, some students did indeed find the constant reminders annoying: "I feel like if I just kept getting notifications, I would delete the app"[FG6]. Therefore, the students suggested that users of the app should have the ability to customise the amount reminders to their own preference.

The majority of the students across all focus groups claimed that using the app had changed some of their energy behaviours to a greater or lesser extent. This was especially evident in FG2 and FG8:

"I didn't use to like switch off, and I would get home and plug in my phone and it is charging. But now I am 'my God', I am wasting so much energy". [FG8].

This was especially linked to the actual tips displayed by the app which were frequently discussed. Some students stated that they wanted to conserve energy but were unaware what measures to undertake. In contrast, some felt they were already doing what they could to save energy and were not aware of more they could do. In relation to the former, several students across the focus groups agreed that the app aided them in "learning about ways saving energy"[FG6]. This converges with other studies that found students in university halls had limited knowledge about how to save energy beyond basic methods (Odom et al., 2008).

To understand the information, the students also argued that the tips had to be designed in a way that they could relate to how much energy they had saved:

"Put it into something I would understand, [that is] is a lot easier. Then I would actually know what I'm doing, rather than me looking at them graphs and my mind is blowing up, I don't know what it means". [FG2].

Furthering this, graphs and numbers were identified as the least favourable way of displaying energy information, as one student stated: "you don't really know how to visualise that"[FG7]. However, students in five of the focus groups (FG1, 2, 3, 5 and 6) were asked if seeing their real-time energy consumption would encourage them to conserve energy. The vast majority of students in these five focus groups agreed that it would as "they would actually see how much they are using"[FG6]. This echoes studies that found real-time energy feedback to prompt positive energy behaviour for students in university halls (Petersen et al., 2007). Although, one of the students in one of these focus groups contested this agreement by explaining: "I wouldn't understand just consumption, I wouldn't know what I was looking at"[FG2].

Therefore, the suggestion of illustrating the environmental consequences of behaviour emerged in five of the focus groups as a way to demonstrate why it is important to conserve energy. Suggestions revolved around visual cues in form of eco-visualisation:

"Maybe send out messages to those not participating saying for example 'you've killed 4 trees today'. That sort of negative". [FG4].

On the contrary, a minority of students in the other three focus groups argued that showing the *positive* impact of individual behaviour is important in order to encourage energy conservation as a common misconception was that:

> *"I wouldn't normally think that me just cutting down could have that much of an impact".* [FG1].

This sparked further discussions around how the app should display information about how much energy students had saved in comparison to previously, but in a contextualised manner:

> *"I think the little facts are good as well, because then it does put it into perspective instead of just 'you'll save energy' as a lot of people will go like 'well what am I actually saving?' You say save energy, but what do you actually mean? If it says you've saved 50 cubic meters of ice from melting that makes you feel like quite the hero".* [FG1].

This aligns with literature stating the importance of participants' understanding about why they should conserve energy as lack thereof could lead to no participation (Foster et al., 2012). Therefore, providing contextual information which demonstrates the importance of conserving energy and the impact of pro-environmental behaviour is crucial to encourage energy conservation (Steg and Vlek, 2009).

In addition to cues and context, the elements of challenge were identified as crucial for engagement, especially in relation to the increased demand for interactive features. As seen in Table 7.3, seven sub-themes emerged in regard to challenge, with all eight focus groups suggesting various elements that could turn the energy conservation challenge into a fun and engaging experience for students. Specifically, these challenge related elements were identified as essential to overcome the split incentive scenario present in BSL. All but one focus group suggested that the app should prompt competition between the flats:

> *"You could make a competition, either in the hall between the flats or across the flats – battle of the flats*". [FG8].

Coupled with this, students across all eight focus groups highlighted that a leader board or a points system would urge this competition further:

"I think a leader board and a points system, because I like to win, I love winning, and I want to be on the top of the leader board at all times". [FG3].

However, the students clearly specified that without rewards included in this competition, there would be low engagement. Arguments reflected that it could be particularly useful for:

"People that didn't really care about the environment but want rewards would be like 'it would be nice to have free coffee once in a while'". [FG6].

Students listed a number of rewards they would enjoy such as vouchers, various free consumables, and refund of accommodation fees. Nevertheless, the most popular reward was credit on their Met Cards. They argued that this gave a certain freedom of choice of reward which the students valued highly. However, in human-computer interaction studies, virtual rewards have been tested (Yun et al., 2013). This included in-app rewards and points etc. (Froehlich et al., 2009; Shiraishi et al., 2009). Whilst, there are limited studies on these types of reward intervention strategies, some of the students did refer to examples of these types of apps.

"I've got this app, it is called Forest. And every time you don't use your phone, it grows trees or bushes. And then when you've finished the time, say 15 minutes, it grows. It is the simplest of rewards, mundane almost, but it is still a reward. It makes me feel good when I've got older trees". [FG3].

There was also general consensus that any way of gamifying the energy conservation would motivate students in student halls to save energy. For example, students suggested that in order to accommodate the differences in knowledge about energy saving, "you could have people level up to more tasks"[FG1] and that "the harder difficulty, the more points you get". [FG3]. Other elements of gamification suggested by students included utilising quizzes and the ability to compare themselves to others: "I love seeing that, for example 'my flat is less than somebody else's'"[FG4]. Lastly, goal setting was mentioned as way to gamify the energy saving app:

"It would be nice if you had like goals and targets that you could reach". [FG1].

Goal-framing-theory has been proven successful for many other studies as it challenges people to achieve aims (Steg and Vlek, 2009; Yun et al., 2013).

Motivational Factors

In addition to app features, students identified a broader range of motivational factors for saving energy which are illustrated in Table 7.4. The table also illustrates which and how many focus groups the themes were discussed in. As seen in Table 7.4, there were two motivational factors that became most salient: community feeling and finance.

Additionally, students strongly agreed with a co-creational approach when asked how they felt about the app being co-developed and tested by students. Several students believed that this coupled with the app being promoted by the university itself was far more likely to succeed than random apps on the app store, or apps that had not been co-created by students. This was because the co-creational aspect assured users it was relevant to them and as one student stated: “If students have actually trialled it, they know it’s suitable for them”[FG7]. Furthering this, the students identified the university as a motivational actor for saving energy as “you are contributing to our status as a university”[FG4], referring to Manchester Met being named a green and sustainable university.

Table 7.4. Motivational Factors

Themes	Occurrences	
	Focus Group	# of Focus Groups
Community feeling	FG1, FG2, FG3, FG4, FG5, FG6, FG7	**7**
Co-creation	FG1, FG2, FG3, FG5, FG6, FG7, FG8	**7**
Finance	FG1, FG2, FG3, FG4, FG5, FG6, FG8	**7**
Sustained behaviour	FG1, FG4, FG5, FG6, FG8	**5**
Habits	FG1, FG2, FG3, FG6, FG8	**5**
University	FG1, FG3, FG4, FG6	**4**
Awareness	FG1, FG3, FG5, FG8	**4**
Enforcement	FG1, FG3, FG7	**3**
Convenience	FG1, FG3, FG5	**3**
Non-Smart tech solutions	FG1, FG2, FG5	**3**
Environment	FG1, FG3	**2**
Relevance	FG1, FG4	**2**
Responsibility	FG1, FG3	**2**
App-based solution	FG1, FG3	**2**
Renewable peak time	FG1, FG6	**2**

Community feeling was a strong theme throughout the vast majority of the focus groups which could be explained by the students stating that they were not aware of - or did not feel like - their individual actions had any impact. This was particularly evident when discussing the "Check your Mate" mission in the Beat the Peak app which several of the students enjoyed:

> *"I liked the missions that you use for saving energy with friends as more people get involved that way".* [FG8].

One of the students pointed out that they had shared the app with a housemate and found it particularly motivating doing energy saving activities together:

> *"My housemate had the app as well and we were doing it together at the same time and she was asking me 'have you checked Beat the Peak and have you seen*

what it says today?' And then I said 'yes yes we can do that tonight!' Having someone else in the household to do it with is good". [FG1].

This was emphasised when specifically discussed in relation to the barrier of saving energy in MOH. Odom et al. (2008) found that if a majority of students in the flat do not save energy, those who are willing to undertake energy saving activities are likely to be less motivated to do so. Therefore, it is crucial to get as many on board as possible and facilitate energy saving with students' lifestyle in halls. Some students in the focus groups mentioned that other people in the household can be demotivating, which resulted in them continually arguing it is important to "get everybody on board"[FG6].

"The problem really is that you have a flat of eight people, and two are really bothered about the environment and the other six aren't. So those two are being brought down by the other six". [FG3].

However, there were some contesting opinions on how to resolve this issue. Creating social pressure around the challenge of conserving energy (Petersen et al., 2007; Khashe et al., 2016) was a salient solution across the focus groups as the students pointed out:

"If someone don't do it, we would call them out on it. So I feel like it would work". [FG6].

Extending this debate, three focus groups discussed the possibility of enforcing good energy behaviour by arguing there had to be a consequence for bad energy behaviour: "maybe the flats with a higher energy consumption, something could happen to them"[FG7].

However, this was strongly contested by other students, with one participant stating that it was:

"…a bit inhumane to force people to do all this. My right is more important than the environment in my opinion". [FG3].

This was also evident in FG1 where the students argued that enforcement could indeed have a counter effect, resulting in students rejecting the energy saving ideas. Nevertheless, most students believed that enforcement would be effective but unwelcome. Illustrating this, one student stated that "enforcement would work, but it would be for the wrong reasons"[FG3].

Financial factors were identified as one of the key motivations for saving energy. When the students were discussing it in relation to the split incentive scenario a common notion was:

> *"Because it comes in my rent, I don't really care. I mean when I do come out of living in halls and into living in houses I obviously will care"*. [FG2]".

When specifically discussing the split incentive scenario, students argued that:

> *"…it really depends on the person because some people just really don't care because it is included. So for those people, I feel like it depends if they actually care about the environment or not".* [FG1].

However, some of the students argued that an incentivised and gamified smart app solution could indeed overcome this issue. A few students stated they do care about the environment, with one student specifically referring to behaving environmentally friendly in halls due to this:

> *"I live in private halls so it is included in my rent, but I am still conscious of how much energy I use, simply because of the environment"*. [FG1].

Regardless, students argued that monetary values should be defined in split incentive scenarios due to the relatable context, but also as an incentive in terms of when moving out as:

> *"…even the people who do care about the environment would probably care more about money".* [FG8].

and:

> *"If you showed them a comparison of their flat, this month actually with British Gas this would have cost this. 'Either smarten your ways or you'll be paying this next year'".* [FG4].

This links to the notion that starting to save energy whilst living in student halls leads to good habits. Furthering this, the students argued that the greatest challenge to the Beat the Peak app was sustaining students' behaviour post using the app and when they were no longer being incentivised. This echoes Yun et al. (2013) who state that such motivational factors are proven effective during the intervention period but are often limited and will not solicit long-term results. Therefore, several students stated that also this could be solved by promoting the app in a way that the changed behaviours become habits.

Referring back to the contextual features of the app, students emphasised awareness as an important motivational factor:

> *"We can't see how much better the environment is for it. I don't even know how saving energy helps the environment".* [FG5].

This issue became evident not only in relation to awareness, but in lack of visible impact of climate change and global warming:

> *"Like you can say about polar bears, but they live hundreds of thousands of miles away. But if it was something closer to home…"* [FG1].

Therefore, students argued that the app was required to motivate students by showing them more localised impacts of climate change:

> *"…things that have got more to do with Manchester and local news, stuff like that. That makes it a bit more personal I think".* [FG4].

However, one student strongly argued that whilst showing local impacts was important, any "real world scenario" could aid the encouragement to take responsibility for personal environmental impact and save energy:

> *"In a real world scenario, this is what is happening, we can't ignore it, we are all part of it so kind of drill that thing to say 'I live here and we have running water and electricity' but in your own country there are several places that don't have these facilities. Forget other countries, in the UK itself there will be places that don't have these facilities. So kind of pitching that information when you save water or saved electricity at a certain point would make it more relatable. It's not someone else's problem, it is ours as well"*. [FG3].

Awareness was especially identified as an important driver when discussing the missions "Greedy to green kitchen", "Every day saver" and "Wash it Eco" as the students stated the three missions raised awareness of how to save energy in ways they were previously not aware of and the broader implications of why it is important to save energy. Nevertheless, the "Beat the Peak switch off" mission was identified as the mission that raised the most awareness as the majority of students were unaware of the peak time hours or the peak time demand on the electricity grid. This in turn led the students to state that knowing their energy saving in BSL halls contributed to take the campus off grid during peak time hours was an incentive itself.

The Innovation Challenge Ideas

When discussing the ideas from the Innovation Challenge, the Smart Energy App from Team 2 OMIE was identified as the student favourite. This was mainly due to their proposed point system and the contextual information provided within the app illustrating energy saved in a manner that students found relatable. Common comments whilst discussing this app included “it seems like a really good idea […] I can see myself using it”[FG7]. Particularly, the students found the opportunity to earn more points by saving more energy during peak time hours incentivising:

> *“I like the double points on the peak hours. You would be more likely to save on those hours, more than normal points”*. [FG6].

Team 3 Eco-Students’ app ‘Eco-Reward’ was strongly disliked due to the initial £50 deposit (which they could lose if their energy behaviours were bad) and the cooking together scheme was identified as intrusive. Students stated that “the whole idea of a loss put me off it straight away”[FG2] and that they “wouldn’t like random people coming round to my flat for tea for security reasons”[FG3].

Regarding Team 1 Energy Savers’ idea ‘G-Hub’, there were some contrasting views on whether the dashboard was a better solution than an app. Some students firmly believed that the interactive elements were crucial to engagement and therefore favoured an app solution over the dashboard:

> *“If it’s just in the kitchen people would just look at it for little, then just not care. You need something that sends notification on your phone you could check on your phone as well in the kitchen”.* [FG6].

On the contrary, other students argued that the app required more effort than a dashboard which could in turn reduce engagement.

> *“…if you actually saw a dashboard as it was physically in the room, then you’d have to see it”.* [FG2].

Whilst this corresponded with some students stating that convenience was the key to encourage students to engage with the smart solution, the majority argued that an app solution would be more convenient:

> *"I read it on the bus most days, just as I was going to and from uni and it took so little time that I could just read it on the bus and it did not take any part of my day up".* [FG1].

However, several students stated that Team Energy Savers' G-Hub dashboard and Team 2 OMIE's Smart Energy App could work together as one solution, by creating an app that links to a dashboard as it would promote individual engagement as well as communal engagement on a flat level.

Although the focus group discussions revolved around a potential smart solution, the students also had the opportunity to reflect on non-smart solutions that could encourage energy saving by evaluating whether or not a smart solution could be more or less effective than these. Only posters were suggested, which clearly emphasised the importance students place on visual cues. Posters were proven successful in another energy conservation study with students (Bekker et al., 2010), however, the discussion quickly drifted back to technology-based approaches, suggesting students preferred this over traditional methods.

7.4 Perceptions, Concerns and Challenges to the Smart City

In the focus groups the students were asked to identify their concerns and perceived challenges to the smart city. Additionally, all the focus groups were prompted to discuss privacy concerns in relation to using their smartphones and apps.

During the course of the focus groups, the discussion regarding the smart city depended on the participants' familiarity of the smart city. It became evident that students had varying awareness about the smart city. A minority of the focus groups demonstrated higher familiarity with the concept (FG1, 4 and 7) and tended to discuss challenges and concerns on a city level, whereas those with less or no familiarity (such as FG6) expressed concerns in relation to individual smart technology use to a greater degree.

Table 7.5 demonstrates themes associated with smart technology related concerns whilst 7.6 illustrates the themes related to students' perceived concerns and challenges to the smart city.

Table 7.5. Concerns about Smart Technology Usage

Theme and sub-themes	Occurrences	
	Focus Group	# of Focus Groups
Privacy concerns		**8**
General privacy	FG1, FG2, FG3, FG4, FG5, FG7	6
Targeted advertisement	FG1, FG3, FG4, FG5, FG6, FG8	6
Tracking	FG1, FG3, FG4, FG5, FG6	5
Terms & Conditions	FG1, FG3, FG4, FG6, FG7	5
Data sharing	FG2, FG5, FG6, FG7, FG8	5
Purpose of data	FG2, FG3, FG4, FG6, FG7	5
Exploitation	FG4, FG5, FG7	3
Trust	FG4, FG5	2
Surveillence	FG3, FG4	2
Security concerns		**7**
Security	FG2, FG3, FG5, FG6, FG7, FG8	6
Hacking	FG2, FG3, FG4, FG5, FG6	5
Other		**6**
Addictiveness	FG2, FG4, FG6, FG8	4
Strorage space	FG3, FG5	2

Table 7.6. Concerns and Challenges to the Smart City

Themes	Occurrences	
	Focus Group	# of Focus Groups
Cost	FG1, FG4, FG5, FG7	**4**
Dependency	FG3, FG4, FG7	**3**
Exclusion & inequalities	FG1, FG3, FG7	**3**
Smart City initiatives	FG1, FG7, FG8	**3**
Dystopian futures	FG1, FG3, FG4	**3**
Viability	FG1, FG7	**2**
Visibility	FG1, FG2	**2**
The smart label	FG2, FG7	**2**
Underlying urban issues	FG1, FG4	**2**

7.4.1 Privacy and Security Concerns

All focus groups were asked about their privacy concerns regarding smartphone and app usage. Whilst the level of concern varied, students from all focus groups did indeed specify some degree of concern related to their privacy. As seen in Table 7.5, several sub-themes emerged. Firstly, the students expressed worries around privacy in a general sense:

> *"Some apps sometimes as for ask for access to your data and you don't know if it is trustworthy because then they can misuse it".* [FG3].

Furthermore, the Cambridge Analytica/Facebook scandal was used as a prompt story for further discussion of privacy concerns and worries. Several students related their privacy concerns to the utilisation of social media. Many expressed a dislike towards elements of this such as targeted advertising, especially for political reasons. One student stated that this type of data collection and use of it was "manipulating, and it's only presenting one side of the story"[FG3]. However, other students strongly felt they were still in control of their own decisions and not easily influenced:

> *"I feel like I am intelligent enough to make my own political decisions without being influenced by social media".* [FG1].

Other students were more relaxed about targeted advertisement and accepted it as part of the modern and highly digitalised society:

> *"I don't think it's misinforming, they're just tailoring how they say stuff to get to you better".* [FG5].

Subsequently, several students also felt that they were in control of their own data and privacy due to choosing what to share on social media and being able to change privacy settings on their smartphones: "I wouldn't share anything that I didn't feel like could be out there"[FG6]. Nevertheless, the vast majority of students in the focus groups admitted they never read the terms and conditions due to it being long and time consuming. Upon reflection, this made the students unsure if they actually were in control of their own data:

> *"You never read the terms and conditions, so you never really know what the companies say about who they are going to give you information to".* [FG6].

Some students argued that they in fact trusted companies that collected their data, whilst others expressed more skepticism about being exploited due to the data being "owned by big corporations”[FG7], leading them to have added concerns:

> *“It’s about what it’s used for and if it’s going to be sold to a third party because that’s the main concern really”*. [FG5].

Furthering this, the purpose of data - both the reason for its collection - and its subsequent use, was found to be the key factor determining the students’ level of concern:

> *“The collection of [data] helping healthcare policy or environmental policy I am really for, you can use my data in any way you think is going to help. But when you start selling that data on or using that data to try to manipulate or influence my behaviour then I’ve got to say ‘enough you can’t have any of it’”.* [FG4].

Evidently, this triggered students to be more apprehensive about sharing their data and several student found it scary “not knowing where your information is”[FG5]. This lead to students agreeing on a call for greater transparency about the purpose of data collection and that companies should be “open about what they’re actually going to do with the data later on”[FG7]. In addition, students stated they wanted to be aware of “how the data is going to be shared”[FG6].

However, one student stated that users of smart technologies had to succumb to exchange some data in order to benefit from products and services:

> *“I feel like that what you agree to when you download these things. You know you are going to have to share some stuff”.* [FG6].

More specific concerns revolved around the tracking of data, especially location data, which emerged as the most prevalent worry for students: “tracking location and similar things I don’t really like”[FG4]. Whilst two students were less worried about tracking due to its ability to improve public security:

> *“It [CCTV] doesn’t bother me because it is for the greater good. Especially in public spaces”.* [FG3].

One student felt that their privacy was under threat and almost became a form of surveillance, therefore suggesting that “it should be easier to opt in and opt out”[FG4].

For example, one student stated that the Cambridge Analytica/Facebook scandal had indeed affected their perception of this issue:

> *"I wanted an Alexa, an Echo Dot, a voice system, but now I'm more apprehensive after seeing the Cambridge Analytica thing, and the Google thing recording random sentences".* [FG3].

On the contrary, two of the students in the focus groups strongly stated they "literally could not care less who has what data"[FG1] and that even though they do occasionally think about it, they were not "overly bothered about it anyway"[FG2]. These findings align closely with the framework developed by van Zoonen (2016) hypothesising that the type of data collected and for what purpose it is collected are the key determinants triggering people's privacy concerns.

In seven of the eight focus groups, security was also raised as a major concern. Whilst general security concerns regarding i.e. data protection was frequently discussed, the students were mostly worried about hacking and security breaches: "Data gets into the wrong hands and gets misused"[FG7].

The most frequent concern was about personal details in general being stolen from their devices. Even the students who expressed no or low concerns regarding privacy were stating some concerns regarding financial information:

"As long as it's not my cards and anything to do with money, I don't care". [FG2].

7.4.2 Broader Challenges and Concerns

As seen in Table 7.6, two of the focus groups discussed the 'smart' label itself. The most salient associations with the term were 'advanced' and 'futuristic' as illustrated by one student:

> *"For me it is like technology, kind of like sci-fi, everything has got something to do with really robust technology".* [FG2].

Additionally, two students stated that they associated 'smart' with technology that is "accessible and fast"[FG7] and "more sustainable"[FG7].

In those two focus groups a broader discussion on the use of the 'smart' label emerged with students stating: "it is over-used, it is like when you play a song over and over"[FG2].

This led one student in the same focus group to suggest an alternative and more suitable term than ‘smart’ in relation to cities:

> *“I think there could be a better term for smart city, smart is used so much now”.* [FG2].

Both concerns and challenges to the concept of the smart city were identified across the focus groups. Cost of establishing and maintaining the smart city emerged as the most salient concern:

> *"I think because of how much it costs to economically build a new technology and pay for someone to do it; I think people will see it as a thing for the far-off future".* [FG1].

The maintenance concerns were rooted in the worries of costs of repairs to city wide technologies in case of faults and errors which strongly linked to the worries students in the focus groups expressed about dependence on technology, especially on a city level: “If one grid goes down, that’s the whole of Manchester”. [FG4]. Noted in relation to dependency, addictiveness to smart technology emerged as a concern in 4 of the 8 focus groups with one student relating the concern to “the amount of time people spend logged in”[FG6], with another asking: “why does everything have to be blinded with technology?”[FG3]. Other students linked it to reduced or complete lack of human to human communication:

> *“People just become so wrapped up in the technological world. Nobody smiles at each other anymore”*. [FG4].

Students in the focus groups further expressed concerns around these forms of dystopian futures by relating them to the socio-economic consequences of increased automation: “We’re taking away people’s life skills by having everything on a phone”[FG4], further linking this to employment:

> *"New technology seem to be replacing things, like artificial intelligence and self-driving cars, it will become a point where the city becomes so automated that people start losing jobs".* [FG1].

Coupled with some of those other comments demonstrated in this section mentioning sci-fi and flying cars, this emphasized a strong sense of dystopic visions associated with the smart city concept.

When discussing this modern dependence on technology, students strongly associated this with another related issue:

> *"There is a wider ethical situation where you cannot be a human being without being active online anymore. You don't exist if you don't have an email account. You can't be a human being anymore without submitting to these companies".* [FG4].

Concerns also related to exclusion and inequalities. Whilst, the students in FG7 referred to the issue in a broader sense: "Inequalities are already existing, but it [the smart city] exasperates them"[FG7], students in FG1 and FG2 identified in particular three groups of people they were worried for: the elderly, the homeless and those with low income. In the latter two focus groups, students frequently mentioned the older generation when illustrating examples of exclusions in the smart city:

> *"…like my granddad he doesn't know what google is, or smart phones or smart meters. He would be completely baffled with all of this and not leave his house and think the world had flying cars and that".* [FG1].

Homelessness was referred to as an unresolved, underlying urban issue that the students believed the smart city failed to address:

> *"I can't believe we can't afford to keep homeless people off the streets, but we can afford to put TV screens into buildings. For me a smart city should be everybody working cohesively, receiving the same standard of care, rather than having a big technological thing".* [FG4].

This was something that the students felt strongly about, with one rhetorically questioning the priorities of smart city initiatives:

> *"What is important, solving the homeless issue or putting loads of effort into making everything greener?"* [FG1].

On the contrary, students also argued that the type of hegemonic pro-environmental enforcement of priorities as illustrated in the above comment would be met with resistance from citizens: "I feel like this reluctance to change is one of the main barriers"[FG1]. Additionally, two students argued that due to "austerity and cuts"[FG7] the smart city "might not reach its full potential"[FG7] and that citizens would not consider the concept viable:

> *"I don't think a lot of people think it's viable, I think it's too much technological integration on such a high level"*. [FG1].

Majority of students in the focus groups stated that they had never heard of the smart city and that it was hard to relate to the concept:

> *"I think because people can't see it, they do expect it to be like flying cars".* [FG1].

Students also pointed out that the concept lacked visibility. Therefore, discussions in the focus groups reflected on how smart city initiatives could make citizens more aware of the smart city through advertisement and campaigns on social media and public transport.

7.5 Chapter Summary

The Innovation Challenge demonstrated three overarching elements for a smart solution to encourage students to conserve energy: visual cues, contextual information and challenge. These factors were strongly reiterated in the focus groups, with particular emphasis placed on educational aspects they believed were required in order for students to engage. The latter was emphasised due to students arguing that whilst they thought conserving energy is important, they needed more information about how to do this. Additionally, challenges such as competitions with rewards as incentives were highly desired and suggested as a way of overcoming the MOH barrier and lack of concern about climate change for some students.

Similar to findings from Chapter 5, majority of students were not aware about the smart city and deemed it an invisible concept. Temporal aspects of the smart city were reiterated in the focus groups, with 'smart' being associated with futuristic and advanced technology. They were also concerned the concept would overlook underlying urban issues and promote inequalities. Moreover, the students demonstrated a clear privacy paradox as they expressed privacy concerns but argued that the desire to have various apps were stronger than these concerns. There was general consensus of acceptance that in order to be part of today's society, privacy had to be exchanged for products and services.

As illustrated in Figure 7.5, saturation was reached in the sixth focus group. The following chapter presents the overall discussions of the results of this research and links it to broader context and academic literature.

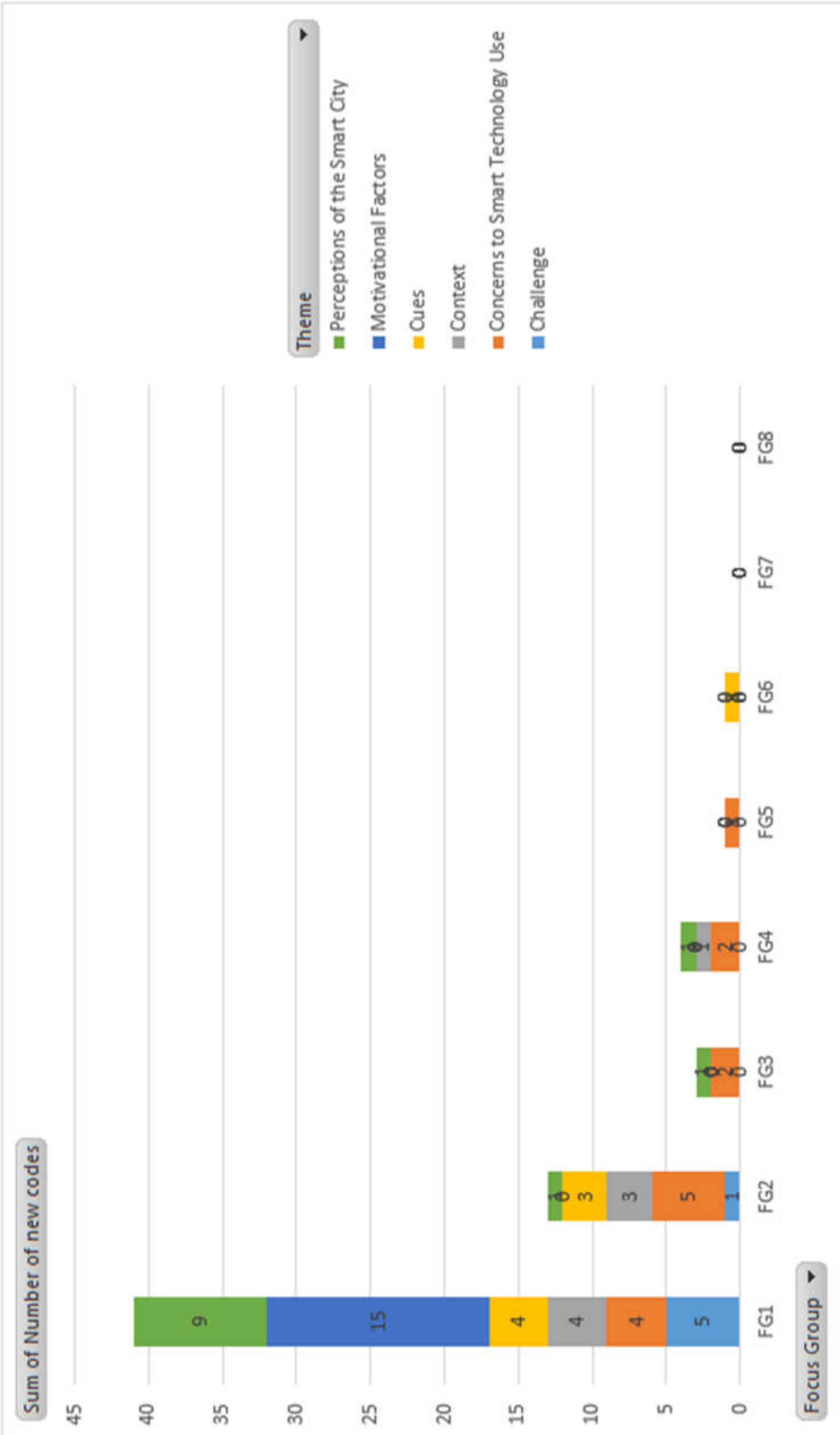

Figure 7.5. Number of New Codes Emerging in each Focus Group

Chapter 8. Discussions

8.1 Chapter Outline

This research has sought to critically analyse the socio-technical challenges to smart city implementations and aspirations. This chapter presents triangulation of the results and discusses these against the broader context of the published literature. Firstly, the chapter discusses stakeholders' contesting perceptions of 'smart' in Section 8.2. Thereafter, it discusses the identified perceptions of the role of the citizen in smart cities in Section 8.3. Section 8.4 discusses the findings for a potential smart solution to overcome the energy saving challenges in the split incentive scenario in Birley Student Living (BSL).

8.2 Contesting Perceptions of 'Smart'

8.2.1 Definitions of the Smart City

Technology at Heart

Over the course of this research, it became evident that the term 'smart' had different meanings to different people. However, whilst contrasting notions emerged, it was clear that technology was the central association with the term for both students and smart city implementers. Although, students' and implementers' understanding of what the aim of these technological applications in smart cities is diverged. Notions were mirrored in the typology (Figure 2.1, Chapter 2, Section 2.8.1) demonstrated by Giffinger and Gudrun (2010) where the smart city contains a range of characteristics throughout several domains. Nevertheless, whilst characteristics described by stakeholders were bound within these domains, it was clear that 'smart' was different across and within them, depending on the individual associations with the term.

This research found that students associated the concept with reduction in energy consumption and increased energy efficiency, closely followed by improved environmental protection. Whilst energy conservation and efficiency are widely accepted benefits of the smart city (Caragliu et al., 2015; Belanche et al., 2016), urban digitalisation has been critiqued for only paying superficial attention to environmental protection (Martin et al., 2018). The literature extends this critique further by arguing that the smart city is a form of greenwashing, misleading citizens to think the concept protects the environment (Viitaen and Kingston, 2014). Given the dominant environmental overtones demonstrated in the students' perceptions, these are conceptually different to the smart city and more aligned with concepts such as green and eco-cities (de Jong et al., 2015). This suggests that despite placing technology at the heart of their understandings of the concept, students' associations potentially represent a much stronger eco-centric view of the smart city than what the concept is prepared to deliver (Martin et al., 2018).

Implementers on the other hand were adamant technology could facilitate increased quality of life for citizens. This was interesting as smart city initiatives are frequently critiqued for not considering citizens (Cardullo and Kitchin, 2018a; b). Although the implementers seemed to conceptualise the smart city in a stronger citizen-centric manner than most definitions in the literature (de Jong et al., 2015), there was strong consensus of technological solutionism. Only in a minority of studies (cf. Rios, 2008) has the smart city been defined in a wholly citizen-centric fashion by placing emphasis on cultural and knowledge exchange rather than technology. Conversely, the implementers' understandings converged with technology intensive strategies in smart cities (McFarlane and Söderström, 2017), arguing citizens' lives will be better with more technologies. This suggests that whilst the implementers do promote citizens in their understandings of the smart city, technology is perceived as the problem solver.

Lack of Public Awareness

Despite implementers adamantly arguing that the smart city is about its inhabitants, this research found extremely low awareness about the concept amongst student citizens. Two thirds of the students surveyed were unfamiliar with the smart city and citizens were only included in their understandings of the concept by a minority. Low awareness amongst citizens was also found by one other study (Thomas et al., 2016), however this research demonstrated that student citizens specifically lack awareness through a much larger sample. To elucidate this issue, implementers explained that the phrase smart city is a jarganistic shorthand that has increasingly become a meaningless buzzword. They further argued that it has dominantly been defined and over-used by the industry to push technocratic agendas. Students in the focus groups agreed with this. Together, this converges with the literature as critiques state that corporate organisations mask their agendas as 'smart' in order to obtain funding (Luque et al., 2014; Söderström et al., 2014).

Moreover, Hollands (2008) points out that developing such buzzwords is a problematic side of urban labelling as practical implications of policies drown in the images and visions associated with the term. Additionally, misinterpretations of the concept can lead to policies not translating into practice (Wiig, 2015). This demonstrates how the term 'smart' therefore creates disconnect between reality and imaginaries and stimulates various problematic conceptions about the concept.

These conceptions were evident amongst students throughout this research as both utopian and dystopian visions were associated with the term 'smart'. Students frequently described the smart city as connected and efficient with zero emissions, protecting the environment using advanced and automated technologies. Following Holland's (2008) argument, these notions depicting a utopic urban environment is highly problematic as the technological fetishism can distract the attention away from solving urban problems (Townsend, 2013; Grossi and Pianezzi, 2017). Finding that 'smart' prompts utopian visions amongst students, even in those unfamiliar with the concept, fuels the argument that IT corporations deliberately use the term to create these imaginaries. This in turn draws attention away from contesting concepts in order to dominate the urban sustainability discourse (Luque et al., 2014; Valdez et al., 2018). On the contrary, dystopian visions described by the students portrayed a concerning future of technological singularity where artificial intelligence (AI) would take over, and the rise of the machines in true Terminator style would ultimately result in losing sight of the human (Kurzweil, 2005). These dystopic notions are mirrored in the critical literature, and scholars argue that frontiers of the concrete utopias attempt to brush them off as misconceptions and stigma (Winner, 1997; Vanolo, 2016). This suggests that 'smart' may not be a suitable prefix to describe the concept as this research has shown it is clearly laden with ambiguity and provokes contesting and concerning imaginaries.

Throughout this research the terminology debate was evident as both students and implementers identified alternative terminologies to 'smart'. By referring to the 'modern city', 'future city', 'eco city', 'sustainable city', 'efficient city', and 'digital city', stakeholders suggested terms they believed better described the aims of the concept, arguing these words promoted a more tangible, relatable and real vision for the agenda. However, the literature argues that underlying characteristics of the smart city resembles a new version of the 'entrepreneurial city' (Hollands, 2014; Datta, 2015; McFarlane and Söderström, 2017; Martin et al., 2018). Through using the smart city concept to compete on the market, Hollands (2014) illustrates how corporations and entrepreneurial city leaders drive urban governance in their favour, leaving little consideration for the 'ordinary' public. This shows that although the 'smart' label is ambiguous, it is extremely powerful in shaping contemporary urbanism (Shelton et al., 2014). This research has illustrated citizens' understanding of the term and calls for their perceptions to be included in order to produce more inclusive and transparent urban agendas (Neirotti et al., 2014).

Spatio-temporal Challenges

From the interviews with implementers it was evident that requirements as to what 'smart' should constitute changed across spatial scales. They pointed out that smart solutions may be implemented and replicated in unsuitable areas, thus not meet the needs of the citizens. Therefore, what is 'smart' for citizens in one area, may not be 'smart' in another. This aligns Hollands (2008) who clearly states that 'smart' for one city is not 'smart' for another. Similarly, Angelidou (2014) points out that replication of technological solutions risks failure due to not being suitable for other cities. This was exemplified by the implementer elaborating on the cycling scheme in Manchester that failed due to not engaging with the needs of the citizens (Chapter 4, Section 4.7). Conversely, other implementers argued that 'smart' requirements may change spatially due to socio-economic factors. For example, less affluent areas or areas with poor broadband penetration will have different requirements for 'smartness' than affluent and technologically enabled areas. Therefore, mitigating various public needs is vital when defining 'smart', however, these needs are vastly decided by spatially generated big data and the companies that implement solutions (Pires et al., 2017). This has been one of the driving arguments for critics calling for a more bottom-up smart city where citizens co-define the problems and solutions (Leszczynski, 2016; Shelton et al., 2015; Pires et al., 2017; Cardullo and Kitchin, 2018a).

Regardless of how their perceptions diverged, both students and stakeholders frequently described temporal dimensions of the smart city. In this regard, the research revealed a clear disconnect between stakeholders as students envisioned the smart city as modern, futuristic and advanced, whilst implementers stressed that citizens needed to see that the smart city is happening in the present. However, Datta (2017:22) argue that "smart cities claim to deal with the present by seizing the future". This in turn relieves smart city implementers of the accountability of outputs as the future is not measurable. Therefore, by using the 'smart' label to promote urban utopias, it has created an understanding amongst the public that the smart city is a concept of the future. Interestingly, implementers found this particularly challenging in relation to engagement as time had to be spent myth busting and familiarising citizens with the actual agendas of the smart city. However, implementers also noted temporal aspects of 'smart' in relation to technological acceleration and by arguing that the meaning of 'smart' would evolve with time (Kitchin, 2019). Examination of temporal aspects of the smart city is limited and have mostly been noted in relation to big and real-time data (Bowker, 2005; Coletta and Kitchin, 2017). However, Kitchin (2019) initiated a new branch of smart city discourse demonstrating that smart cities mediate and are mediated by various temporal relations, rhythms and modalities. As temporalities affect perceptions of place and space (Laclau, 1990; Massey, 1992; Edensor, 2012), this suggests that moving towards a spatio-temporal understanding of the concept could contribute to a more citizen-centric smart city. Especially as the temporal notions identified in this research are evidently feeding into challenging technocratic utopic and dystopic imaginaries (Grossi and Pianezzi, 2017).

Summary

'Smart' remains laden with ambiguity and a wide array of connotations, more so from a citizen perspective. However, it is a powerful prefix that defines contemporary urban agendas. As seen throughout the above sections, perceptions of 'smart' pose spatio-temporal challenges. Through the continuous promotion of the smart city as a utopian concept, this research found that dominating definitions are creating challenges in shifting towards a citizen-centric smart city. Yet, by enabling citizens to partake in defining the smart city, paying particular attention to their temporal notions, this could potentially aid this shift.

8.2.2 Benefits and Aspirations to the Smart City

Citizens and the Environment

This research found that the students and implementers mostly identified the same range of benefits with the smart city. However, whilst the students noted environmental improvements as the number one benefit, the implementers ranked delivery of environmental benefits and increased wellbeing for citizens equally. This converges with benefits outlined in the literature as it states the concept promises both environmental benefits and increased quality of life for citizens (Nam and Pardo, 2011; Gabrys, 2014; Caragliu et al., 2015; de Jong et al., 2015). However, a minority of students highlighted a disbelief in the promised environmental benefits by explaining that a high-tech city would worsen the issues and use more resources and energy. This converges with critical literature stating that the environmental impacts of ICT require more attention in form of for example Life Cycle Assessments (Hilty et al., 2014; Börjesson Rivera et al., 2014). The smart city aims to maximise the efficiency of urban systems (Caragliu et al., 2011) and this emerged as a clear pattern amongst both stakeholder groups. However, Luque et al. (2014) point out that these benefits are often not realised. Further, they argue that economic savings often take priority over social benefits. Implementers clearly highlighted that the smart city would bring monetary savings, but they were adamant that benefits to the citizens were more important. This diverges from another case study of Seattle that found service improvements and cost savings to be the top perceived benefits by city officials, and prioritisation of citizens were low (AlAwadhi and Scholl, 2013). However, this divergence may elucidate the differences in perceptions of 'smart' between cities.

Although the majority of students did not identify citizens in their understanding of the smart city, they did so when describing smart technologies by stating how they should benefit the person using it, and some when expressing perceived benefits of the smart city. This suggests the students struggled to translate their understanding of 'smart' from individual technologies to a broader conceptualisation of the smart city. In turn, this demonstrates a broader disconnect between understanding the implications of use of individual technology to a city level. This issue has been demonstrated in assorted socio-technical systems where the system produces desired outputs without end-users being aware of why (Harrison and Donnelly, 2011). Implementers commented on this and explained that individual technologies are tangible and visible, but that smart city solutions are more abstract and invisible (Janssen and Kuk, 2016). As stated by implementers, a lot of the smart city operations run in the background. This therefore suggests that students are not translating their understandings from individual technologies to a city level due to their lack of awareness of the concept.

The Future Smart City

In the interviews, the implementers clearly outlined two overarching aspirations for the future smart city: increased focus on citizens and environmental improvements. In relation to the environment, reduced energy consumption and lower emissions emerged as the main targets. As for the citizens, implementers argued that deployed technologies should adapt more to the needs of the citizens and that citizens should be more involved in smart city developments. Whilst the literature critiques the technologies deployed within the smart city for not serving the needs of the citizens (Greenfield, 2013), it also urges increased citizen involvement in order to produce technologies to accommodate needs (Cardullo and Kitchin, 2018a). Nevertheless, critics state that the undying need to solve problems with technology could only result in major socio-geographical consequences and unevenness (Harvey, 2003). This contributes to further question who the smart city is for and whose needs these smart agendas will meet (Viitaen and Kingston, 2014; Vanolo, 2016).

Summary

Environmental benefits and improvements to citizen wellbeing were the two overarching benefits highlighted by stakeholders. However, students struggled to translate their understandings from individual technologies and to a city level as they only identified benefits to people in relation to technologies and not the smart city concept. Additionally, there is a critical question as to who will benefit from the smart city (Willis, 2019).

8.2.3 Concerns Regarding the Smart City

Privacy and Security

From expressing uneasiness about collection of personal data, monitoring, hacking and security breaches, students clearly identified privacy and security as their two highest concerns regarding the smart city. This strongly converges with the literature as these are, perhaps, *the* most critiqued aspects of the concept (Graham and Wood, 2003; Wood and Webster, 2010; Batty, 2013; Martinez-Balleste et al., 2014; Kitchin and Lauriault, 2015; van Zoonen, 2016; Kitchin, 2016). However, the results from this research showed a clear but problematic connection between students' attitudes towards privacy and security, and their actual behaviour. Whilst the majority of both the students and implementers reported privacy and security related concerns, their levels of concern fluctuated. Particularly for students, a high level of concern did not necessarily result in a reticence or resistance to actually using smart technology. Initially identified in the student survey, students in the focus groups repeatedly explicated that although they were concerned about their privacy, they were not likely to alter their technological behaviour as a result. This was mainly due to an overarching desire to have the benefits offered by smart technologies. This resonates with Lim et al. (2018) who found that citizens were concerned about their privacy, however, they were receptive towards it due to the services offered by engaging with smart technologies. These findings suggest that a disconnection between concerns about privacy and actual behaviour in response to these concerns exist (cf. Kokolakis, 2017).

Furthermore, the vast majority of students also admitted that they do not read terms and conditions (T&C). Their desire to receive the benefits from apps drove them to agree to T&C, even if they felt uncomfortable with the points within them. Therefore, coupled with the findings discussed in the above section, these results strengthen the clear differentiation between concerns and behaviours for both stakeholder groups, summarising a 'privacy paradox' (Norberg et al., 2007; Barth and de Jong, 2017). Students' privacy concerns therefore aligned with van Zoonen (2016) privacy framework which hypothesises that concerns depend on type of data that is collected and purpose for that data collection. Students reported specific data they found more private than others and that they would not mind giving up data if they knew about and agreed with the intended use of it.

It is important to note that data related concerns stretched beyond that of privacy and security as several social implications of implementing the smart city was identified. Implementers spoken to in the study argued a certain discomfort regarding the rapid, unnecessary smartification of urban spaces representing technological determinism (Pasquale, 2015). However, they firmly believed that technology could solve urban problems. The concerns expressed by the stakeholders align with those in the intensifying discourse about how smart cities are leading data driven governmentalities, depleting cultural factors, thus consequently challenging democracy (Leszczynski, 2016). Vanolo (2014) argues that smart technology and collection of big data facilitate 'smartmentality'; a new way of controlling citizens through nudging and subconsciously altering their behaviour. Several students in the focus groups expressed a particular worry regarding targeted advertising in the dawn of the Cambridge Analytica/Facebook scandal as this gained wide media coverage at the time of this research (Cadwalladr and Graham-

Harrison, 2018). However, it is debated that this form of advertisement is subconsciously affecting behaviour and desires as well as opinions (Kitchin et al., 2017). This in turn stresses the importance of unclogging the black boxes of big data to ensure transparency (Bunge, 1963; Pasquale, 2015). Black boxing in smart cities has been identified as a major problem and barrier to engagement (Ma and Lam, 2019). However, Ma and Lam (2019:37) recognise barriers to openness and transparency: "legal and licensing, technical and operational, use level, institutional and governance, economic aspects". Additionally, Janssen and Kuk (2016) argue that openness and transparency do not necessarily result in better public understanding of algorithmic governance. This, therefore, suggests that whilst making smart cities more transparent, an approach whereby citizens truly understand how their data are used is vital in order to ensure democracy.

In contrast, other students reported low levels of concern about privacy due to three main reasons. *First*, the students stating low concerns said they had nothing to hide. *Second*, the students described well known apps from the app store, such as major social networking apps, as safe which echoes findings from studies by Shklovski et al. (2014) and Gu et al. (2017) who found that trust in apps resulted in lower privacy concerns. *Third*, students felt in control of their data. Whilst studies such as Batty (2012) and Kitchin (2013) warn that ownership and control over personal data pose problems in smart cities, the students in the focus groups indicated that they in fact felt in control of their own data due to being able to disable access from apps or because they understood why it asked for access to certain data. Providing a justification for why apps want access to various data has also been found to lower privacy concerns (Gu et al., 2017).

Several implementers also highlighted privacy as a concern (albeit when prompted to think about it), but emphasised that despite that, their level of concern was generally low. The consensus was that privacy is protected and that data collection is crucial as it provides benefits in form of public services. Implementers further argued they believed that citizens were not and should not be concerned about privacy. However, this is problematic in two ways: first, the implementers are projecting their own beliefs onto the citizens, and second, students are in fact concerned about their privacy, yet willing to yield to trade-offs due to benefits. As noted by Ross et al. (1977) false consensus such as this can create problems. In this case, it is risking privacy not being appropriately addressed as citizens are willing to exchange privacy for services which is ethically questionable. Therefore, the results show that whilst privacy is a noted concern, it is an accepted part of modern society (Shklovski et al., 2014). End-users are willing to exchange their data in order to participate in society as the majority perceive the benefits to outweigh the consequences.

Societal Consequences

The students identified two overarching yet interrelated concerns in relation to the balance between humans and technology. They felt uneasy about the dependency on technology and potential consequences any disruptions or errors could have. Yet, smart city technologies are attempting to improve resilience of infrastructural systems (Taylor Buck and While, 2017). However, when whole urban systems become dependent on this technology, cities can be perceived as vulnerable, especially with recent events in mind such as the hacking of the power grids in Kiev (Kshetri and Voas, 2017). In contrast, Batty (2013) argues that utilisation of big data can in fact more easily detect errors in the system. The latter was also argued by the implementers, however, in response to the concerns, they called for greater resilience of these systems. Nonetheless, the implementers raised concerns regarding unnecessary smartification of urban spaces where traditional operations are functioning sufficiently. Whilst this can boost the efficiency of the urban systems (Caragliu et al., 2011), both stakeholder groups repeatedly articulated these notions regarding consequences of technology replacing humans. This therefore suggests that whilst smart technologies can provide greater efficiency and assist detecting system faults, there is uneasiness amongst stakeholders about the magnitude of dependency of technology in case of major errors.

It was evident that both stakeholder groups felt uneasy about the problematic scenarios ‘smart’ and, arguably, disruptive, technologies embody. This corresponds with the range of concerns identified about how technology would affect human life in the future which they described in various dystopian scenarios. First identified in the student survey, these dystopian visions were elevated in the focus groups where students elaborated on the socio-economic implications of the increased automation witnessed in today’s urban systems (Vanolo, 2016). Implementers complimented these concerns by discussing how the demand for automation was driven by contemporary technological fetishism and solutionism (Harvey, 2003; Söderström et al., 2014). There were genuine concerns identified amongst the students regarding losing sight of the human and ‘the rise of the machines’ where imaginaries involved AI taking over. Softer visions involved less human control and reduced physical activity. The latter was also addressed by implementers who stated worries around the end of using city centres as meeting places for interactions due to technology. Collectively, these dystopic imaginaries are echoed in Vanolo (2016) where scenarios in which the city have no place for its citizens are described. Additionally, it is crucial to consider Greenfield's (2013) argument that smart cities in fact fail to meet the needs and interests of its citizens. For example, students and implementers commonly identified efficiency as a benefit to the smart city, however, this can in turn limit the focus on safeguarding socio-cultural values (Angelidou, 2014). This demonstrates how the dystopian visions should not be brushed off as misconceptions as they are genuine concerns amongst the public, clearly produced through the industry's use of the 'smart' label.

Furthermore, both students and implementers expressed worries regarding underlying urban issues such as inequalities and exclusion and how the smart city fail to address these challenges. Some implementers defended the concept by suggesting it may assist in mapping out some of these issues such as fuel poverty. That said, though, both students and implementers stressed comparable concerns by arguing that a knowledge and wealth gap creates complex accessibility problems to smart technology, leading certain groups of people to be marginalised in the smart city (Willis, 2019). This links to the digital divide concerns associated with the concept whereby some groups of citizens are not 'connected', thus are unrepresented in big data sets and by extension are not able to access benefits of the smart city (Partridge, 2004). Social and spatial inequalities - especially in terms of poverty and deprivation - have often been overlooked in smart city debates (Viitaen and Kingston, 2014; Shelton and Lodato, 2019), yet they were notable concerns amongst both students and implementers. The ability to afford the technology that allows participation in the smart city was identified as a concern and especially students worried this would create a greater gap between the rich and poor, leading some to argue that city officials should work on solving poverty over investing in new technologies and ICTs. The affordability of technologies is a consistent concern and critique of the contemporary technology driven society, causing great worries regarding unevenness (Harvey, 2003). These findings therefore highlight that whilst citizens perceive smart cities to deliver environmental benefits, they also call for greater attention to the prioritisation of socio-economic issues.

Summary

In summary, concerns surrounding smartification and speculative futures are evident amongst both students and implementers. Coupled with the strong concerns regarding privacy, this raises problematic imaginaries where ethical questions surrounding lack of personal freedom is a centralised concern (Kitchin, 2016). Additionally, this research has highlighted ethical concerns among students and implementers, raising critical questions regarding the role citizens will play in smart urban futures. These concerns align with the repeated question as to who the smart city is for, and who gets left behind (Viiitaen and Kingston, 2015; Engelbert et al., 2018; Willis, 2019).

8.3 Citizens' Role in the Smart City

8.3.1 The Smart Citizen

Who is the Smart Citizen?

Following the concerns discussed in 8.2.3, perceptions suggested that the smart city is for someone who is techno-literate with the ability to afford technology, and willing to exchange their privacy for public benefits. However, when describing a 'smart citizen' implementers of the smart city downplayed these perceptions. Whilst the phrase 'smart citizen' was not frequently used by smart city implementers, they expressed notions around the characteristics of what they believed made a citizen 'smart'. Characteristics mainly mirrored implementers' perceived role of citizens in smart cities. These ranged from basic end-users of technology, to co-creators and empowered citizens. However, only a minority of implementers framed the citizens within the latter two categories. The majority described smart citizens as being aware of urban public services and understanding the benefits offered by technology. Additionally, they described the smart citizen as someone who is open to changes proposed to them and as early adopters of technology on the market.

The Role of the Smart Citizen

There was a confusing connection between implementers' associations of a more citizen-centric smart city and their favouring of less human interaction. When describing their aspirations for the smart city, the majority of implementers rooted for a more citizen-centric agenda. However, interestingly, when describing a smart technology, it became evident that implementers believed human control over these technologies should be minimized. Whilst the research found that students understood smart technology as a technology that should benefit people, they too described 'smart' as a technology that requires less human interaction. However, as opposed to the implementers who explained this automation and increased automation as a beneficial outcome, less human control was associated with concerns for the students. Although this concern was shared by a minority of implementers, the vast majority favoured less human interaction. These concerns were mirrored in the dystopian imaginaries discussed in Section 8.2.3 (Vanolo, 2016). Therefore, smart technologies were strongly associated with humans-off-the-loop (Coletta and Kitchin, 2017). In-the-loop refers to that the human is in control of the technology and makes the decisions, on-the-loop refers to the technology operating automatically, but is being overseen by a human who can interfere with the decision making, and off-the-loop refers to the technology system operating independently without any human interaction (as described in Chapter 2, Section 2.10.1). With increasing humans-off-the-loop technologies, algorithmic governance is progressively altering the rhythms and temporalities of urban spaces (Pasquale, 2015; Coletta and Kitchin, 2017). As humans then will have less opportunities to intervene in these processes, automated decision making will dominate urban spaces, creating blurry lines regarding accountability of decisions.

Following this, the students reported extremely low awareness of the term Internet of Things (IoT). Whilst IoT was strongly associated with connectivity to the internet and between devices, the majority of students iterating this were familiar with the term. Those not familiar with the term described IoT as information and 'things' on the internet. However, this low awareness may suggest that the vast majority of students have no power in changing these data-driven governmentalities as 'ordinary citizens' due to not being in professional roles or position of knowledge facilitating this. This in turn demands increased transparency of these systems with the opportunity to peek inside the "black-box". Coletta and Kitchin (2017:14) found that "within automated systems, the rules for acting on data and making decisions is largely black-boxed, especially for ordinary citizens". This quantification of urban spaces remains subjective to the algorithms programmed by large technology companies (Boyd and Crawford, 2012). Whilst open data platforms with solutions such as feedback loops can adjust some of the algorithms (Ma and Lam, 2019), citizen involvement is still limited (Cardullo and Kitchin, 2018a). This suggests that citizens become passive sensors that generate data in the smart city rather than empowered decision makers who drive change (Gabrys, 2014). The debate around the role of the citizen in the smart city has recently been given more attention in the academic discourse, with studies such as Shelton and Lodato (2019:14) arguing that "in practice, the 'actually existing smart citizen' might not actually exist at all".

Summary

The perceptions of smart citizens demonstrated by implementers suggests that citizens are mostly perceived as users of technology instead of decision makers. As Shelton and Lodato (2019) highlight, the role of the smart citizen in practice is ambivalent. However, through examining the notions of implementers, this research suggests that citizens are not actively partaking in smart city initiatives as aware and informed citizens.

8.3.2 Citizen Enactment in Smart City Developments

Throughout examples and narratives about how citizen engagement carried out by implementers, it became evident that citizen enactment in the smart city is patchy and does not provide them with leadership or positions of power. The majority of the academic literature calls for more citizen engagement due to this issue, but critics note that public and private actors use citizen engagement as a mask to further supress democracy and steer urban planning to meet their own agendas (Rosol, 2015). Additionally, through depicting smart utopias and Pires et al. (2017:4) state that:

> "To the extent that citizens welcome this vision and participate voluntarily in its realization, the urban data revolution is presented, often unproblematically, as a model of civic engagement".

A minority of implementers did in fact admit that citizen engagement is poorly carried out in practice. This claim is given stronger confidence by other studies arguing citizen engagement is not translating well from policy to practice (Wiig, 2015). Meanwhile, implementers described instructional approaches as well as examples from campaigns and workshops to draw a distinction between communications and engagement, stating that making citizens aware of the smart city is not equal to engaging them. Simultaneously, citizens were also described as end-users or consumers whose needs were required to be met. This resonates with Cardullo and Kitchin (2018b) who argue that contemporary models of the smart city misconstrue citizen-centric visions through neo-liberal practices and civic paternalism which fundamentally aim to fuel technological solutionism.

The research did, however, find that implementers' perceived role of citizens was contesting as they argued that citizens should be more involved in some situations than others. This was particularly evident when implementers described solutions that were aimed to improve citizens' lives versus more materialistic ones such as efficiency improvement of buildings. Nevertheless, these findings demonstrate a clear disconnection with implementers' aspirations of future citizen-centric smart cities as it is highly debateable whether this type of participation is in fact bottom-up. The citizen-centric smart city described by implementers are in line with technological solutionism and tokenistic rhetoric which diverges from what the literature describes as a true bottom-up and co-created smart city model (Cardullo and Kitchin, 2018a; Engelbert et al., 2019).

However, recent studies challenge the technocratic critiques of the smart city, demonstrating that, in several cases, smart city rhetoric has in fact shifted toward citizen-centric agendas (Cowley et al., 2018; Cowley and Caprotti, 2019). Despite, adamantly arguing for their approaches to citizen engagement, the implementers' notions diverged from these studies as a dominant top-down down vision of a smart city was described. Additionally, for a minority of implementers in this research, inclusivity was perceived to inhibit innovation, prompting them to openly favour a top-down approach for engagement. In reference to Cardullo and Kitchin's (2018a) reworked ladder of participation (described in Chapter 2, Section 2.10.1), implementers clearly expressed tokenistic and consumer related engagement strategies. This converged with Cardullo and Kitchin's (2018a) findings from a Dublin case study where tokenistic tendencies to citizen engagement were also dominant. This therefore challenges arguments suggesting that smart cities are in fact moving towards more citizen-centric visions. Together, this suggests that in order to ensure citizens' 'right to the smart city' and the required empowerment to drive or make changes in their cities, there needs to be a re-imagination of what makes a citizen 'smart' in a bottom-up approach (Cardullo and Kitchin, 2018a; Shelton and Lodato, 2019; Willis, 2019).

Summary

The research shows that the implementers do wish to move towards a citizen-centric smart city. However, their description of citizen engagement in the smart city, and their problematic characterisation of bottom-up approaches require attention before this can happen. These findings converge with Engelbert et al., (2019:352) who state:

> "…contemporary imaginations of the smart city, as well-intended as they might be, are still cultivating a top-down version of citizen participation and are excluding the interests and perspectives of citizens".

Therefore, in order to ensure citizens 'right to the smart city', there is a need to move forward from the tokenistic citizen engagement that is being described and pay more attention to the role of the 'smart' citizen (Cardullo and Kitchin, 2018a; Shelton and Lodato, 2019).

8.3.3 Barriers to a Citizen-Centric Smart City

Awareness

Throughout this research, lack of public awareness was identified as a significant barrier to implementation as it causes difficulties for citizen engagement. Given the low awareness amongst students, it amplifies the argument that citizens are passive participants in the smart city by engaging with individual technologies collecting big data without their awareness (Gabrys, 2014). Referring to the privacy paradox identified in 8.2.3, there is a clear issue between citizens wanting the benefits of the technologies available and making informed decisions as part of urban agendas. Additionally, it highlights the way in which implementers referred to technology adoption as civic engagement as problematic. This research suggests that there is a need to raise initial awareness of the concept amongst the public in order to move past the more passive forms of participation in the smart city.

Implementers also highlighted that due to many competing urban agendas the citizens were presented with mixed messages and information (Luque et al., 2014; Taylor Buck and While, 2017). The students also argued that the smart city is 'invisible', fuelling the utopic and dystopic associations with the concept as it becomes more difficult to relate to it as a concept taking place in present time. This was particularly evident as when students highlighted environmental benefits as the main output of smart cities, they simultaneously demonstrated a clear disbelief in the concept's viability due to being highly technical and questioned the concept's effectiveness long term. Implementers stated that in order to raise awareness, smart initiatives must be clear about the benefits of implementations and effectively communicate these to the citizens. However, this brings back the argument that whilst the implementations may be perceived as a benefit to those who implement them, the citizens should judge whether it actually addresses their needs (Pires et al., 2017).

On the other hand, implementers noted the possibility that not all citizens wish to get involved. Additionally, they proposed the possibly that only the 'already engaged' citizens participated, representing the interests of a minority of the citizens. This converges with the literature arguing that 'do-it-yourself urbanists' are potentially those with the most 'right to the city', although, it is debatable whether this form of participation is more democratic (Iveson, 2013). Citizens may have different perceptions as to what the urban problems in their areas are, and what the solutions should be (Kokx and van Kempen, 2010). Therefore, if all views are not considered, it poses barriers to a holistic smart city and may cause exclusions (Engelbert et al., 2019). Subsequently, students highlighted citizen engagement as a concern, articulating that whilst they perceived it as the key to successful implementation of the concept, people would not adopt the technologies if they did not appeal to their needs. Students from the focus group therefore expressed a strong interest in co-creating solutions to problems relevant to them, arguing these would possibly be more effective due to sharing identity with the target end-users. Therefore, the smart city discourse should continue to push for an environment where stakeholders, including the citizens, come together and co-create solutions to urban problems that suits the needs of the citizens (Letaifa, 2015; Voytenko et al., 2016).

Local Challenges, Local Solutions

Given this context, implementers argued that devolution to local authorities could potentially facilitate more citizen-centric smart cities by enabling tailored solutions for local communities where cultural factors are considered and co-creational approaches could be explored. This is strongly critiqued by the literature as scholars argue the concept uses devolution as a disguise to give more power to large technology companies that maximise their profit through standardised technological solutions and policies that do not improve the quality of life of citizens (Shelton and Lodato, 2019). In contrast, Marxist critiques of this neo-liberal approach to urbanism underlines that large-scale issues, such as those the smart city aspire to tackle, are best solved when power is centralised (Harvey, 2012). However, in order to centralise power, it requires a certain level of determination within agendas whereas smart city solutions still require trialling and testing before benefits are realised (Luque et al., 2014). Moreover, centralising power may supress local innovation. Nevertheless, due to funding issues and austerity, implementers also stated that with devolution, goals would be difficult to achieve as cities have limited financial abilities to make upfront investments.

Cost and Time

Cost was identified as the main barrier to implementation by both students and implementers, with implementers emphasising it as the main obstacle to implementing a citizen-centric smart city. As funding is associated with deliverables, it limits the adaptability of projects and often ends in shortfalls for prioritisation of citizen engagement (Cardullo and Kitchin, 2018b). Therefore, several implementers placed the responsibility of citizen engagement on large IT corporations as local authorities struggle financially. From the student perspective, the cost of implementation was highly concerning as they argued the money may be better spent elsewhere. Students also reiterated their concerns regarding the affordability of technologies required to participate in the smart city (Harvey, 2003). Cost has been highlighted as one of the central issues of developing new smart cities in the literature, emphasising that it requires large investments from both public and private actors (Angelidou, 2014). Implementers further argued that due to the limited timescales of smart city projects, it is difficult to accommodate citizen participation events and trials on a frequent basis. Coupled with the financial barriers to implantation of a citizen-centric smart city, prioritisation of the citizens appears less important in these public-private partnerships of smart city developments. Therefore, the worries expressed by students and implementers are highly relevant as these developments promote new forms of neo-liberal urbanism (Shelton and Lodato, 2019). Whilst it can form new partnerships that produce innovation (Angelidou, 2014), it draws the attention away from the importance of involving citizens in these developments.

Lack of Trust

Students also stated that policy makers and politicians did not share the view that citizen engagement is beneficial for successful implementation. Moreover, the lack of trust in politicians and companies was highlighted as a barrier to engagement by students, with the lack of trust in public actors also being experienced as a barrier to implementation by implementers. Implementers articulated frustration over how government-led initiatives were perceived as intrusive by citizens, making them resist participation. However, whilst this may be a prevention to engagement, it can be perceived as a rather dystopic scenario where totalitarian regimes force technocratic solutions on citizens, making smart cities a hegemonic concept (Vanolo, 2016).

Summary

Together, this suggests that whilst in theory, devolution of power to local governments could aid cities in meeting the needs of the citizens, there are both financial and broader neo-liberal barriers to implementing a more localised and citizen-centric smart city. Therefore, in addition to the increased theoretical attention to reimagining the smart citizen and citizen engagement, there is a need to address these practical barriers to moving towards a citizen-centric smart city (Cardullo and Kitchin, 2018b; Engelbert et al., 2019).

8.4 The Birley Student Living Smart Solution

8.4.1 Drivers for Energy Conservation

Concerns about Climate Change

This research found that the degree to which students were concerned about climate change depended on their awareness of the related environmental consequences. Although research addressing students' level of concern about climate change is limited, findings echo previous studies such as Cordero et al. (2008) who found that 80% of university students in their survey thought global warming was an urgent environmental concern. Additionally, Wachholz et al. (2014) illustrate that two thirds of the university students surveyed were very concerned about climate change. The student survey in this thesis demonstrated that the university was most powerful motivational actor encouraging to behave more environmentally friendly. On the contrary, politicians were perceived as the least motivating actor as they believed political leaders who are accountable for mitigation did not care about climate change issues (Gadenne et al., 2011).

However, students participating in the focus groups stated that climate change was hard to relate to as they felt the effects of it were not apparent to them. These notions, in addition to misconceptions about climate change, have caused scepticism in the past (Whitmarsh, 2011). Thus, students argued that there is a need to turn climate change into a tangible concept in order to take action towards preventing it (Spence et al., 2011; Weber and Stern, 2011). This aligned with findings from the student survey as results showed that understanding individual impact on the environment and the adverse effects of climate change motivated students to behave more environmentally friendly. However, whilst the findings from this research converge with the literature suggesting that knowledge and awareness of consequences of climate change influence environmental attitudes and concerns (Schwartz, 1968; Kollmuss and Agyeman, 2002; Whitmarsh, 2011), other studies suggest there is a major knowledge-action gap (Kollmuss and Agyeman, 2002; Wachholz et al., 2014). This therefore suggests that there is still some way to go for concerns regarding the environment to translate into sustainable living.

Attitudes towards Energy Conservation

Overall, this research found that students placed high importance on energy conservation. Although students in split incentive scenarios thought it was slightly less important than those with responsibility for bills, environmental motivations were identified as the main driver for energy conservation across all household backgrounds. Positive attitudes towards energy conservation have been found to predict energy reduction (Abrahamse and Steg, 2011). However, the students illustrated that their awareness of how to conserve energy and the efficiency of their energy behaviours could be higher. This suggests that although the students placed high importance on energy conservation, they may need assistance for this perceived importance to translate into sustainable practice. Furthermore, this research found that the more concerned students are about climate change, the more important they believed it is to save energy, emphasising the relationship between environmental attitudes and concern and energy usage. This resonates with the work of Whitmarsh and O'Neill (2010) who found that perceived personal importance of the issue of climate change was a significant predictor for energy conservation.

Relationships with NEP and Values

Despite research claiming that environmental attitudes and concerns play a lesser role in energy conservation than socio-demographic factors such as income and household size (Gatersleben et al., 2002; Abrahamse and Steg, 2011), this research found that these variables were strongly related to attitudes towards energy conservation. The students stating high concerns about climate change and those placing high importance on energy conservation demonstrated a significantly higher NEP score than those with lower concerns and perceived importance. In contrast, Whitmarsh and O'Neill (2010) found that pro-environmental self-identity was a more significant predictor for energy conservation than the NEP scale.

The student survey demonstrated that biospheric values significantly contributed to explaining higher levels of environmental concern and egoistic values explained lower concerns. This converges with other studies examining the relationship between value orientations and pro-environmental behaviour (cf. de Groot and Steg, 2007; 2008). However, although biospheric values contributed most significantly to explaining environmental attitudes and concerns, students tended to score highest on altruistic value items. This converges with Howell (2013) who found that whilst people rated the biospheric value item 'protecting the environment' highly, they tended to ascribe more strongly to an altruistic value orientation overall. Therefore, this could suggest that promotion of biospheric values may not be necessary in order to encourage energy conservation.

Similar to Ogunbode (2013), this survey found significant differences between students' academic disciplines, both in regard to environmental concerns and value orientations. Whilst physical science students demonstrated high environmental concern, engineering students scored lowest on the NEP scale. Architecture, creative arts and design students ascribed strongly to a biospheric value orientation, and students studying law, business and administrative ascribed highly to the egoistic values. This suggests that educational course background play a significant role in environmental attitudes and concerns.

Summary

Students' high concerns for climate change and perceived importance about conserving energy may translate into good energy behaviours. However, understandings of consequences of climate change were viewed as the most critical area of concern. Additionally, students explained that they could be more aware of ways to conserve energy in their households. Biospheric values also played an important role in attitudes and perceptions towards energy conservation. However, students ascribed more to altruistic values overall. Nonetheless, educational background played a significant role in these concerns and attitudes. Therefore, whilst concerns about climate change may drive perceived importance of energy conservation, the understanding of environmental issues is crucial.

8.4.2 The Beat the Peak App

Real-time Energy Information

Overall, this research found strong positive attitudes towards real-time energy information amongst the students surveyed and those participating in the focus groups. This aligns with Pepermans (2014) who investigated consumer attitudes towards engaging with smart meters and found that consumers were overall highly interested in monitoring their own consumption. Similarly, the students believed that it would be useful to know their real time energy consumption in order to manage it more efficiently and the vast majority believed it would encourage them to conserve energy. This aligns with the other studies that found that enabling students to see their real-time energy consumption did in fact reduce consumption in university halls of residence (Petersen et al., 2007; Chiang et al., 2014; van der Horst et al., 2015).

Although several students stated that it would be useful and encouraging to see their real-time energy in order to lower their bills, no significant differences in attitudes towards real-time energy information and household backgrounds were found. This suggests that despite studies suggesting financial drivers are highly important in lowering energy consumption (Abrahamse and Steg, 2011), seeing real-time energy information could potentially overcome situations such as split incentive scenarios where these drivers are eliminated. This was explained by students believing that seeing their real-energy consumption could help turn energy usage into a more tangible concept which would make them more inclined to change their behaviour. They also argued that it would be useful to see the immediate impact of their behaviour change as this could aid their understanding of individual behaviour on energy conservation (Froehlich et al., 2009). This suggests that real-time energy information can potentially contribute to overcome the barriers of energy invisibility (Stern and Aronson, 1984; Goodchild et al., 2017).

The survey revealed that those who already placed high importance on energy conservation, and those who are aware and energy efficient, found real-time energy information more useful and encouraging than those who reported lower importance, awareness and efficiency. Although, that said, the survey also found that those students surveyed with experience of real-time energy devices who reporting low level of encouragement did not frequently look at the energy information. However, students did highlight that real-time energy information in form of numbers may be a barrier to lowering their energy consumption as it lacks context (Fang and Hsu, 2010). This emphasises the need to couple the real-time energy information with more interactive modes of engagement (Petersen et al., 2007; Emeakaroha et al., 2014). Despite this research indicating positive attitudes towards real-time energy information, students who argued that if they were already doing everything they can, they would not find it useful. However, several additional factors were identified by the students for a potential smart solution for Birley Student Living (BSL) to encourage energy conservation, especially for those with lower environmental concerns.

Visual Cues

Throughout the research it became evident that students favoured various forms of intuitive visual feedback. Firstly, students argued that a creative design and the use of colours and the overall language used could encourage them to save energy. This converges with previous studies suggesting that visual feedback using technology can play a crucial role in successfully encourage energy conservation (Fang and Hsu, 2010). Although their solution was not technology based, Bekker et al. (2010) found that using visual prompts in forms of illustrating daily electricity savings did encourage energy conservation and that the students were positive to continue conserving energy post intervention.

However, students clearly articulated that interactive displays would be more engaging, therefore suggesting that a smart solution would be better than traditional methods. Research suggest that the use of ambient displays can create a buzz around the topic, which in turn could engage more people (Rogers et al., 2010). Additionally, the favouring of interactive technologies converges with previous studies that have utilised ambient displays and eco-visualisation and found these successful to prompt energy conservation (Odom et al., 2008; Fang and Hsu, 2010). Moreover, students suggested that the solution should send out reminders and notifications to perform tasks, and that it must be easy to use and interpret. The importance of ease of use and easy to interpret visual cues are mirrored in the literature (Venkatesh et al., 2003; Froehlich et al., 2009; Vine and Jones, 2016). However, use of nudging through ambient displays can be problematic if not coupled with educational strategies as this form of persuasive engagement does not increase knowledge about why energy conservation is important (Petersen et al., 2007; Agha-Hossein et al., 2014). Therefore, such visual cues can be useful in form of reminders and prompts to perform certain tasks but should provide information about why the task is important and what the benefits of the activity is (Szalma, 2009).

Contextual Information

This research also found that despite demonstrating an eco-centric worldview with high concerns about climate change, the students admitted to not having enough knowledge about how to save energy. This suggests that environmental concern does not necessarily result in energy saving activities due to lack of knowledge about conservation methods. This converges with other studies that found low awareness amongst students about how to conserve energy (Odom et al., 2008). However, findings from focus groups suggested that the students are eager to learn new ways to conserve energy and placed high importance on being given tips on how to undertake energy saving measures. This was also reflected at the Innovation Challenge as all the ideas included forms of instructional strategies on how to be more energy efficient. This converges with findings from studies providing people with tips on how to conserve energy as consumption was reduced when tips were applied (Ueno et al., 2006; Fischer, 2008).

Whilst the students found nudging techniques useful, educational strategies were favored. They reported that placing the energy information into an environmental context was useful as students wanted to understand the impact of their individual behaviour. As noted, students gave positive indications of seeing real-time data, however, they outlined that graphs and numbers should be put into tangible and more relatable environmental contexts. Fischer (2008) found that by giving energy reduction an environmental value, it encourages people to reduce energy. Therefore, referring back to ambient displays with eco-visualisation, the students suggested that their energy savings could be illustrated in a way that show how it positively impacted on the environment. Additionally, if they had consumed more than they normally would, the students suggested that feedback should be given in form of environmental consequences. Providing context as to why it is important to conserve energy has been identified as a crucial factor to encouraging pro-environmental behaviour (Steg and Vlek, 2009). Coupled with the findings from the survey, this suggests that awareness of consequences could potentially influence students' energy usage (Schwartz, 1968; Stern and Aronson 1984). On the contrary, studies suggest that there is a knowledge action-gap as knowing the consequences of climate change does not translate into taking action to prevent it (Kollmuss and Agyeman, 2002). Therefore, the students noted that the smart solution was required to undertake additional strategies to overcome barriers to engaging people who are not concerned enough to take action.

Challenge

It became evident throughout this research that students thought real-time energy information and a smart solution could positively challenge them to conserve energy. They perceived this a particularly useful form of strategy in order to overcome the lack of environmental concern barrier. Additionally, university halls of residence are subject to multiple occupancy housing (MOH) which can also be a barrier to overall energy conservation if the majority is not participating. Therefore, students believed that turning the energy conservation into a competitive challenge for the flat could boost team spirit and community feeling around the issue. By knowing the flat is conserving energy collectively, they argued this would be motivating and ensure students not wanting to stray from the norm (Lindenberg and Steg, 2013). Odom et al. (2008) argue that such social dimensions strongly influence energy conservation in university halls of residence as they found social motivation to be the key component for participation in a competition-based energy intervention. Additionally, energy conservation competitions in student halls of residence have been proven successful, not only because it provides contest, but it puts social pressure on collective participation (Petersen et al., 2007).

However, in order to motivate those performing badly in the beginning, it could be beneficial to develop strategies to reward improvements as well as those winning (Vine and Jones, 2016). Therefore, Vine and Jones (2016) note that such behaviour change competitions require a clear and well-designed focus that are appropriate for the participants as ambiguity can lead to confusion. As such, co-creating the smart solution together with the students could potentially lead to a competition-based intervention to overcome the MOH barrier that could be motivational despite not being highly concerned about the environment.

Coupled with competition, there were some distinct elements of building up a challenge the students identified as highly engaging such as the ability to compare themselves to others and goal setting. The students argued that being able to compare their savings with others and even compete against them were highly useful in order to determine their performance. Throughout the Innovation Challenge and focus groups it became evident that the use of leader boards would strongly encourage energy conservation. This converges with the social comparison theory stating that being able to compare to others and compete increases motivation to do better (McMakin et al., 2002). Additionally, students in the focus groups highlighted the importance of goal setting and how the goals must not be unrealistic as this can make participants lose motivation. This is echoed in Foster et al. (2012) who found that goals must be achievable in order to be engaging, that the goals must be visualised to students' understanding and be set short term. The latter was mirrored in the findings from both the Innovation Challenge and focus groups as the students argued feedback on goal achievements should be given on a weekly or monthly basis. Therefore, goal setting can be highly motivational in order to conserve energy if adapted to students' understandings (Abrahamse et al., 2005).

Incentives or Enforcement

Students in the focus groups reflected on whether the energy conservation challenge should be tackled by incentives or enforcement. Incentives was the preferred option. The Innovation Challenge and focus groups revealed different types of rewards desired by students. These ranged from communal rewards such as pizza parties, to individual monetary rewards. Interestingly, although tangible rewards seemed to be the preferred incentive, the use of virtual rewards and a points system were discussed, and students demonstrated positive attitudes towards this. Use of such incentives has proven successful in previous studies as participants get an emotional and psychological incentive to perform well (Froehlich et al., 2009; Shiraishi et al., 2009). Although the points being virtual, the students suggested these could be exchanged for real life, tangible rewards. However, whilst the use of tangible rewards as incentives can be useful to entice initial engagement, it may be a barrier to assess whether the intervention was a success or not (Steg and Vlek, 2009). Moreover, Geller (2002) notes that use of rewards may cause a spike in desired behaviours before returning to baseline after they are withdrawn. However, studies such as Petersen et al. (2007) found that using educational strategies resulted in persisted energy conservation in university halls of residence after rewards were discontinued. Vine and Jones (2016) suggest using rewards to enhance motivation but underline they should be utilised with caution and should not be over-emphasised as this may implicate on the intervention. Therefore, use of rewards may be helpful, but should be used as a feedback and recognition strategy, not the focus.

Whilst a less favourable approach amongst the majority, some students argued this was perhaps the only way to ensure engagement with the solution and that non-participation or negative environmental behaviour should have consequences. This diverges with the literature as it suggests that enforcement and penalties can have negative effects on the as it is associated with dictation of behaviour (Geller, 2002). This was particularly evident in the focus groups when discussing the Innovation Challenge idea of Team Eco Students where a deposit of £50 was required to participate, which students could only earn back by conserving energy. Consequently, being forced to perform certain activities can result in unmotivated participants and the solution could be perceived as intrusive (Foster et al., 2012). This suggests motivational strategies provide people with freedom to control their energy consumption without the risk of disempowering them (van der Horst et al., 2015).

From Hassle to Habits

Despite reiterating concerns about climate change during the focus groups, students admitted to being ‘lazy’ and that if conserving energy became an interruption in their routine or they had to go out of their way to do perform energy saving activities, they were unlikely to do it. Research suggests that if the desired behaviour alters habits, it is unlikely that participants will change their behaviour (Yun et al., 2013). Additionally, it converges with literature stating that high environmental concerns are more likely to influence less personal impact activities than activities that require a change in personal routines (Gatersleben et al., 2002). However, students adamantly argued that if the smart solution was convenient to use and employed features that encouraged them to conserve energy in their halls of residence, this would prompt them into good, long-term habits for when they moved out of student halls. Throughout the focus groups, it became evident that the students preferred the smart solution to be app based rather a form of dashboard due to convenience. The literature also suggests that life events such as relocating can facilitate opportunities to change people's behaviour (Schäfer et al., 2012). Therefore, whilst it is a challenge to alter habits, students gave positive indications towards the potential of a smart solution achieving this. In addition, it stresses the importance of co-creating the solution with the user group in order for it to meet their needs, thus being adopted into use (Vine and Jones, 2016; Voytenko et al., 2016; Yeh, 2017). This was reinforced through the students' positive attitudes towards being part of the co-creation process as they argued that this would likely produce a smart solution suitable for a student environment.

Summary

This research has found strong and positive indications that the use of real-time energy information and intuitive visual cues, coupled with educational and contextual information and gamification can overcome energy conservation barriers in split incentive scenarios. Findings indicate that motivational strategies supported by instructional approaches could help students reduce their energy consumption. Coupled with rewards as incentives, this suggests that a smart solution reflecting these features could shape long-term pro-environmental habits for students if the environmental impact of their energy conservation activities is understood.

The following chapter draws out the key conclusions from these discussions, as well as providing recommendations for future avenues for research.

Chapter 9. Conclusions

9.1 Introduction and Chapter Outline

This research was motivated by the recent critiques of the smart city with the aim to provide the citizen-centric perspective called for in contemporary literature. The aim derived from the complexities around smart cities' aim to deliver environmental improvements by increasing the efficiency by using ICTs and to implement solutions that improves the quality of life of citizens (Caragliu et al., 2015). The term has strong technocratic notions attached to it and has - for the most part - been defined by the large IT corporations operating on the market (Söderström et al., 2014). This fuelled the call for more citizen-centric understandings and approaches to the smart city as collaboration with citizens is an integral part of this shift. Learning about citizens' notions and perceptions of the 'smart' label will provide a more holistic understanding of the concept, thus ultimately go some way to address fundamental socio-technical challenges to creating smarter cities.

This research not only outlined these challenges to smart city implementation in relation to citizens, it brought citizens' own perceptions into the discourse. In order for implementations to deliver the environmental aspirations associated with the smart city concept, citizens are required to adopt technologies and partake in activities providing data. However, for citizens to do so, the technologies should meet *their* needs and aspirations. Albeit, with the dominating technocratic perspectives of implementers, there is doubt if the technological solutions in smart cities do in fact improve citizens' lives. Students represent a large proportion of the population in many smart cities and can be seen as the typical smart citizen according to understandings to date. Therefore, the conclusions of this research contribute to understanding citizens' role in contemporary smart cities and consequently evaluate conceptual implications of this research on the smart city and broader sustainable urbanism.

Following this, the aim and objectives of this thesis have been achieved as illustrated in Figure 9.1.

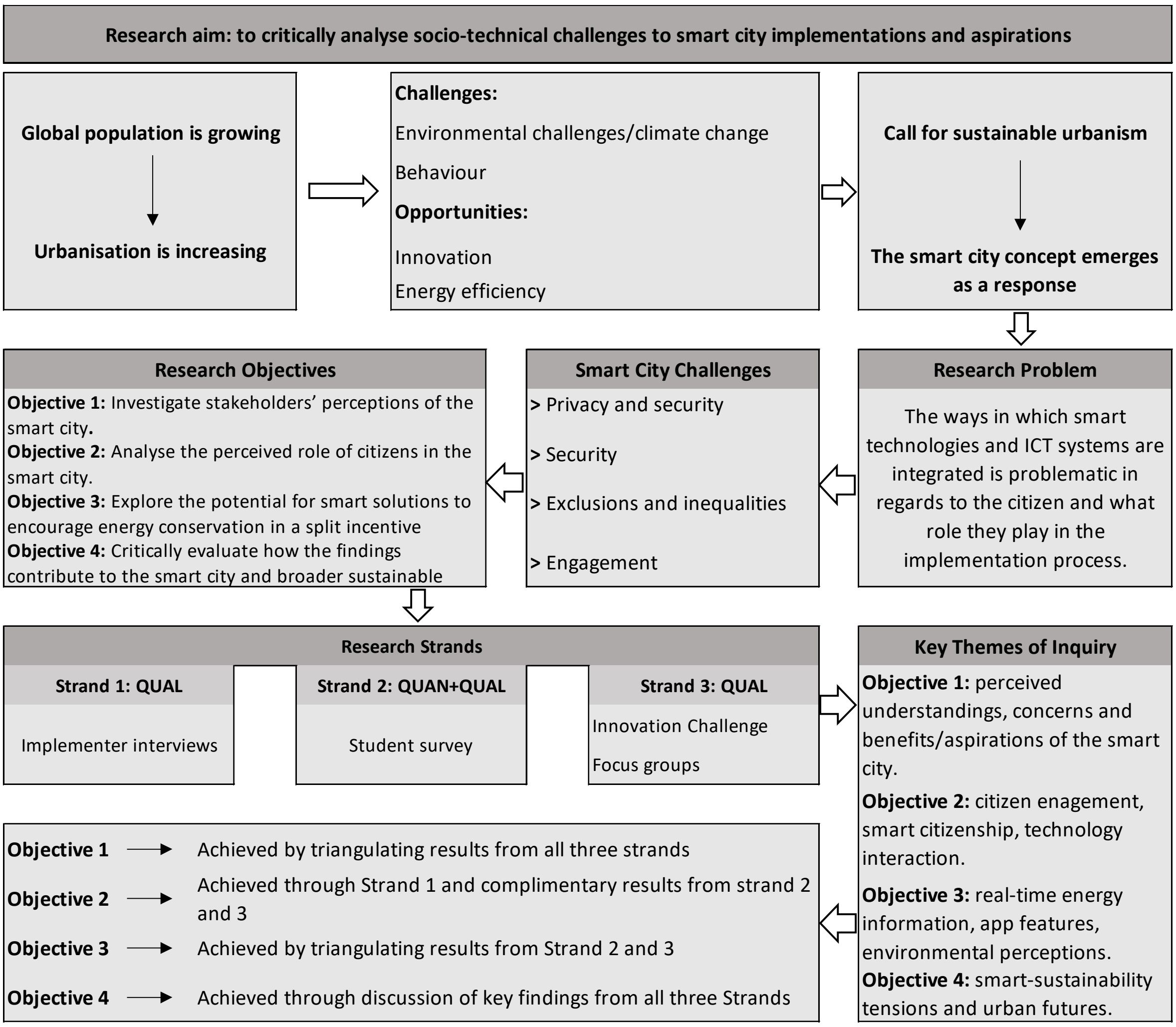

Figure 9.1. Illustration of how Aim and Objectives have been Achieved

This chapter draws out the key findings from the discussions in Chapter 8 and highlights the theoretical contributions to knowledge and the novelty of this research. Finally, the chapter ends with making recommendations for future research inquiries.

9.2 Theoretical Contributions

Several key findings derived from this thesis that have extended the critical scholarship and theoretical debates surrounding smart cities. The main contribution to knowledge made by this thesis is the insight it has given to citizens' own perceptions about the smart city. The researcher is only aware of one other study (Thomas et al., 2016) with similar inquires to this study which emphasises the novelty of this thesis. Previous literature has provided guidance for what could be the challenges to the smart city which helped place findings from this study into context, and thus this research contributes to existing critiques of the concept but from a novel perspective. Additionally, by including perceptions of the implementers of the smart city, it enabled the research to compare results and draw sound conclusions based on comparing expert opinions with citizens. The key findings of this thesis are summarised as follows:

Objective 1: Investigate stakeholders' perceptions of the smart city.

- Despite stakeholders placing technology at the heart of their understanding of the smart city, there are contesting perceptions about the aspirations for smart cities.
- There is an evident privacy paradox demonstrated by students and implementers as both groups express concerns around it whilst simultaneously accepting that one must exchange data for services.
- Strong temporal notions are associated with the 'smart' label through the descriptions of smart technology and understandings of the smart city as a future concept.

Objective 2: Analyse the perceived role of citizens in the smart city.

- Despite claiming that agendas are moving to more citizen-centric implementations of the smart city, engagement not only remains patchy and limited, but dominantly top-down and tokenistic.
- Smart technology is vastly associated with less human interaction, giving citizens less control over actions, potentially leading to speculative futures.
- Based on the findings above, there is a clear need to redefine the 'smart' citizen.

Objective 3: Explore the potential for smart solutions to encourage energy conservation in a split incentive scenario.

- There are positive indications given in this thesis that a smart solution could overcome energy conservation challenges.
- Visual cues, contextual information and challenge in form of gamification are vital to encouraging energy conservation through smart solutions in a split incentive scenario.

Objective 4: Critically evaluate how the findings contribute to the smart city and broader sustainable urbanism.

- Smart-sustainable tensions are evident in relation to the smart city. This is particularly demonstrated in the relationship between technology, environment and control.
- Clear utopian and dystopian imaginaries are heralded in the smart city concept, implicating on engagement with the concept and implementation of urban futures.

Contesting Perceptions of the Smart City

Despite associating technology with the smart city, stakeholders have **contesting perceptions** about the concept. This research illustrates how students link it to a concept that could potentially deliver environmental benefits and an easier and better life for citizens. Implementers on the other hand strongly believe that in addition to the benefits outlined by the student citizens, the concept will address underlying social problems. This demonstrates two problems. Firstly, despite students centralising technology in their understandings, they demonstrated a far stronger eco-centric understanding of 'smart' than what the concept is prepared to deliver. This finding contributes to the critiques of the smart city, arguing that the concept leads to potential false interpretations and hopes that the smart city will solve environmental issues (Martin et al. 2018). It also suggests that low awareness of the concept can fuel these false hopes as majority of students were unfamiliar with the smart city and therefore illustrating the power of using the 'smart' label as a prefix to drive agendas. Secondly, whilst the implementers of the smart city adamantly expressed citizen-centric notions about the concept, their favouring of technological solutionism was still evident by placing technology at the heart of their definitions and by reiterating how it could improve citizens' lives. Therefore, this thesis demonstrates that when attempting to understand the smart city, technology should always be placed at the heart of the concept.

Smart Cities as Privacy Paradoxes

There are undoubtedly complex socio-technical challenges posed by the smart city and this research revealed that stakeholders' concerns were nuanced in this respect. However, students demonstrated several **worries related to privacy**. In contrast, implementers expressed a significantly lower level of concern about privacy than students. Additionally, students have accepted the exchange of privacy for benefits and public services as part of everyday life which strongly questions the ethical dimensions of smart cities (Kitchin, 2016). Moreover, this finding contributes to understanding how **the smart city sparks privacy paradoxes**. Privacy related challenges in smart cities are not extensively researched. However, findings in this thesis show that students' privacy concerns are related to the type of data collected and for what purpose. Therefore, this research can recommend that scholars analysing privacy issues in relation to citizens in the smart city should consider the two-dimensional privacy framework proposed by van Zoonen (2016). Using the framework enables evaluation of what types of data are perceived personal and if the purpose for collecting it is perceived as performing a service or acting as surveillance. Consequently, this research calls for more transparency in smart cities where 'ordinary citizens' are able to **unpack black boxes**.

Temporalities of Smart Cities

This research identified strong **temporal associations** with the 'smart' label. Stakeholders demonstrated strong notions around the temporalities of the smart city which heavily influenced how they understood the smart city concept and related concerns and benefits. This finding contributes to the new avenue of smart city research encouraged by Kitchin (2019) as the temporalities of smart cities remain vastly underexamined. In particular, this research stresses the need to raise awareness amongst citizens that **smart cities are being implemented in the *present*** time, not only in the future as especially demonstrated by the students' low familiarity of the concept and through the associated utopian and dystopian futures. Additionally, the thesis contributes to theorising the 'smart' label as a forever evolving term as technological acceleration implicates on people's perceptions of it. This in turn suggests that the smart city concept can in fact be adaptable as needs and aspirations are changing. Therefore, smart city initiatives and projects should aim to facilitate this adaptability by **avoiding standardisation of frameworks**, and policy and practice.

Redefining the Smart Citizen

This research has contributed to the debate around smart citizenship and calls for a redefinition of the 'smart' citizen. The thesis contributes to giving clarity to the role of citizens in smart cities as it is currently argued that they play a much more ambivalent role in practice than in theory (Shelton and Lodato, 2019). As found in this research, citizens are evidently framed as consumers and end-users in the smart city. Conversely, findings have shown how the concept - as currently construed - is hegemonic, paternalistic, and driven by technological solutionism that may result in citizens resisting the smart city. Additionally, this thesis has demonstrated how **citizens in contemporary smart cities play a complicated - yet passive - role** as end-users and consumers as the ‘ordinary citizen’ is not empowered to drive change (Cardullo and Kitchin, 2018a). As the consensus was that citizens are components that could be by-passed in smart city implementations (Söderström et al., 2014), this urges a redefinition of smart citizenship in order to facilitate cities where citizens make informed decisions, albeit with the assistance of technologies.

In turn, these findings contribute to the debate calling for more ‘just’ smart cities where citizens have the ‘the right’ to their cities and the power to change and influence policy making (Kitchin, 2019). The research revealed that most of the implementers’ vision of a bottom-up smart city remains top-down as the **engagement still falls within the boundaries of tokenism**. Consequently, it has also shown how conceptions around smart citizenship and citizen engagement in developments of the smart city remains framed by technological solutionism and neo-liberal ideologies (Hollands, 2008; Cardullo and Kitchin, 2018b).

Despite implementers adamantly **aspiring to develop more citizen-centric smart cities**, this thesis revealed that these **visions do not seem to translate into practice** due to two main reasons: first, the bottom-up notions expressed by implementers are not truly bottom-up as the level of citizen participation fall within tokenism and consumerism, and second, there are major financial and timeframe barriers to co-develop the smart city with citizens (Cardullo and Kitchin, 2018a; b). Therefore, the financial aspect of implementation and cost of technologies was identified as the main barrier to engagement along with awareness of the smart city. These findings contribute to understanding why the smart city is not moving towards more citizen-centric models and can in therefore turn inform decision making in urban planning.

Overcoming Energy Conservation Challenges

Through taking a co-creational approach, this research has identified that **human behaviour barriers can potentially be challenged with technology**. This research identified that a smart solution could indeed aid overcoming barriers to energy conservation in multiple occupancy housing (MOH) and split incentive scenarios such as Birley Student Living (BSL). However, whilst technology can work as an 'olive branch' and a prompt for more sustainable living, this research found that awareness and **knowledge about the threats of climate change is the key to behaviour change.**

This research found that the majority of students hold an eco-centric worldview driven by altruistic and biospheric values, indicating **positive attitudes and perceptions towards preserving the environment** (Dunlap et al., 2000; Howell, 2013). However, it also demonstrated that whilst energy conservation is perceived as important to the students, their awareness about how to save energy is partial and that their current energy behaviours leave room for improvement. Additionally, **limited contextual understanding of how individual behaviour impacted on the environment was identified as a key barrier** to energy conservation and broader pro-environmental behaviour.

With respect to designing a smart solution to address energy conservation challenges in split incentive scenarios, this thesis found encouraging indications that provision of **contextualised and real-time energy information using intuitive visual cues and gamification** could potentially change student behaviours. This contributes to existing studies suggesting that similar elements have resulted in decreased energy consumption such as Petersen et al. (2007) and Foster et al. (2012). The contextualised information is especially important in order to illustrate the positive and negative impacts of individual behaviour on the environment as students reported that climate change was an abstract concept. This framing could therefore turn the critical issues of climate change into a more localised and tangible problem that students could relate to more easily.

The students reported that **gamification elements would create a community-oriented feeling around climate change** problems and assist in overcoming the issues around not caring about related issues. The research revealed positive encouragements that this coupled with continuous incentives can indeed overcome the barriers to engagement. However, the challenge is to form sustained behaviour outside of the contextualised environment when incentives are removed. Whilst drivers may shift towards financial ones if students start being responsible for energy bills, the research indicate that establishing good energy habits could indeed prolong these behaviours post-interventions.

These findings therefore suggest that a smart solution to overcome energy conservation in split incentive scenarios and/or MOH should include what this thesis refers to as "**the three Cs**": cues, context and challenge as illustrated in Figure 9.2 below. This contributes to providing a theoretical framework for developing a smart solution design and brings behaviour change theories such as for example goal framing theory into the digital era.

Cues	Context	Challenge
Colours	Real-time information	Gamification
Eco-visualisation	Relatable information	Leader boards
Language	Individual impact	Competition
Ease of use	Awareness	Goal setting
Reminders	Tips	Rewards

Figure 9.2. The Three Cs

Based on this proposed framework, this research suggest that a **smart solution can increase awareness about energy conservation** and potentially help overcoming energy invisibility (Goodchild et al., 2017). Additionally, engaging students in energy conservation activities can contribute to closing knowledge-action gap (Kollmuss and Agyeman, 2002), leading to environmental concerns translating into energy conserving activities. As universities are major actors in the urban sustainability challenges and smart cities (Karvonen et al., 2018), findings in this thesis can aid society's response to climate change.

Ensuring Sustainable Urbanism

Debates continue around how cities can be both smart and sustainable and as Martin et al. (2018:275) state:

> "A key practical challenge for smart cities is to work out which sectors of the urban digital economy need to grow and which need to shrink in order to protect the environment and promote social equity".

This research outlines the challenges to ensure smart cities tackle sustainable urbanism by calling for greater attention to be paid to social factors. It challenges the contributions of smart cities to broader sustainable urbanism in two ways. Firstly, by encouraging **a shift in rhetoric** where citizens are part of framing the problems and the solutions in order to ensure a more 'just' smart city where citizens reclaim their rights to drive change. Secondly, by calling for the **need for citizens to understand how their behavioural impact** on urban planning and the environment, thus making more informed decisions.

Smart-sustainability tensions presented in contemporary smart cities require attention in order to ensure sustainable urban growth (Martin et al., 2018). Additionally, through **co-creating urban solutions** with a broader range of stakeholders, the smart city can begin to serve the interests of a much more representative proportion of the population. The engineers have been irreplaceable in the past (Townsend, 2013), and there is no doubt they still play a central role in developing the smart city. However, the perspectives of 'ordinary citizen' need to be considered in order to prevent dystopian imaginaries and data-driven governmentalities that does not serve the interests of citizens. Through recommending **greater involvement of citizens** and prompting grassroots and bottom-up approaches to evolve, this thesis challenge the paternalistic and tokenistic approaches expressed by implementers to ensure implementation of a holistic smart city where social equity is integral (Shelton and Lodato, 2019).

This can in turn assist citizens in understanding how individual technologies implicate on the city and how this affects sustainable urbanism. By enabling **citizens' 'right to the smart city'** (Kitchin et al., 2019), this promotes awareness of urban environmental challenges and empowerment to make informed decisions. When localised challenges are tackled and large-scale issues made tangible, it can encourage behaviour change and ensure environmental protection as well as increasing social equity. This research therefore encourages the need to **shift towards more informed and 'just' use of smart technologies** in order to ensure citizens understand the outcomes of utilising them (McFarlane and Söderström, 2017).

That said, this thesis discovered **an intricate relationship between technology, control and the environment** as illustrated in Figure 9.3.

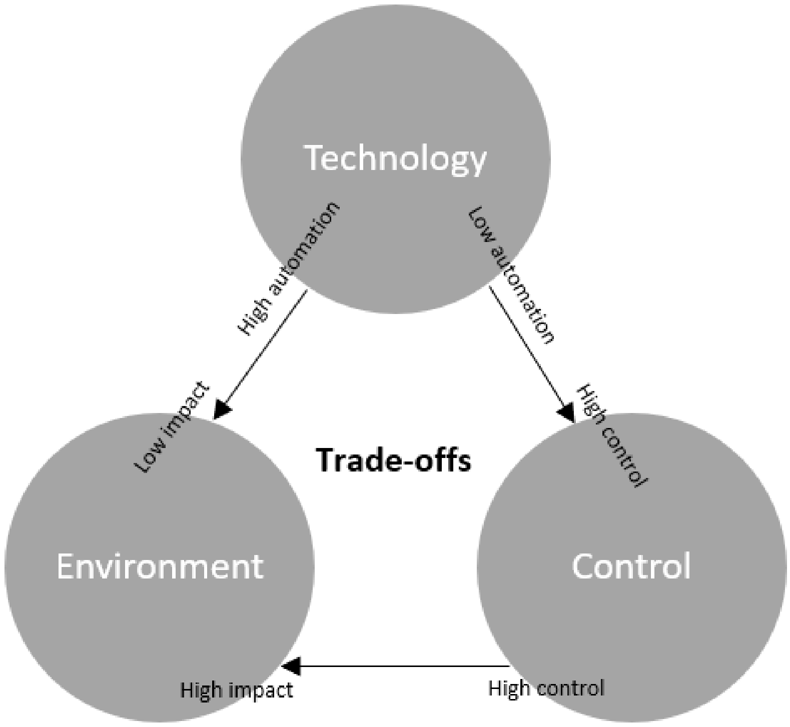

Figure 9.3. The Relationship between Technology, Control and the Environment

With high levels of automation and advanced smart technologies, low environmental impact can be ensured through more efficient use of energy. However, this in turn gives lower control to citizens thus less freedom of choice. Consequently, increased automation is less likely to contribute to raising awareness around energy conservation and issues around sustainable living. On the other hand, lower levels of automation give higher control to citizens but increases the chance of making unsustainable choices with higher impact on the environment. Therefore, the relationship between technology, control and the environment present **a complex nexus of trade-offs in sustainable urbanism**. This stresses the importance of the findings in this thesis regarding **empowering citizens to co-create smart solutions that encourage sustainable behaviour**.

Future Urban Imaginaries

With the relationship between technology, control and the environment in mind, this thesis has revealed **new and contesting epistemologies about smart cities** (Kitchin, 2014c). Additionally, it has shown how the 'smart' label fuels utopian and dystopian imaginaries for stakeholders. As a result of the contesting perceptions, it has become evident that **there is no 'one model fits all' smart city** (Williams, 2010; Kitchin, 2014a). The imaginaries examined in this thesis contribute to theorising stakeholders' perceptions of the future urban scenarios presented in Vanolo (2016) (see Chapter 2, Section 2.9.3). Findings suggest that student citizens are highly concerned about the dystopic scenario "Smart 'no freedom' cities" whilst aspiring for the utopian case of "The sustainable smart city". However, based on the interviews with smart city implementers, it became clear that status quo is "Neo-liberal smart cities". Going forward, in order to avoid dystopian pitfalls and false utopian promises, this research reiterates that opening a more **transparent dialogue with citizens** can ensure that the future smart city is inclusive and citizen-centric.

9.3 Future Research

This thesis has provided several avenues for future research inquires. First, as smart city research with citizens is extremely limited, future research should aim to pursue similar inquiries to this thesis in other smart city districts. This will reveal potential spatial differences in perceptions and agendas and can point towards best practice for overcoming challenges to implementing citizen-centric smart cities. Such comparative case studies will also strengthen the understanding of the geographies of smart cities.

Second, as this research was cross-sectional in nature, future research should include longitudinal studies. Such research could aim to examine potential changes in perceptions of 'smart' as the term evolves. This is particularly interesting considering the strong temporal notions attached to the term discovered in this thesis. A longitudinal study should also monitor changes in citizen engagement approaches in order to determine whether in fact the smart city does become more citizen-centric and bottom-up as promised and aspired by implementers.

Third, this thesis has provided the basis for developing a smart solution for encouraging energy conservation in student halls of residence. Future research should aim to establish case studies. For example, living lab-based case studies with real-time energy monitoring enabled, where a smart solution based on the findings of this thesis could be tested with students. This will show whether the positive indications of using intuitive visual cues, contextual information and challenges found in this research work in practice. In practical terms, a successful smart solution at the Manchester Met Birley campus could ensure self-sufficiency of electricity during peak time hours and ultimately take the campus off the grid between 5pm and 7pm. This in turn reduces electricity demand from a large institution in the city, easing the constraints on the national grid. Although the research around the potential for a smart solution was framed by the split incentive scenario energy challenge in BSL, it could be replicated in similar halls of residence where real-time energy monitoring is enabled.

Fourth, as this research was based on self-reported answers, there is a need to examine citizen engagement challenges through ethnographic research methods. This could enable researchers to explore first-hand, for example, whether other smart city districts where different initiatives operate are dominated by the same tokenistic and top-down citizen engagement strategies found in this research. Additionally, this would give better insight to who the citizens participating in such events are, and how they are being engaged.

Fifth, this thesis has opened for future research to make methodological contributions. Using an innovation challenge as a research method was novel as these are usually ran as hackathons for participants with IT backgrounds. As the literature on such methods remain limited due to their new emergence, future research should aim to develop a solid framework for conducting innovation challenges as part of a wider methodology.

Finally, and perhaps most urgent need for future research is to examine the perceptions of the broader population. This research has provided the views of student citizens which is a unique part of the population as they can be regarded as digital natives and digitally enabled. Therefore, future research should replicate inquiries from this thesis to analyse the perceptions of other groups of the population, for example, working adults, elderly or even people with different demographic backgrounds.

The thesis hopes to encourage further research to be undertaken in collaboration with citizens in order to ensure that their needs and aspirations are met when implementing the smart city. The research sought to understand the challenges to achieve inclusive and citizen-centric smart cities whilst at the same time examine opportunities for change. The research has aimed to open new discussions around the role of the citizen in smart cities and the importance for implementers to avoid hegemonic engagement approaches. By outlining the avenues for future research above, this thesis wishes to encourage other studies to undertake these which will contribute to a sound understanding of citizens in the smart city.

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Appendices

Appendix 1. Sample Interview Invitation Email

Dear [Interviewee Name],

I hope you don't mind me contacting you. My name is Regine Saga, I am a PhD student at Manchester Metropolitan University and my research is centred around challenges to implementations of Smart City solutions and public engagement in the Smart City (please see the attached participant information sheet for more information about the study). I am currently interviewing various stakeholders in Smart City projects and was hoping to interview you in regards to this. Would you be available for an interview? If you are, would you please let me know a suitable date + time for you? I am happy to come to your office location. Many thanks for your time and I hope to hear from you soon!

Kind regards,
Regine Sonderland Saga
PhD Researcher
Manchester Metropolitan University

Appendix 2. Participant Information Sheets and Consent Forms

A. Interviews

What is the purpose of the study?

The purpose of this study is to analyse challenges to implementation of Smart City solutions from a stakeholder perspective. My research will focus on potential socio-technical issues and concerns regarding smart technologies and perceived engagement barriers for end-users. The data collected will be used for research and educational purposes, including academic publications.

Why have you been invited?

You have been invited because you are involved in implementing smart city solutions in Manchester.

What will the study involve?

The interview is informal with open ended questions to allow discussion. The questions will build upon findings from contemporary academic literature about smart city challenges and findings from other data. The data collected in the interviews will be used to compare the challenges and concerns explained by end-users. This way, the research will produce a holistic and critical understanding to potential engagement barriers and integration issues of smart city solutions.

Will my data be confidential?

You are entitled to withdraw at any stage of this research. All information collected from you will be kept strictly confidential. With your permission, direct quotes will be used to support arguments and conclusions in this study and will be anonymized. Any other information about you that is used in the research will also be anonymized. No personally identifiable information about you will be stored. If you approve, the interview will be recorded on a voice recorder, stored – and coded on to a password-protected computer that only the researcher and the supervisory team will have access to. All handling, processing, storage and destruction of data will be in compliance with Manchester Metropolitan University Data Protection Policy:

http://www.mmu.ac.uk/policy/pdf/policy_ref_data_protection_policy.pdf

What if there is a problem?

If you have a question or concern about any aspect of this study, you should ask to speak to the researcher who will do their best to answer your questions. Please contact the researcher Regine Sonderland Saga: r.sonderland-saga@mmu.ac.uk. Alternatively, you can contact a member of the researcher's supervisory team: Dr. Paul O'Hare: paul.a.ohare@mmu.ac.uk or Dr. Rachel Dunk: r.dunk@mmu.ac.uk.

Participant Identification Code for this project:

1. I confirm that I have read and understood the information sheet Dated 09.07.18 for the above project and have had the opportunity to ask questions about the interview procedure. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason to the named researcher. ☐
3. I understand that my responses will be audio recorded and used for analysis for this research project. ☐
4. I understand that my responses will be **used** for research and educational purposes, including academic publications. ☐
5. I understand that my responses will remain anonymous. ☐
6. I agree to take part in the above research project. ☐
7. I understand that at my request a transcript of my interview can be made available to me. ☐

________________________	________________	____________________
Name of Participant	Date	Signature
________________________	________________	____________________
Researcher	Date	Signature

To be signed and dated in presence of the participant

Once this has been signed, you will receive a copy of your signed and dated consent form and information sheet by post.

B. Innovation Challenge

What is the purpose of the study?

The purpose of this study is to examine the role of smart technology in encouraging people to improve their environmental behaviour. Birley Fields Campus is situated within the Corridor Manchester (which is a smart city district), and the campus is built to high energy efficiency standards, making it a suitable testbed. My research will focus on how an app promoting energy saving behaviour can potentially encourage the user to save energy. The results of this research study will be included in my final PhD thesis and published in a peer reviewed journal article.

Why have you been invited?

You have been invited to partake in this innovation challenge because it is important to co-develop smart solutions with the public in order to best facilitate energy saving potentials.

What will the study involve?

This challenge will involve testing a proto-type app for energy saving at the Birley Fields campus. You will suggest ideas on how the app can be altered or improved in order to encourage energy saving for those using it. Additionally, you will be asked questions related to the use of smart technology in today's society. Data collected will shape future versions of the app and improve understanding of user's concerns, perceptions and needs regarding smart technology.

Will my data be confidential?

You are entitled to withdraw at any stage of this research. All information collected about you will be kept strictly confidential. Direct quotes from you will be used to support arguments and conclusions in my research and all quotes will be anonymized. Any other information about you that will be used in the research will be also completely anonymized. You will not be asked to provide your name at any stage of this research. All handling, processing, storage and destruction of data will be in compliance with Manchester Metropolitan University Data Protection Policy:

http://www.mmu.ac.uk/policy/pdf/policy_ref_data_protection_policy.pdf

What if there is a problem?

If you have a question or concern about any aspect of this study, you should ask to speak to the researcher who will do their best to answer your questions. Please contact the researcher Regine Sonderland Saga on: 07565260663 or r.sonderland-saga@mmu.ac.uk. Alternatively, you can contact a member of my supervisory team: Dr. Paul O'Hare (paul.a.ohare@mmu.ac.uk) or Dr. Rachel Dunk (r.dunk@mmu.ac.uk).

Participant agreement and consent

I confirm that I have read and understand this information sheet dated **21.02.18** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered for me. ☐

I agree to take part in the above study and I authorize the researcher to use information I provide in this workshop as part of the study described above. ☐

I understand that all my responses will remain anonymous. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason to the researcher. Information collected until I withdraw can be used as part of this study unless I specifically ask for it not to be. ☐

____________________	____________________	____________________
Name of Participant	Date	Signature
____________________	____________________	____________________
Name of Researcher	Date	Signature

C. Focus Groups

What is the purpose of the study?

The purpose of this study is to examine the role of smart technology in encouraging people to improve their environmental behaviour. My research will focus on ways you can potentially become more energy efficient in your home through the use of an app. Results from this research study will be included in the researcher's final PhD thesis and potentially published in a peer reviewed journal article.

Why have you been invited?

You have been invited as you are a student at Manchester Met who have signed up to trial an energy saving app and agreed to evaluate that experience in a focus group post this trial period.

What will the study involve?

In the focus group there will be other participants who tested the app. You will discuss how you what you think about the app that has been available to you, and broader challenges to engagement with smart technology. The data collected in the focus groups will be used to gain a better understanding of how apps can encourage energy saving and potential challenges to the smart city.

Will my data be confidential?

You are entitled to withdraw at any stage of this research. All information collected about you from this focus group will be kept strictly confidential. Direct quotes from you will be used to support arguments and conclusions in this study and all quotes will be anonymized. Any other information about you that will be used in the research will be also completely anonymized. The discussion will be audio recorded, stored – and coded on to a password-protected computer that only the researcher and the supervisory team will have access to. All handling, processing, storage and destruction of data will be in compliance with Manchester Metropolitan University Data Protection Policy: http://www.mmu.ac.uk/policy/pdf/policy_ref_data_protection_policy.pdf

What if there is a problem?

If you have a question or concern about any aspect of this study, you should ask to speak to the researcher who will do their best to answer your questions. Please contact the researcher Regine Sonderland Saga on: 07565260663 or r.sonderland-saga@mmu.ac.uk. Alternatively, you can contact a member of the researcher's supervisory team: Dr. Paul O'Hare (paul.a.ohare@mmu.ac.uk) or Dr. Rachel Dunk (r.dunk@mmu.ac.uk).

Participant agreement and consent

I confirm that I have read and understood this information sheet dated **19th December** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered for me. ☐

I agree to take part in the above study and I authorise the researcher to use information I provide in this focus group as part of the study described above. ☐

I understand that the focus group will be audio recorded. ☐

I understand that all my responses will remain anonymous. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason to the researcher. Information collected until I withdraw can be used as part of this study unless I specifically ask for it not to be. ☐

Name of Participant	Date	Signature
Name of Researcher	Date	Signature

Appendix 3. Interview Schedule

Section 1: The 'smart' label

1. Please describe what you understand by the "Smart City".
2. Please could you describe what you think makes a technology "Smart"?

Section 2: Concerns, Perceptions and Aspirations

1. What do you think the benefits of the "Smart City" could be?
2. What are your aspirations for the "Smart City"?
1. What concerns or worries do you have related to the "Smart City"?

Section 3: Smart Citizenship

1. Please describe what you understand by a 'Smart Citizen'.
2. What approaches do you believe to be most effective in engaging citizens in Smart City developments?
3. How is citizen participation currently enacted in developing the Smart City?

What do you believe to be the grand challenges to citizen participation?

Appendix 4. Code Table for the Interviews

Smartness	Relates to understandings and perceptions of what 'smart' entails and means to different participants	**Smart City**	Relates to their understanding of the smart city	**Etic**
		Smart Technology	Relates to their understanding of what makes a technology smart	**Etic**
		Smart Citizen	Relates to their understanding of what a smart citizen is	**Etic**
		Technological development	Relates to how rapid technological development can be a challenge when it comes to delivering smart city projects	**Emic**
		Tangibility	Relates to how they think people associate smart with something that is tangible	**Emic**
		Terminologies	Relates to how their notions regarding the smart terminologies in different settings	**Emic**
Citizen Engagement	Relates to citizen engagement approaches and potential barriers to it in the smart city	**Citizen role**	Relates to how the citizens are involved -and framed in smart city projects	**Etic**
		Top down	Relates to their views on or examples of top down engagement approaches	**Emic**
		Bottom up	Relates to their views on or examples of bottom up engagement approaches	**Emic**
		Identifying problem	Relates to how understanding and addressing a problem willl result in higher engagement	**Emic**
		Piloting	Relates to how piloting or trialing the solution first helps engagement later.	**Emic**
		Citizen needs	Relates to how identifying, understanding and responding to citiznes needs can boost engagement and evolve the smart city	**Emic**
		Incentives	Relates how they believe incentives can boost engagement	**Emic**
		Community feeling	Relates to how team spirit among people can boost engagement with a smart technology.	**Emic**
		Face-2-face	Relates to how they believe face-2-face engagement is the best way to ensure participation	**Emic**

Citizen Engagement	Relates to citizen engagement approaches and potential barriers to it in the smart city	**Existing channels**	Relates to how they believe existing channels can facilitate engagement	**Emic**
		Champions	Relates to how they believe getting champions from different communities to engage the citizens will work	**Emic**
		Campaign	Relates to how campaigns and messaging in the campaigns can impact on engagement	**Emic**
		Technology type	Relates to how the various technology types themselves can impact on engagement	**Emic**
		(Social) media	Relates to how social media can affect engagement with smart technologies.	**Emic**
		Awareness	Relates to how awareness about the smart city and smart technology and how it can affect the engagement	**Emic**
		Training	Relates to how training can increase engagement	**Emic**
		Responsibility	Relates to their notion around who is responsible for (engaging) the citizens in the smart city	**Emic**
		Co-creation	Relates to how co-creation can impact on implementation and includes narratives	**Etic**
		Visability	Relates to how a more visible smart city can impact on engagement	**Emic**
		Citizenship	Relates to how the notions around citizenship can be a barrier to citizen engagement	**Emic**
		Access	Relates to how facilitating access can improve citizen engagement	**Emic**
		Long-term engagement	Relates to how challenges to long term engagement in smart city initiatives can be a barrier to engagement.	**Emic**
		Generational	Relates to how older generations can be a challenge to engage	**Emic**
		Resistance	Relates to how citizens can resist smart technologies	**Emic**

Benefits	Relates to their perceived benefits of the smart city and smart technologies	**City goals**	Relates to how the smart city concept can assist the city in potentially achieving their goals	**Emic**
		Aspirations	Relates to their ideal aspirations for the smart city	**Etic**
		Standardisation	Relates to how they believe standardisation can benefit the smart ciy	**Emic**
		Learning process	Relates to how they believe the learning process of smart city projects can be a benefit	**Emic**
		Empowerment	Relates to how smart technology can empower citizens to make decisions	**Emic**
		Easy	Relates to how they think a benefit of the smart city should be to make people's lives easier	**Emic**
		Environmental	Relates to how they think the smart city can bring environmental benefits	**Emic**
		Operational efficiency	Relates to how they think use of smart technology or the smart city in general can improve operational efficiency	**Emic**
		Wellbeing	Relates to how they think use of smart technology can increase people's health, quality of life and general wellbeing	**Emic**
		Safety	Relates to how they think the smart city can make cities safer	**Emic**
		Monetary Savings	Relates to how they think smart city projects and smart technologies can bring financial savings to the city	**Emic**
Concerns	Relates to their perceived concerns to the smart city	**Inequalities**	Relates to notions regarding potential inequalities created in society by smart technologies or how smart tech can address them	**Etic**
		Exclusion	Relates to groups of people or areas that may be excluded by the smart city	**Etic**
		Employment	Relates to concerns around employment	**Emic**
		Replication	Relates to potential concerns in regards to replicating smart city solutions	**Emic**
		Unintended consequences	Relates to what kind of unintended consequences they believe to be of a concern in regard to smart city implementation	**Emic**
		Privacy	Relates to their notions on privacy concerns about smart technology and the smart city	**Etic**

Concerns	Relates to their perceived concerns to the smart city	**Security**	Relates to their notions on security concerns about smart technology and the smart city	**Etic**
		Adaptability	Relates to how adaptability within projects can be perceived as a concern	**Emic**
		Transparancy	Relates to how smart city implementations and data collection should be transparent	**Emic**
		Cost	Relates to how they think cost is a concern to the smart city	**Emic**
		Timing	Relates to how getting the timing right regarding implementation can be a concern	**Emic**
		Dependency	Relates to how dependency on smart technology can be a concern related to smart cities	**Emic**
		Smartification	Relates to how they believe a smartification of societal functions that does not require alternation can be a concern	**Emic**
		Sales approach	Relates to notions around how "smart" or smart city has become a sales approach	**Emic**
		Involvement	Relates to their concern about companies getting involved in smart city projects just for the sake of saying they've been involved, selling unecessary tech	**Emic**
		Beneficiaries	Relates to who they think benefits from the smart city and how	**Emic**
		Investments	Relates to concerns around who will be responsible for investing in implementing the smart city	**Emic**
		Ownership	Relates to concerns around who ownership of data and technologies in the smart city	**Emic**
		Underlying issues	Relates to how their notions of how the smart city can or cannot solve underlying urban issues	**Etic**
		Utopia	Relates to how their notion of a utopic vision is unrealistic and a concern in bringing the city forward	**Emic**
		Automation	Relates to how automation can erase the need for human decision making and how this may be a concern	**Emic**

Limitations	Relates to potential limitations to smart technologies and smart city projects	**Technical errors**	Relates to technological errors or limitations of smart technology	**Emic**
		Loosing track of purpose	Relates to how they think projects forget why they are doing things. Losing track of purpose.	**Emic**
		Evaluation	Relates to how the evaluation process of smart initiatives are diffuse	**Emic**
		User-centric	Relates to how a limited user-centric design can make implementations unsuccessful	**Emic**
		Collaboration	Relates to the collaboration (or lack of it) between stakeholders in the Smart City	**Etic**
		Stakeholder type	Relates to their notions around which stakeholders are more likely to successfully implement the smart city	**Emic**
		Time scales	Relates to how time scales of smart city projects can be a barrier to citizen-centric implementation	**Emic**
		Political realities	Relates to how political realities can be a barrier to implementation of the smart city	**Emic**
		Power	Relates to notions around who has the power to implement the smart city	**Emic**
		Funding	Relates to how funding can be a barrier to implementation and citizen engagement in smart city projects	**Emic**

Appendix 5. The Student Survey

Student Survey Instrument

Note: Two survey instruments were employed, the first was created and administered using Bristol Online Surveys (BOS) and the second using SurveyMonkey (SM). Questions that were formulated differently in the two versions are identified here, as are those questions that only appeared in the SM version.

Section 1: Understandings of 'smart'

The Smart City

1. Are you familiar with the concept of the "Smart City"
[Multiple Choice (only one answer)]

- ○ Yes
- ○ I've heard of it - but I'm not sure what it means
- ○ No - I've never heard of it

2. Please describe what you understand by the "Smart City"
[Open comment box]

3. What concerns or worries do you have related to the "Smart City"
[Open comment box]

SM VERSION ONLY
4. What do you think the benefits of the "Smart City" could be?
[Open comment box]

Smart Technologies

5. In today's modern world we often hear about smart technology. However, there is no clear definition of what smart technology is. Please could you describe what you think makes a technology smart?
[Open comment box]

Internet of Things

6. Are you familiar with the term "Internet of Things" (IoT)?
[Multiple Choice (only one answer)]

- ○ Yes
- ○ I've heard of it - but I'm not sure what it means
- ○ No - I've never heard of it

Internet of Things Cont.

7. Please describe what you understand by the "Internet of Things"
[Open comment box]

Smart Phone Ownership, App Usage and Privacy

8. Which operating system does your smart phone have?
[Multiple Choice (only one answer)]

- ○ I do not have a smart phone *[Skip to Question 12]*
- ○ iOS
- ○ Android
- ○ Other (please specify in box below)

[Text Box, 50 characters]

9. Have a look at your smart phone. How many apps have you currently got installed/downloaded (not including the ones originally installed pre-purchase such as clock, calendar, etc.)? Please enter your answer in number format.
[Text Box, number format]

10. How concerned are you about your privacy when using your smartphone or when downloading apps?
[Multiple Choice (only one answer)]

○	○	○	○	○
Not at all concerned	Slightly concerned	Moderately concerned	Concerned	Very concerned

Please explain why:
[Optional open comment box]

11. Do you read the full privacy policy of an app before installing it?
[Multiple Choice (only one answer)]

- ○ Yes
- ○ No

Please explain why:
[Optional open comment box]

Section 2: Energy Conservation - Perceptions & Behaviours

Views on Society & Environment I (NEP Scale)

12. Listed below are statements about the relationship between humans and the environment. For each one, please select to what extent you agree or disagree with it.
[Multiple Choice, one answer per row]

	Strongly disagree	Mildly disagree	Unsure	Mildly agree	Strongly agree
We are approaching the limit of the number of people the earth can support	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs	○	○	○	○	○
When humans interfere with nature it often produces disastrous consequences	○	○	○	○	○
Human ingenuity will insure that we do NOT make the earth unliveable	○	○	○	○	○
Humans are seriously abusing the environment	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them	○	○	○	○	○
Plants and animals have as much right as humans to exist	○	○	○	○	○
The balance of nature is strong enough to cope with the impacts of modern industrial nations	○	○	○	○	○
Despite our special abilities, humans are still subject to the laws of nature	○	○	○	○	○
The so-called "ecological crisis" facing humankind has been greatly exaggerated	○	○	○	○	○
The earth is like a spaceship with very limited room and resources	○	○	○	○	○
Humans were meant to rule over the rest of nature	○	○	○	○	○
The balance of nature is very delicate and easily upset	○	○	○	○	○
Humans will eventually learn enough about how nature works to be able to control it	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe	○	○	○	○	○

Views on Society & Environment II (Value Scale)

13. Please rate how important you feel the following are to you personally (-1 = opposed to your values, 0 = not important and 7 = extremely important). Try to vary your scores and not rate more than two options at 7.
[Multiple Choice, one answer per row]

	-1	0	1	2	3	4	5	6	7
Social justice (correcting injustice, care for the weak)	○	○	○	○	○	○	○	○	○
Equality (equal opportunity for all)	○	○	○	○	○	○	○	○	○
Helpful (working for the welfare of others)	○	○	○	○	○	○	○	○	○
A world at peace (free of war and conflict)	○	○	○	○	○	○	○	○	○
Protecting the environment (preserving nature)	○	○	○	○	○	○	○	○	○
Respecting the earth (harmony with other species)	○	○	○	○	○	○	○	○	○
Preventing pollution (protecting natural resources)	○	○	○	○	○	○	○	○	○
Unity with nature (fitting into nature)	○	○	○	○	○	○	○	○	○
Influential (having an impact on people and events)	○	○	○	○	○	○	○	○	○
Wealth (material possessions, money)	○	○	○	○	○	○	○	○	○
Authority (the right to lead or command)	○	○	○	○	○	○	○	○	○
Social power (control over others, dominance)	○	○	○	○	○	○	○	○	○
Ambitious (hard-working)	○	○	○	○	○	○	○	○	○

Concern About Climate Change

14. How concerned are you about climate change?
[Multiple Choice (only one answer)]

○	○	○	○	○
Not at all concerned	Slightly concerned	Moderately concerned	Concerned	Very concerned

Please explain your answer:
[Optional open comment box]

Energy Conservation

15. How important do you think it is to save energy?
[Multiple Choice (only one answer)]

○	○	○	○	○
Not at all important	Slightly important	Moderately important	Important	Very important

Please explain why:
[Optional open comment box]

SM VERSION ONLY
16. How aware are you about how to save energy in your home?
[Multiple Choice (only one answer)]

○	○	○	○	○
Not at all aware	Slightly aware	Moderately aware	Important	Very aware

SM VERSION ONLY
17. Thinking about how you use energy in your home, how efficient do you think your current behaviour is?
[Multiple Choice (only one answer)]

○	○	○	○	○
Very inefficient	Moderately inefficient	Neither efficient nor inefficient	Moderately efficient	Very efficient

SM VERSION ONLY
Please comment on (briefly explain) your answers about your level of awareness and behaviour:
[Optional open comment box]

Motivational Actors for Pro-Environmental Behaviours

18. Considering your life up until now, have any of the following motivated you to behave in more environmentally friendly ways? Please tick all that apply.
[Multiple Choice (check all that apply)]

- ☐ No-one has motivated me
- ☐ Parents and/or other relatives
- ☐ Friends and/or neighbours
- ☐ Other (please specify in box below)
- ☐ School
- ☐ University
- ☐ Work
- ☐ Scientists
- ☐ Politicians
- ☐ TV and/or radio
- ☐ Newspapers (however accessed)
- ☐ Social media

[Text Box, 100 characters]

Please explain in what way(s) you were / were not motivated:
[Optional open comment box]

Smart Energy Devices

With the smart technology available today, some people might have a smart meter, a smart monitor and/or a smart thermostat in their home.

Smart meter: monitors and displays your real time energy usage across appliances, and removes the need for meter readings as it feeds this information automatically to the utility companies.

Smart monitor: monitors and displays your real time energy usage, but does not feed this information automatically to the utility companies.

Smart thermostat: lets you control your heating remotely from your smart phone and may or may not also display how much energy you use.

19. Do you live (or have you ever lived) in a home with a smart meter, a smart monitor and/or a smart thermostat?

[Multiple Choice (only one answer)]

- ○ Yes - I currently live in a home with a smart meter, monitor or thermostat
- ○ Yes - I used to live in a home with a smart meter, monitor, or thermostat
- ○ No - I have never lived in a home with a smart meter, monitor or thermostat *[Skip to Question X]*

20. How often do (or did) you look at your smart energy device?

[Multiple choice (only one answer)]

○	○	○	○	○	○
Never	Very rarely *Once a week or less*	Rarely *2-3 times a week*	Occasionally *4-5 times a week*	Frequently *6 or more times a week*	Very frequently *at least once a day*

21. Do (or did) the smart device(s) you have (or had) ever display information that encouraged you to save energy?

[Multiple choice (only one answer)]

○ Yes ○ No

Please explain in what way(s) your smart device(s) did or did not encourage you to save energy:

[Optional open comment box]

Real Time Energy Data

22. How useful do you think it would be to know your real-time energy consumption?

[Multiple choice (only one answer)]

○	○	○	○	○
Not at all useful	Slightly useful	Moderately useful	Useful	Very useful

Please explain why:

[Optional open comment box]

Real Time Energy Data Cont.

23. How likely do you think it would be that knowing your real-time energy consumption would encourage you to use less?
[Multiple choice (only one answer)]

Not at all likely	Slightly likely	Moderately likely	Likely	Very likely
○	○	○	○	○

Please explain why:
[Optional open comment box]

Section 3: Household Characteristics & Demographics

Household Characteristics (BOS VERSION)

Do you live:
[Multiple choice (only one answer)]

- ○ At home with parents or other relatives
- ○ In privately rented accommodation alone
- ○ In privately rented accommodation shared with others
- ○ In privately owned accommodation alone
- ○ In privately owned accommodation shared with others
- ○ In Manchester Met halls
- ○ In private halls

Do you pay all of or a part of the energy bills in your accommodation?
[Multiple choice (only one answer)]

○ Yes ○ No - it is included in my board / rent / accommodation fees

Household Characteristics (SM VERSION)

Who do you live with? Please tick all that apply.
[Multiple choice (check all that apply)]

- ☐ No-one
- ☐ Partner (who is a student)
- ☐ Partner (who is not a student)
- ☐ Parents / legal guardians or other adult (aged 18+) family members
- ☐ My children or other family members aged under 18
- ☐ Other students
- ☐ Non-family / non-student adults

Household Characteristics (SM VERSION) Cont.

Please select the statement below which best describes the ownership of your home:
[Multiple choice (only one answer)]

- ○ I and/or my partner owns the home that I live in
- ○ My parents or other family members own the home that I live in
- ○ I live in university owned or privately owned student halls
- ○ I live in a rented home
- ○ Other (please describe in the box below)

[ ] *[Text Box, 100 characters]*

Please select the statement below which best describes your level of responsibility for paying for energy usage in your home:
[Multiple choice (only one answer)]

- ○ I do not pay for my energy usage
- ○ Payment for energy use is included in my rent/board/accommodation fees
- ○ A fair use / set amount of energy use is included in my rent / board / accommodation fees (I pay for excess usage / split excess with my housemates)
- ○ I pay a share of the energy usage (e.g. split the bill with housemates / family members)
- ○ I pay for the entire energy usage in my home (e.g. no-one else contributes)

Demographics

Gender
[Multiple choice (only one answer)]

○ Male ○ Female ○ Other ○ Prefer not to say

Age in years (please enter as whole number)
[Numerical text box]

Country of domicile
[Multiple choice (only one answer)]

○ United Kingdom ○ EU / EEA Overseas ○ International Overseas

Ethnic background
[Multiple choice (only one answer)]

- ○ White British
- ○ Asian British
- ○ Black / African / Caribbean / Black British
- ○ Other White background
- ○ Other Asian background
- ○ Other Black background
- ○ Other ethnic group
- ○ Prefer not to say
- ○ Mixed / multiple ethnic groups

Level of Study
[Multiple choice (only one answer)]

○ Undergraduate ○ Postgraduate

Course of study (e.g. degree title):
[Open comment box]

Appendix 6. Example of Open-ended Question Coding Student Survey

			DATA COLLECTION & SECURITY			DIFFICULTIES IMPLEMENTING			
			DATA	SECURITY	PRIVACY	COST+TIME	ENGAGEMENT	POLITICAL WILL	REALISTIC?
MY ID	Heard of SC	What concerns or worries do you have related to the "Smart City"?	Mass data collection/sharing of data/data abuse/reliability of big data analy	Hacking/security/lack of encryption/cyber attacks/data phishing/safety/data protection/misuse of informati	Privacy/Too much info being public/being spied on/surveillence/monitoring	people/energy prices/government investments/costs for infrastructure/not compatible with current/c	Citizen participation/lack of engagement/wont be used/that people wont engage/some not bothered/awareness	Lack of political will	unrealistic / difficult to implement / not fully or well implemented/
230	Yes	I've seen Terminator.							
231	No	No idea							
232	No	None							
233	No	I do not have any yet							
234	Yes	It is not 100% will be safe, Also, people will depend on technology nothing to do (more		1					
235	No	Unfamiliar with concept so unable to fairly express worries							
236	No	That there is a lot of time and money going into it (I presume) and I worry that it won't have a big enough effect on energy saving to be				1			
237	No	-							
238	No	Could be vulnerable to hackers or even corruption, very easy access and transportation of information would make it easy to achieve.		1					
239	No	I don't know enough about it							
240	No	I don't know							

Appendix 7. Code Table for the Innovation Challenge

Master Code	Definition	Sub-code	Definition
Smart Solution Features	Relates to features participants felt were important in order to ensure engagement	**Cues**	Relates to students preferences about how information is presented within the smart solution, including visuals
		Context	Relates to how the smart solution can place energy consumption into context through providing details about positive and negative impact
		Challenge	Relates to how a smart solution can challenge someone to save energy such as gamification and goal setting etc.
(Overcoming) barriers to Engagement	Relates to perceived barriers to engagement with the smart solution and how to overcome them	**Team Spirit**	Relates to how a community feeling and team spirit can motivate students to save energy together and how it can be discouraging if not everyone is participating
		Climate Change Concern	Relates to the level of concern a person has about climate change as this can be a barrier to reduce energy consumption

Appendix 8. Beat the Peak App Missions

Greedy to Green Kitchen

Your kitchen probably contain the most energy greedy appliances in your house. But small changes can lead to less wasted energy: (1) Turn the oven off slightly before the food is done. (2) Cooking with lids on your pans will keep the heat in and cook it faster. (3) Try to only boil the kettle with the amount of water you are going to use. (4) Check the temperature setting on your refrigerator, around 3°C is efficient. (5) Check how full your freezer is, the fuller = more efficient. (6) Defrost your freezer if it contains a lot of ice.

Wash it Eco

Your washing machine accounts for approximately 7% of your energy bill. But here is how you can reduce energy when doing your laundry: (1) Wait until you have a full load before washing. (2) Wash on a short 30 degree cycle. (3) Wear your clothes for an extra day, PS; sniff test required! (4) Select the 'eco' option on the machine for your next load of washing. (5) Instead of using the tumble dryer, dry your clothes on a rack. (6) Try not to leave wet clothes in the washer so you have to re-wash them.

Every day Saver

Sometimes it can be hard to save energy on a daily basis. Try to incorporate these tips into your daily routine: (1) Turn off the lights when you leave a room. (2) Do not leave appliances on standby, switch them off at the socket. (3) Avoid using hair dryer, straightener or electric shaver, do a crazy hair day! (4) Turn off your electric heater if you have one, put on extra clothes instead. (5) Make a meal from ingredients you do not have to cook. (6) Use the microwave to cook some meals, it uses less energy than the cooker.

Beat the Peak Switch off!

At peak times, the electricity grids in Britain are under constraint due to high demand, meaning e.g. more power stations are required to be built in the future. Using electricity at off peak times, can prevent that and save the environment from a lot of CO2 emissions. This challenge calls for you to switch everything off during peak time 5pm – 7pm. Tips: (1) Turn off everything and go out. (2) Turn off all lights in all rooms. (3) Have your meal outside these hours. (4) Do not hoover. (5) Do not do your laundry. (6) Do not charge devices.

Check your mate

Saving energy alone is good, but doing it together with others is better! We challenge you to do fun and energy saving activities with your friends and family this week. Get them engaged! Some tips: (1) Have a candlelit board game night with your friends or family. (2) Play a game in your household where everyone get points for spotting switches that can be turned off. (3) Do a load of washing together with someone in your household. (4) Cook a meal for each other in turns rather than separately. (5) Watch a film together on one device.

Take the pledge

Today, you are challenged to take one or multiple energy saving pledges to carry on with! Pledges: (1) Buy energy saving bulbs for your bedroom lights. (2) Turn off all appliances at sockets. (3) Check the environmental policy of your energy provider and consider a switch. If you live in Manchester, google "Greater Manchester Big Clean Switch Campaign" for more info. (4) Change one of your bad energy habits. (5) Continue with some of the energy saving tips learnt from the app after trial. (6) Challenge someone else to take one of these pledges.

Appendix 9. Focus Group Plan and Schedule

Introduction: A little bit on the background of the app, why it was made and what it sought to achieve. Then I will present the agenda so they understand what we will be doing for the next hour. The people in the group will have tested the same app so the discussion stays focused. Everyone has to fill out a short questionnaire at the beginning of the focus group covering demographics and characteristics.

Discussion 1: App evaluation: energy saving and motivations

Q1. (a) What did you like about the app and what did you not like? A list will be made from an A3 sheet with post-its.

(b) Which features would you like to see in the future versions of the app?

Q2. (a) Did the app change any of your energy behaviours?

(b) Were there any energy saving tips prompted by the app that you already do?

(c) If the app did change your behaviour, do you think you will keep saving energy post app-trial?

Q3. (a) Is there anything else that would encourage you to save energy besides this app or other technologies e.g. smart meters?

(b) Would that encourage you more or less than the app?

I will also explain some of the things that the app was meant to do, but did not. However, I am hoping to do this towards the end so that the conversation does not take a negative turn.

Comments: I will draw on ideas that were presented in the innovation challenge to further spike discussions here, e.g. if it is suggested that the reward system within the app is not motivating enough.

Intermittent presentation:

I will present ideas from the innovation challenge to see what participants think of those.

Q5. In the survey, we found that top motivators for being more environmentally friendly were university and social media. With this in mind, to what extent do you think a university promoted energy saving app will influence people to be more environmentally friendly? (Integrated in Birley + broader scope). Link 5 & 6.

Q6. The main motivations for saving energy are either environmental or financial. How can the app encourage people who do not pay for their energy to save energy? (This question depends on whether the focus group participants live in split incentives or not which I will specifically ask respondents about).

Discussion 2: Smart Tech and the Smart City: Concerns, Perceptions and Aspirations

Introduction: I will quickly present an overview of what a Smart City is here as the survey found that majority of respondents had never heard of the concept.

Q(7). How did it make you feel thinking you have been part of a trial that may lead to actual implementation of this app for Birley Residents? Would you like to be part of more initiatives like this and do you think it can help energy saving in student halls? Knowing it is student tested rather than just implemented.

Q1. Why do you think that respondents in my survey all knew how to describe a smart technology but not a Smart City?

- **(a)** What can the smart city do to make people aware of their projects and outcomes? (Initiatives drown in each other which makes it less transparent).

Q2. What do you think are the main challenges to the Smart City? (A3 List with post it's of which themes will be discussed).

Q3. (It is expected that they all list privacy as a challenge. If not I will ask why not). Are you concerned about the data that is being collected about you? Does it make you use smart technology differently? Are there a difference in public and private space and what type of data?

Q4. How can the smart city show you that the data collected can benefit you?

- **(a)** Where are your boundaries for exchanging your data for services?

Q5. What do you think about the new privacy legislations coming out? (I will tell them about this if they do not know. If they have no idea that is also a finding).

- **(a)** Will it change the way you use smart technology?
- **(b)** Do you think it will make people more aware and in control of their data?

Comment: Here, after they have discussed, I will present the main findings from the survey which are privacy and security. I will also tell them about two things they may be unaware of and see how they react, hoping it will further spike a discussion around privacy and data ownership.

Closing of discussion

Here, I will summarise the main points from both discussions and allow for any questions or further comments anyone may have. To conclude, participants will be thanked for their time.

Appendix 10. Focus Group Recruitment Advert

Assignment Available – 'Beat the Peak' App Tester

The Environment Team need a group of students to test an App called 'Beat The Peak' between 16th April and 29th April 2018.

Duties will include downloading an energy saving app called 'Beat the Peak' on to a smartphone or tablet and interact with it for 15 minutes every day for 2 weeks starting on 16th April until (and including) 29th April 2018.

The students would then be required to attend a 1.5 hour focus group to evaluate their experience of the app when thetrial period has ended. The focus groups will be held in the John Daltonbuilding.

Hours of work: 15 minutes (0.25 hours) every day for two weeks from 16/04/2018 until 29/04/2018
1.5 hours focus group in a slot during week commencing 30/04/2018 or 07/05/2018

Rate of pay: this role will be paid at the standard Jobs4Students pay rate which stands at £8.77 per hour (£7.83 hourly pay + £0.94 holiday pay)

Personal Requirements:

No particular skills or experience are required but:

Applicants must:

1. Have access to a Smartphone or Tablet to work on this assignment
2. Be available to attend **one** of the focus group sessions listed below:

Monday 30th April: Afternoon
Wednesday 2nd May: Afternoon
Friday 4th May: Morning

Tuesday 8th May: Morning
Wednesday 9th May: Afternoon
Thursday 10th May: Afternoon

To apply: please email jobs4students@mmu.ac.uk your name, student ID, course title and contact number letting us know which focus group slot(s) you would be available to attend along with confirmation about whether you have a smartphone or tablet.

Closing date for applications – 9.00am on Thursday 5th April

Appendix 11. Code Table for the Focus Groups

Master Code	Definition	Sub-code	Definition	Code Type
Cues	Relates to students preferences about how information is presented within the app, including visuals.	**Colours**	Relates to in-app colours that students either find annoying or visually stimulating	**Emic**
		Ease of use	Relates to how easy the students thought the app was to use	**Emic**
		Nudging	Relates to how the students found nudging through notifications	**Emic**
		Language	Relates to how the students found the language used in the app	**Emic**
		Overall design	Relates to how the students found the overall design of the app	**Emic**
		Video	Relates to how a video instead of just image display could be more engaging	**Emic**
		Verbal	Relates to how a verbal element in the app can encourage students to save energy	**Emic**
		Interactiveness	Relates to how interactive the students thought the app was and how interactive they think potential energy saving smart tech should be	**Emic**

Context	Relates to how the app places energy consumption into context through providing details about positive and negative impact.	**Tips**	Relates to what the students thought about the energy saving tips that was prompted by the app	**Emic**
		Environmental consequences	Relates to how illustrating environmental and financial consequences of behaviour can impact on students' motivation to save energy	**Emic**
		Personal impact	Relates to how understanding personal impact of pro-environmental behaviour can be encouraging	**Emic**
		General information	Relates to how the students found the general information displayed in the app	**Emic**
		Personalise	Relates to how personalised information can make it more encouraging to save energy	**Emic**
		Real-time consumption	Relates to how motivating students find it to see their real time energy consumption	**Etic**
		Tangibility	Relates to how the energy information should be contextualised into tangible examples	**Emic**
		Savings	Relates to how illustrating environmental and financial savings can impact on students' energy saving	**Emic**

Challenge	Relates to how a smart technology can challenge someone to save energy such as gamification and goal setting etc.	**Leaderboard**	Relates to what extent a leaderboard to encourage the students to save energy in student halls where they do not pay for bills	**Emic**
		Points system	Relates to how a points system can act as an incentive to save energy	**Emic**
		Goal setting	Relates to how goal setting can encourage the students to save energy	**Emic**
		Gamification	Relates to what extent games can encourage students to save energy in student halls where they do not pay for bills	**Etic**
		Comparison to others	Relates to how students would feel more ecouraged to save energy if they could compare their consumption to others'	**Emic**
		Competition	Relates to what extent a competition set up could encourage students to save energy in student halls where they do not pay for energy bills	**Emic**

Motivational Factors	Relates to the factors that motivates students to save energy.	**Habits**	Relates to how significant habits and routines are for the students' energy saving behaviour	**Etic**
		Environment	Relates to how significant environmental factors are for the students energy saving behaviour	**Emic**
		Finance	Relates to what extent monetary factors can be encouraging for students to save energy	**Emic**
		Awareness	Relates to how environmetal and energy awareness could encourage students to save energy	**Emic**
		Enforcement	Relates to how enforcement can make students behave more (or less) environmentally friendly	**Emic**
		Community Feeling	Relates to how a community feeling and team spirit can motivate students to save energy together and how it can be discouraging if not everyone is participating.	**Emic**
		Relevance	Relates to how local and personal effects of climate change is more likely to motivate students to save energy as it feels more relevant	**Emic**
		Resposibility	Relates to how seeing your usage can make you take responsibility for the environment	**Emic**
		Convenience	Relates to what the students think of various smart technologies used to encourage energy saving.	**Emic**
		Incentivisation	Relates to how they believe incentives can encourage energy savings	**Emic**
		Non-Smart tech solutions	Relates to how non-smart technology solutions can motivate students to save energy more or less than smart tech	**Etic**
		Sustained Behaviour	Relates to how the students believe the app has a long-term effect on their behaviour or not	**Etic**
		University	Relates to how university is a motivational factor for saving energy	**Etic**
		Co-creation	Relates to how students feel about co-creating the app	**Etic**

Perceptions of the Smart City	Relates to perceptions (mostly concerns) regarding the smart city	**Viability**	Relates to how the students don't think the smart city concept will be viable	**Emic**
		Visability	Relates to how lack of a more visible smart city can cause concerns and disengagement	**Emic**
		Access	Relates to concerns about certain citizens not being able to access smart technologies	**Emic**
		Cost	Relates to concerns regarding the financial cost of building the Smart City	**Emic**
		Smart City initiatives	Relates to students perceptions about smart city initiatives.	**Etic**
		The smart label	Relates to notions around the smart label	**Emic**
		Dystopian futures	Relates to how the students envison the smart city as a dystopian future	**Emic**
		Underlying issues	Relates to how their notions of how the smart city does not address underlying urban issues	**Emic**
		Resistance	Relates to how the students think resistance to change is a barrier to the smart city	**Emic**
		Dependency	Relates to the concern about being dependent on technology in case errors happen	**Etic**
		Tech advancement	Relates to the concerns regarding rapid technological advancement	**Emic**
		Exclusion/Inequalities	Relates to concerns regarding the exlcusions and inequalities to the smart city	**Etic**

Concerns to Smart Technology Usage	Relates to the broader concerns students have about the use of smart technology, apps and IoTs	**Terms & Conditions**	Relates to perceptions on terms & conditions of apps	**Etic**
		Privacy	Relates to concerns regarding privacy when using smart technology	**Etic**
		Hacking	Relates to concerns about being hacked and perceptions around hacking	**Emic**
		Targeted Advertising	Relates to perceptions around targeted advertising	**Emic**
		Tracking	Relates to concerns around being tracked or monitored by smart technologies	**Emic**
		Security	Relates to perceptions around storage and protection of data	**Emic**
		Surveillence	Relates to concerns about surveillence issues imposed by smart cities	**Emic**
		Addictiveness	Relates to how students perceive smart technology as addictive	**Emic**
		Data sharing	Relates to perception around sharing of personal data	**Etic**
		Purpose of data	Relates to concerns around lack of transparency for collection of certain data	**Etic**
		Trust	Relates to the students not trusting private companies	**Emic**
		Exploitation	Relates to how students feel companies exploit them for data	**Emic**
		Precautions	Relates to precautionary measures undertaken by students in order to protect their privacy	**Emic**
		App strorage	Relates to the size of the app in (MB-GB etc.) and how it takes up too much storage space on a phone	**Emic**

Appendix 12. Research Outputs

Oral Presentations

Sønderland Saga, R. Dunk, R. M. and O'Hare, P. (2018). 'Understandings of the Smart City: The Perspective of University Students'. *Fourth Energy and Society Conference: Energy transitions in a divided world*. Exeter, UK.

Sønderland Saga, R. Dunk, R. M. and O'Hare, P. (2018). 'University Students' Perspectives of a Smart City: Integrating Needs and Aspirations'. *EASST 2018: Making Science, Technology and Society together*. Lancaster, UK.

Sønderland Saga, R. and Dunk, R. M. (2017). 'Gamification in a Living Lab: Energy saving challenges in student halls'. *MMU Science and Engineering Research Symposium*. Manchester, UK.

Articles

Sønderland Saga, R. and Dunk R. M. (2017). 'Gamification in a Living Lab: Energy saving challenges in student halls'. *Environmental Scientist*, 26(4), pp. 32 – 39.