How Do Incumbent Energy Firms Realise the Potential for Value Creation from the Adoption of Smart Meters?

A study of organisational affordances, organisational capabilities, and generative mechanisms in the UK energy sector

By

Sarah Oufan

Marketing and Strategy Section, Cardiff Business School, Cardiff University

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ABSTRACT

Big data technologies are advanced technologies that enable data to be collected in real-time at large volume and at low cost. Anecdotal evidence suggests that insights derived from big data have the potential to transform business strategies and business models and thereby improve marketing, product and service development, human resources, operations, and other core business functions. As such, there has been significant academic and practitioner interest in studying big data and value creation in organisations. However, much of the previous research has focused on studying the relationship between big data resources and investments and their impact on firm performance, and therefore have overlooked the processes and mechanisms through which firms realise the value creation potential from big data technologies. Lack of knowledge and understanding on how organisations realise the value creation potential may explain why some organisations still fail to reach their strategic goals despite investing substantial resources into big data technologies.

Against this backdrop, this thesis aims to address this research gap by seeking to understand how organisations realise the value creation potential from adopting a specific big data technology (i.e., smart meters) in the UK energy sector. To do so, I collect qualitative data (interviews, company documents, news articles, governments reports, and publicly available documents) in two case study organisations: BlueHouse and GreenWorks (anonymised names).

Using affordance theory lens, I provide empirically grounded insights into the opportunities for value creation that smart meters provide (organisational affordances), explain how these value creation opportunities are realised (organisational capabilities and actualisation enablers), and explain what constrains these value creation opportunities from being realised (generative mechanisms). My findings extend affordance theory by empirically examining the role of organisational capabilities and generative mechanisms in the affordance actualisation process. They also provide meaningful insights on the process of realising the value creation potential from the adoption of a new technology within incumbent firms.

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1 THESIS INTRODUCTION

1.1 INTRODUCTION

> *"Transformation is impossible unless hundreds or thousands of people are willing to help, often to the point of making short-term sacrifices. Employees will not make sacrifices, even if they are unhappy with the status quo, unless they believe that useful change is possible. Without credible communication, and a lot of it, the hearts and minds of the troops are never captured."*
>
> (John P. Kotter, Leading Change)

In 2008, the UK government passed the *Energy Act 2008*[1] which gave powers to begin the process of adopting smart meters in the UK energy sector. A few years later, in 2011, the smart meter mandate was in force, and the smart meter rollout began, whereby energy suppliers were required to offer every home and business in the UK a smart meter by 2020. Smart meters are advanced electricity and gas meters that offer a range of intelligent functions to consumers, operators, and networks by providing the means to automatically record and communicate energy consumption data in near real-time (Hinson 2019). They are the biggest and most important digital transformation upgrade to national energy infrastructure in the UK (Ofgem 2017), with the aim to build a flexible and resilient energy system that is fit for the 21st century (BEIS 2018). Smart meters are intended to create a digital and data-driven energy system that will provide many intended benefits for energy consumers (e.g., accurate bills, easier switching), energy suppliers (e.g., reduced customer service overheads, reduced site visits), and energy networks (e.g., balancing the grid) (Hinson 2019). Last but not least, smart meters encourage the emergence of innovation opportunities within and beyond the energy sector and allow for the seamless integration of new technologies and services into the energy system (BEIS 2018). The combined benefit of smart meters to consumers, suppliers, and networks is estimated at £19.5 billion (BEIS 2019).

Fast forward 10 years, many of the intended benefits from smart meter adoption remain unrealised. While significant progress has been made with the installation of 21.5 million

[1] Energy Act 2008: https://bills.parliament.uk/bills/259

meters across the UK (BEIS 2020)[2], it still leaves a vast majority of meters that remain uninstalled – approximately 30 million of them. While there have been several new entrants to the energy market that have been able to capitalise on the value creation opportunities from the adoption of smart meters, many of the incumbent energy firms have not been able to match the same level of benefits realisation. As a result, the smart meter rollout has only delivered a net benefit of £6 billion in contrast to its intended net benefit of £19.5 billion, falling short of £13.5 billion (Hinson 2019). The aim of this thesis is to better understand **why** many of the value creation opportunities from smart meters remain unrealised, and in particular within the context of incumbent energy firms.

Big data technologies (e.g., smart meters; smartphones, smart watches) are advanced technologies that enable data to be collected in real-time, at large volumes, and with low costs (Ringel and Skiera 2016). Anecdotal evidence suggests that the insights derived from big data have the potential to transform business strategies and business models and thereby improve marketing, product and service development, human resources, operations, and other core business functions (Chen et al 2015). As such, there has been growing interest in management research on big data, with the number of academic and practitioner publications on the topic growing exponentially year on year. However, much of the previous research has focused on examining and measuring the impact of big data investments on firm performance (Gupta and George 2016; Côrte-Real et al. 2017; Mehmood et al. 2017; Shamim et al. 2019), and have therefore overlooked the processes and mechanisms through which firms realise value from big data technologies (Günther et al. 2017). As a result, previous studies have failed to address the reasons why organisations still fail to reach their strategic goals despite investing substantial resources into big data technologies (Grover et al. 2018), as exemplified by the smart meters mandate.

In the last decade, affordance theory has emerged as the predominant way to theorise about IT-associated organisational change by leading researchers in the field of information systems (e.g., Leonardi 2013; Volkoff and Strong 2013; Strong et al. 2014; Lehrer et al. 2018; Dremel et al. 2020), and more recently in the field of marketing (De Luca et al. 2020). Within the management literature on big data, affordance theory has been utilised to conceptualise big data technology in terms of its possibilities for action (opportunities for value-creation;

[2] Install figure is true as of 31 March 2020

organisational affordances), and how organisations realise these value creation opportunities (affordances actualisation) (Lehrer et al. 2018; Dremel et al. 2020a; De Luca et al. 2020). Therefore, affordance theory has helped researchers conceptualise and theorise on the processes and mechanisms through which firms realise value from big data technologies through investigating the rich and convoluted experience of organisational actors involved in adopting a new big data technology.

While significant attention has been paid to studying the organisational affordances of big data technologies and their actualisation in several industries including automotive engineering (Leonardi 2013), healthcare (Strong et al. 2014; Anderson and Robey 2017), financial services (Leidner et al. 2018), insurance, banking, telecommunication, e-commerce (Lehrer et al. 2018), gaming (Tim et al. 2020) and automotive manufacturing (Dremel et al. 2020a), no study has so far looked into the energy sector, despite the recent and relevant adoption of smart meters in the energy industry in the UK and across the world. Smart meter adoption is both of value and relevance to the study of organisational affordances and affordance actualisation, as it is an ideal setting to investigate how energy firms realise the value creation potential afforded to them by the adoption of big data technologies; in fact, smart meters are viewed as biggest and most important digital transformation upgrade to national energy infrastructure in the UK (Ofgem 2017). Anecdotal evidence has suggested that smart meters enable several possibilities for action for energy consumers (e.g., reduce energy bills), energy companies (e.g., energy price customisation), and system operators (e.g., optimise energy flow) (Zheng et al. 2013; DECC 2015; BEIS 2018). However, no study has empirically and systematically analysed the value creation potential from adopting smart meters within organisations.

Against this backdrop, this study extends the affordance theory perspective to the context of the energy sector. By doing so, this research helps us understand and explain how organisations - especially complex ones - develop and implement new possibilities for action in light of the adoption of a big data technology – smart meters. This research does so in three key ways: first, by understanding what these possibilities for action are (organisational affordances). Second, by understanding how these possibilities for action can be realised. Third, by understanding why certain possibilities for action are not realised despite being perceived as “value-adding”.

1.2 RESEARCH PROBLEM AND RESEARCH QUESTIONS

In light of the above, the key research problem that this thesis seeks to address is:

> *How do incumbent firms in the energy sector realise the value creation potential from the adoption of smart meters?*

This research problem statement is the source of the following three research questions:

1. What are the organisational affordances that smart meters afford?
2. What are the key organisational capabilities that enable smart meter affordances actualisation? And how do they enable the actualisation process?
3. What are the generative mechanisms that enable/constrain affordance actualisation? And how are they manifested in terms of empirical outcomes?

1.3 RESEARCH METHODOLOGY

To answer the research questions, I adopt a qualitative case study design informed by a critical realist philosophical foundation (Bhaskar 1975; Bhaskar 1979; Wynn and Williams 2012). The reason for adopting a qualitative study over a quantitative study is to explore and understand how big data value creation is realised in organisations (e.g., understand the processes and mechanisms); as opposed to, testing the relationship between big data technologies and organisational outcomes (e.g., between big data investments and firm performance) (Saunders et al. 2015). In fact, a case study design allows for an in-depth investigation of a contemporary phenomenon within its real-life context (Yin 2014), by developing holistic descriptions (Easton 2010). Moreover, the case study design has become a commonplace methodology within affordance-based big data research (Lehrer et al. 2018; Dremel et al. 2020a). The adoption of a critical realist philosophical foundation aligns with my world view on knowledge creation: as a researcher, I view the world as independent of human consciousness, whereby knowledge about the world can be achieved through our observations of it, hence knowledge is socially constructed (Eriksson and Kovalainen 2008). Additionally, critical realism is most consistent with affordance theory's underlying ontological and epistemological assumptions about the nature of reality and what we can know (see section 3.1) (Volkoff and Strong 2017). For these reasons, critical realism was deemed that most suitable philosophical foundation.

To answer the research questions, I conducted primary data collection, consisting of 47 semi-structured interviews over 10 months between May 2018 and March 2019, which resulted in 581 pages of interview transcripts. Data collection took place in two key energy companies in the UK, which I refer to with the pseudonyms 'BlueHouse' and 'GreenWorks'. The rationale for the inclusion of two cases as opposed to just one is that the inclusion of more than one case study allows for the processes, outcomes, generative mechanisms, and conclusions about causes and outcomes to be drawn more effectively (Ackroyd and Karlsson 2014), and avoid the risk of micro level analysis whose causal chain ends at the office door (Kessler and Bach 2014).

During my time at both companies, I spent several hours in participant observation. In addition to conducting interviews and participant observation, I also reviewed several company documents, news articles, governments reports, and publicly available information that were of relevance to the research problem. The inclusion of complementary data sources helped me establish a more assured basis for the identification of organisational capabilities and generative mechanisms by incorportating data triangulation into my analysis (Kessler and Bach 2014).

In order to analyse the rich qualitative data generated, I borrow from the principles of grounded theory, in particular the principles of constant comparison, memos, open coding, and axial coding (Strauss and Corbin 1998). The reason for doing so is because grounded theory and its principles encourage thorough and systematic scrutiny and analysis of the data, and help the researcher avoid the risk of premature closure (Goulding 2002), which is deemed important to gain a rich, in-depth, and contextual understanding of the focal research problem.

1.4 RESEARCH FINDINGS AND CONTRIBUTION

This thesis provides novel insights and contributions into how organisations realise value from the adoption of big data technologies through investigating affordance perception and actualisation in a highly relevant but under-researched empirical context; specifically, the focus is on the energy sector and the adoption of smart meters by incumbent firms. This research is set in the UK energy sector, whereby I investigate how two energy companies (GreenWorks and BlueHouse) perceive and actualise smart meter affordances. This research contributes to knowledge on big data and organisational value creation, organisational affordance actualisation, and more broadly, to the literature on information systems, innovation, and firm performance. It does so in three key ways:

First, this thesis sheds light on the organisational affordances that smart meters enable that were previously unknown to the literature. I do so by deriving an empirically-grounded conceptualisation of 17 organisational affordances that smart meters enable. I also categorise these organisational affordances into five key clusters including customer-oriented affordances, energy trading affordances, business process improvement affordances, energy market localisation affordances, and service innovation affordances.

Second, this thesis provides insights into how energy companies realise the value potential from big data technologies that are previously not studied in the context of the energy sector. The findings of this thesis shed light on how energy companies perceive and actualise organisation-level smart meter affordances. I do so by documenting a set of organisational capabilities needed to actualise smart meter affordances, and by explaining how each organisational capability delivers several "actualisation enablers" that promote the affordance actualisation process. The organisational capabilities identified are a combination of technical and non-technical capabilities and include big data management capability, big data analytics capability, technology adoption capability, customer engagement and communication capability, innovation capability, communication and collaboration capability, and strategic management capability.

Third, this thesis not only sheds light on how smart meter affordances are actualised within energy companies but also why organisational affordances are not actualised despite organisations having the necessary capabilities to perceive and actualise them. This has not been previously explained in the literature so far. I do so by introducing, conceptualising, and providing empirical evidence for a set of generative mechanisms that - for the most part - constrain an organisation's ability to actualise smart meter affordances. The generative mechanisms identified include an organisation's 'immune system', siloed organisational structures, organisational legacy, and a prevention-driven regulatory focus.

All three research contributions provide important and relevant theoretical, policy, and managerial implications, which I discuss in detail in the discussion and conclusion chapter (see chapter 7).

The quote at the beginning of this chapter captures the essence of this thesis: change and digital transformation within organisations is a challenging, complex-to-organise endeavour that requires thousands of people in organisations "*to believe that useful change is possible*" and to come together in a communicative collaborative way to make change happen (Kotter 2011). The aim of this thesis is to better understand how organisations realise the value creation potential from the adoption of a big data technology –smart meters. Despite smart meters being viewed as a technical artefact, realising the value creation potential from smart meters is far from simply being a technical endeavour. In fact, this research has highlighted that - more than anything else – people and actors in organisations play an important and key role in leading organisational change and digital transformation that enables them to realise the value creation potential from adopting smart meters. This research has shed light on the challenging nature of digital transformation and the importance of understanding how change happens and why it may not happen. Moreover, this research speaks to the fundamental role that actors in organisations (including leaders) play in identifying the value creation potential that smart meters enable, in identifying and developing the organisational capabilities that enable them to do so, and in identifying the reasons why they are unable to reap the rewards of their digital transformation efforts.

In the following section, I provide an outline for the structure of the thesis.

1.5 THESIS OUTLINE

The remainder of the thesis is structured as follows (see Figure 1 below). In **chapter two**, I discuss the literature review and theoretical framework. Here I highlight the research gaps through articulating the big data definitions, big data value creation opportunities, and the prevalent theoretical approaches utilised in extant literature. In addition, I position affordance theory as the theoretical foundation to address the research questions from this research.

In **chapter three**, I discuss and outline the research methodology. In particular, I discuss the philosophical standpoint of critical realism and the approach to qualitative case study design. I also outline the processes of data collection, coding, analysis and interpretation.

In **chapter four**, I seek to answer the first key research question of: *What are the organisational affordances that smart meters afford?* I do so by outlining 17 key organisational affordances that smart meters afford and categorise them into five key clusters.

In **chapter five**, I seek to answer the second key research question: *What are the key organisational capabilities that enable smart meter affordances actualisation? And how do they enable the actualisation process?* I do so by highlighting the seven key organisational capabilities that energy companies need to actualise smart meter affordances. I also discuss how each organisational capability enables affordance actualisation by highlighting the actualisation enablers for each organisational capability.

In **chapter six**, I address the third key research question: *What are the generative mechanisms that enable/constrain affordance actualisation? And how are they manifested in terms of empirical outcomes?* I do so by identifying and articulating the generative mechanisms that enable or constrain an organisation's ability to actualise smart meter affordances. I highlight four key generative mechanisms alongside their manifestations in terms of empirical outcomes.

Finally, in **chapter seven**, I discuss the contributions of this thesis to the wider academic literature, as well as management practice and policy. I conclude the chapter by acknowledging the research limitations and highlighting avenues for future research.

Chapter 2 - Literature Review and Theoretical Framework

This chapter is mainly concerned with reviewing the existign literature, as well as identifying and articulating the suitable theoretical framework for this thesis. The chapter is structured around four key elements: big data definitions, big data value creation opportunities, theoretical approaches in big data management research, and utilising affordance theory as the main theoretical foundation for this thesis.

Chapter 3 - Research Methodology Chapter

This chapter highlights the way in which data was collected and analysed in order to answer the research questions. The chapter is structured around five key elements: research paradigm, qualitative case study, research context, data collection, and data analysis.

Chapter 4 - Findings I

This chapter is concerned with conceptualising, articulating, and discussing the first key set of findings from this research: the organisational affordances. It does so by highlighting 17 organisational affordances that smart meters afford by categorising them around five key clusters of organisational affordances.

Chapter 5 - Findings II

This chapter is concerned with conceptualising, articulating, and discussing the second key set of findings stemming from this research: the organisational capabilities. It does so by highlighting seven key organisational capabilities that organisations require to actualise smart meter affordances; as well as, highlighting the actualisation enablers for each organisational capability.

Chapter 6 - Findings III

This chapter is concerned with conceptualising, articulating, and discussing the third key set of research findings that this research sheds light on: the generative mechanisms. It does so by highlighting four key generative mechanisms that - for the most part - constrain an organisation's ability in actualising smart meter affordances. It also highlights the empirical outcomes for each generative mechanism.

Chapter 7 - Discussion and Conclusion

This chapter is concerned with the contributions of this thesis to the wider academic literature, management, and policy. The chapter is structured around four key elements: theoretical implications, policy implications, managerial implications, and research limitations and future directions.

Figure 1. Thesis Outline

CHAPTER TWO

2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

BIG DATA DEFINITION, BIG DATA VALUE CREATION OPPORTUNITIES, AND THEORETICAL APPROACHES

2.1 INTRODUCTION

Big data comes from everywhere, from sensors used to gather climate information to sensors embedded into mobile phones, automobiles, smart energy meters, and industrial machines to posts on social media, multimedia content (pictures and videos), and purchase transaction records, just to name a few (EIU 2012; Millage 2013). Today, consumers are *"communicating, browsing, buying, sharing, searching [and] creating their own enormous trails of data"* (McKinsey & Company 2011). These data trails are mainly driven by the widespread diffusion and adoption of mobile devices, social media platforms, and "Internet of Things" related concepts, which have increased business data generation and collection speed exponentially (Fosso Wamba et al. 2015). 90% of the data on the internet today were created since 2016, due to people, businesses, and devices becoming data factories that pump out vast amounts of data every day (IBM 2017). For example, Walmart collects 2.5 petabytes of data every hour, whereby one petabyte equals 10^{15} bytes of data (Jin et al. 2016).

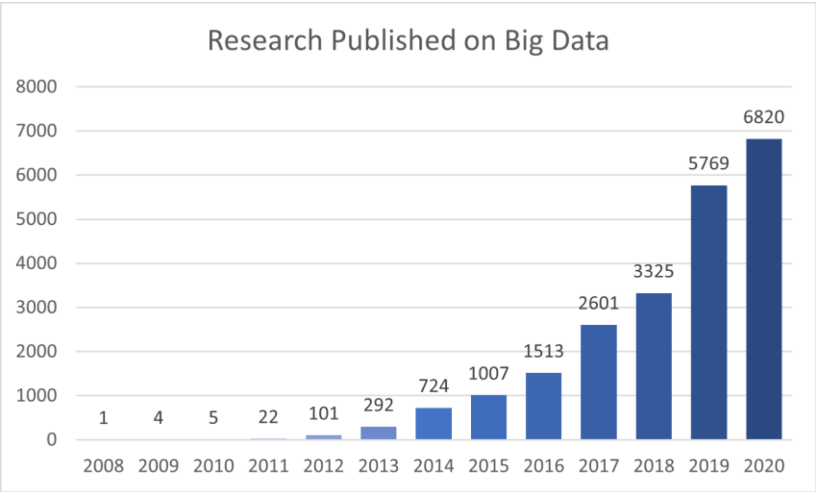

Figure 2. Research published on big data in management research between 2008 and 2020

Anecdotal evidence suggests that insights derived from big data have the potential to transform business strategies and business models and thereby improve marketing, product and service development, human resources, operations, and other core business functions (Chen et al. 2015). As such, the growing interest in research on big data in the business discipline is not surprising. The graph above showcases this surge in interest (see Figure 2), whereby the number of publications on big data has been growing exponentially year on year.

The literature review for this thesis follows a systematic literature review methodology as outlined by Tranfield et al. (2003) and Denyer and Tranfield (2009). The graph below (Figure 3) highlights the multiple stages followed in carrying out the systematic review. The initial review was initially carried out in May 2017, and subsequently updated in March 2021 in order to include the journal articles that were published in the period between May 2017 and March 2021.

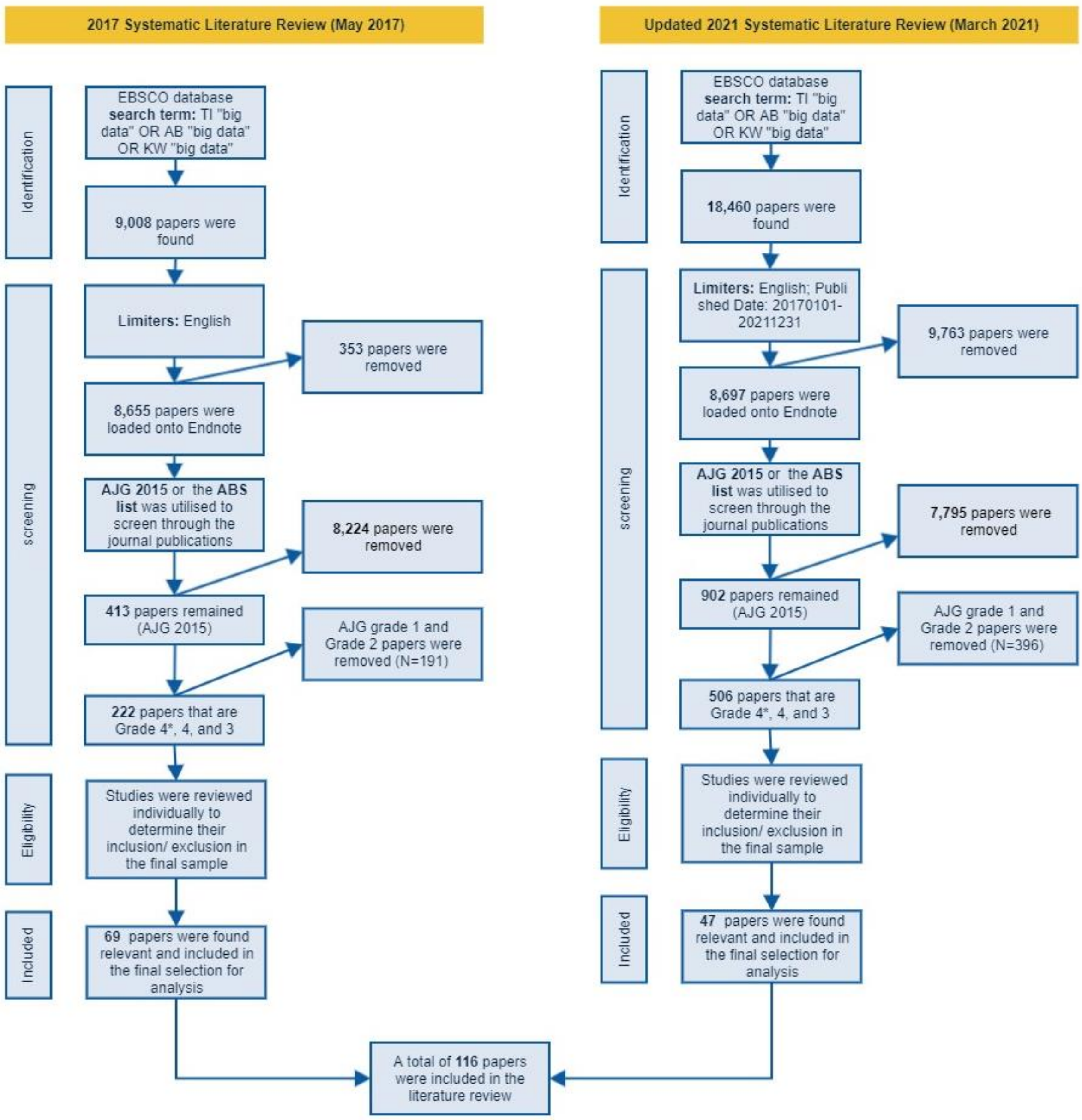

Figure 3. Systematic Literature Review Methodology

Business Source Premiere or Business Source Complete (EBSCO) was the database of choice for carrying out the systematic literature review for two main reasons: first because it provides a comprehensive portfolio of business, management, economics, and cognate journals, and second, it is the most commonly used and generally accepted source for systematic review studies in management research (e.g.,Kunisch et al. 2015; Kranzbühler et al. 2017; Savino et al. 2017). The search was initially carried out on 11 May 2017 and further updated on 31 March 2021 in order to include the journal articles that were published between the years of 2017 and 2021. In both instances, the search was initiated by searching the title, abstract, or keywords for the descriptor "big data". This returned a large number of hits (9,008 and 18,640 for 2017 and 2021 searches respectively), which is not uncommon in the first round of searching (Endres and Weibler 2017). Following this initial search, the Academic Journal Guide, previously known as the "ABS list" was utilised to screen the papers based on journal quality. Following this screening process, the decision was made to limit the selection to top-tier journals of the Academic Journal Guide (grade 3, grade 4, grade 4*). Although narrowing the papers to top grades of journals limits review coverage, it mitigates review reliability concerns (Matthews and Marzec 2012). This process narrowed down the number of papers quite substantially to 222 and 506 papers for 2017 and 2021 searches respectively. Following this screening process, each paper was individually reviewed for inclusion or exclusion in the literature review. This was done by reading the title and abstract and where necessary the main body of the article in order to determine their relevance to the study of big data in organisations. There were three key categories that qualified for the exclusion of papers at this stage, and they include:

1) Journal articles that only mentioned the keyword "big data" in passing and big data was not central to the phenomena of interest
2) Journal articles that were purely technical. For example, papers that were concerned with the computation of algorithms or a particularly technical aspect of a big data model (e.g., increasing model reliability)
3) Journal articles that did not have a clear organisation or management focus (e.g., the automation of the grading process in schooling)

Once this process was completed 116 papers were remaining that were included in this literature review.

This chapter is structured around four key elements. First, I discuss the many big data definitions utilised in the management literature. Second, I highlight the several dimensions of value-creation that big data enables. Third, I discuss the multiple theoretical foundations through which big data has been studied and to what end. Finally, I outline the rationale behind utilising an affordance theory lens for addressing the research questions that this thesis is concerned with. With that in mind, the key research problem that this thesis seeks to address is: *how do incumbent firms in the energy industry realise the potential value of smart meters?* I do so by answering the following three research questions:

1. What are the organisational affordances that smart meters afford?
2. What are the key organisational capabilities that enable smart meter affordances actualisation? And how do they enable the actualisation process?
3. What are the generative mechanisms that enable/constrain affordance actualisation? And how are they manifested in terms of empirical outcomes?

2.2 BIG DATA DEFINITIONS

Several definitions for the concept of big data exist today. The literature has used the term "big data" to refer to several aspects of big data including the technologies that generate big data, the characteristics of the data generated, the analytics and technologies for storing and analysing big data, and a combination of all three. Table 1 below provides examples of such definitions. The definitions of big data seem to be characterised along three dimensions, which I refer to as big data technology (BDT), big data analytics (BDA), and big data characteristics (BDC). BDT refers to a technology that generates large volumes of data, in real-time, at a low cost. BDA refers to the tools and technologies used to analyse and extract value from big data. Finally, BDC refers to big data characteristics, whereby big data is described to be large, diverse, and generated at speed. Despite the numerous definitions for big data, two things are clear in the overarching definitions. The first is that big data is "*so large and complex that they require **advanced and unique** data storage management, analysis, and visualisation technologies"* (Chen et al. 2012). The second is that *"Big data without analytics is just a massive amount of data. Analytics without big data are simply mathematical and statistical tools and applications"*(Sanders 2016). As such, to generate value from big data, organisations would need to invest in big data technologies (BDT) that generate the data, they would need to invest in big data management to store data that is large, diverse, and continuously flowing. Finally, they would need to invest in big data analytics capabilities (BDA) to analyse and realise the value of big data. In the following three sections, I will briefly describe the three variations of big data definitions in more detail.

Author	Big Data Definition	Definition Focus
(Ringel and Skiera 2016)	Big data technologies is a term used to describe advanced technologies that enable data to be collected in real-time at large volume and low cost.	BDT
(Dijcks 2013)	The term big data refers typically to the following types of data: (a) traditional enterprise data, (b)machine-generated/sensor data (e.g., Weblogs, smart meters, manufacturing sensors, equipment logs), (c)social data. Increased volume and velocity of data in production settings means that organisations will need to develop continuous processes for gathering, analysing, and interpreting data.	BDT
(Müller et al. 2016)	Big data is a by-product of technological advancements and more often than not, it is collected without a specific purpose in mind.	BDT
(Meriton et al. 2020)	Big data technologies (BDT) are the latest instalments in a long line of technological disruptions credited with advancing the field of supply chain management (SCM) from a purely clerical function to a strategic necessity.	BDT
(Chen et al. 2012)	Data sets and analytical techniques in applications that are so large and complex that they require **advanced and unique** data storage, management, analysis, and visualisation technologies.	BDA
(Chen et al. 2015)	The process of using **advanced technologies** to examine big data in order to uncover useful information (e.g., hidden patterns, unknown correlations, etc.) to help with making better decisions across business processes among functions or companies.	BDA
(Irani and Love 2015)	A collection of data and technology that accesses, integrates, and reports all available data by filtering, correlating, and reporting insights **not attainable with past data technologies.**	BDA
(Côrte-Real et al. 2017)	A new generation of technologies and architectures, designed to **economically** extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery and/or analysis.	BDA
(Lehrer et al. 2018)	BDA technologies provide features of sourcing, storage, event recognition and prediction, behaviour recognition and prediction, rule-based actions, and visualisation that afford service automation and BDA-enabled human-material service practices.	BDA
(Mikalef et al. 2017a; Ciampi et al. 2021)	Refers to a company's ability to leverage on technology and talent to exploit big data towards the generation of the insights that are necessary to overperform rivals.	BDA
(McAfee and Brynjolfsson 2012)	Big data is not just another way of saying analytics. It is similar to analytics in the sense that it seeks to glean intelligence from data and translate it into business advantage. However, there are three key differences: volume, variety, and velocity.	BDC (3Vs)
(Chen et al. 2012)	Big data is high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making.	BDC (3Vs)

(Yoo 2015; Müller et al. 2016)	The distinctive characteristics of big data, Volume, Variety, Velocity and Value or '4Vs'. The 4Vs surpass the ability of many conventional models of analysis in handling such data and therefore necessitates advanced analytical tools.	BDC (4Vs)
(Fosso Wamba et al. 2015)	A holistic approach to managing, processing, and analysing the 5 V data-related dimensions (i.e., volume, variety, velocity, veracity, and value) to create actionable ideas for delivering sustained value, measuring performance, and establishing competitive advantages.	BDC (5Vs)
(Beulke 2011; Opresnik and Taisch 2015)	There are five big data characteristics: volume; increasing due to machine-generated data, velocity; increasing due to frequency and speed of transactions, variety; the increase of structured and unstructured data number of data sources, value; enquiring into how value is being extracted from existing data; and verification; tackling the issue of data quality and data security levels.	BDC (5Vs)
(Seddon and Currie 2017)	Introduces a conceptual model of the 7Vs of big data: volume, variety, velocity, value, veracity, variability (changing structure of what is collected), and visualisation (making sense of patterns and trends).	BDC (7Vs)

Table 1. Big Data Definitions are characterised along the dimensions of big data technology, big data characteristics, and big data analytics.

2.2.1 Big Data Technologies (BDT)

Big data technologies is a term used to describe advanced technologies that enable data to be collected in real-time at large volume and low cost (Ringel and Skiera 2016). Big data technologies are viewed as a technological disruption that has become a strategic necessity for achieving superior firm performance (Meriton et al. 2020). Common examples of big data technologies that generate vast amounts of data in real-time at low cost are smartphones, smart watches, and smart meters. Further examples of big data technologies that generate such data are social media platforms that generate data on user activity, search engines that generate data on user searches, and manufacturing sensors that generate data on equipment performance and malfunctioning (Dijcks 2013). Such data is a by-product of technological advancements and more often than not, big data is collected without a specific purpose in mind (Müller et al. 2016). Additionally, this data can create challenges for organisations that will need to develop continuous processes for gathering, analysing, and interpreting big data (Dijcks 2013).

2.2.2 BIG DATA ANALYTICS (BDA)

In order to analyse big data, organisations require new, unique, and advanced technologies to carry out big data analytics (BDA) (Chen et al. 2015). Table 1 above provides several definitions for big data analytics, however, simply put, big data analytics (BDA) is the process of turning big data into valuable insights (De Luca et al. 2020). It encompasses new, advanced, and unique analytic technologies (Chen et al. 2015) that can economically and cost-effectively uncover useful insights (Chen et al. 2012; Côrte-Real et al. 2017) that are not attainable with past data technologies (Irani and Love 2015). Such insights can help businesses create actionable ideas for delivering sustained business value, measuring performance, and establishing competitive advantages (Fosso Wamba et al. 2015; Mikalef et al. 2017a; Ciampi et al. 2021). Big data analytics can include text analytics, audio analytics, video analytics, social media analytics, and predictive analytics (Gandomi and Haider 2015). It can also include APIs, data lakes, stream analytics, web analytics, mobile analytics, rule-based systems, and visualisation applications (Lehrer et al. 2018).

2.2.3 Big Data Characteristics (BDC)

Big data characteristics have been described along several dimensions including the 3Vs, 4Vs, 5Vs, and 7Vs. The notion of the '3Vs' was first used to describe the characteristics of big data. The 3Vs refer to volume, variety, and velocity. *Volume* refers to the large volume of data that requires advanced data storage. *Variety* refers to the greater variety of data (i.e., formats and sources). *Velocity* refers to the increased frequency of data, whereby data is generated and streamed in real-time or near real-time (McAfee and Brynjolfsson 2012). The notion of 3Vs was followed by the notion of '4Vs' adding the dimension of *value* to describe the characteristics of big data. This was done to highlight the importance of extracting insights and value from big data (Yoo 2015; Müller et al. 2016). Big data value refers to actionable and economically worthy insights, whereby the benefits to the firm exceed the costs of big data investment (Fosso Wamba et al. 2015). Research suggests that companies utilising big data to inform their decision making were 5% more productive and 6% more profitable than their competitors (McAfee and Brynjolfsson 2012). Big data value creation opportunities can include gaining insights that help companies understand consumer behaviour, inform business decisions, improve business processes, develop business innovation, and understand the competitive market (Grover et al. 2018). The notion of 4Vs was followed by the notion of '5Vs' adding the dimension of *veracity* (Fosso Wamba et al. 2015) or *verification* (Opresnik and Taisch 2015). *Veracity* or *verification* highlight the importance of tackling data quality and data security levels to avoid making incorrect inferences (Beulke 2011; Fosso Wamba et al. 2015; Opresnik and Taisch 2015). Finally, the notion of 5Vs was followed by the notion of '7Vs' adding the dimension of *variability* and *visualisation* to describe the characteristics of big data (Seddon and Currie 2017). *Variability* refers to the changing structure of the data being collected, whereas *visualisation* refers to the process of visually making sense of data patterns and trends.

2.2.4 Challenges emerging from Big Data Characteristics (BDC)

In the previous section, I highlight the idea that big data characteristics (volume, variety, and velocity) can often be a source of potential value for organisations. However, it is worth noting big data characteristics can also present a source of challenge for organisations seeking to realise business value from big data. For example, data volume can create challenges around selecting the relevant parts of the data that should be inputted into the modelling process (Brynjolfsson et al. 2016), preparing data for analysis (e.g., anonymising and sanitising data at scale) (Menon and Sarkar 2016), and analysing data at scale (Li et al. 2016; Shi et al. 2016). Additionally, data variety can present challenges for data analysis - in particular - around utilising unstructured forms of data. Finally, data velocity can create challenges for the analysis of continuously streaming and moving data (Chen et al. 2015). All of which means that current data management and analysis methods are fast becoming obsolete, and organisations require the development and adoption of new tools that can analyse data at scale (Li et al. 2016; Shi et al. 2016), that can handle the analysis of various forms of data (Lovrić et al. 2013; Ketter et al. 2016; Chan and Chong 2017), and that can analyse data that is generated continuously and at speed (Groves et al. 2014; Saboo et al. 2016).

2.3 BIG DATA VALUE CREATION OPPORTUNITIES

The literature on big data has highlighted several value creation opportunities that big data can afford organisations with. Value-creation is the primary aim of any business entity: it is about managing an organisations capabilities, resources, and relationships to create and deliver value in the form of new products, services, processes, or business models to achieve superior firm performance (Bowman and Ambrosini 2000; Lepak et al. 2007). There are different ways to create value in organisations using big data technologies (Grover et al. 2018), and they include better understanding consumer behaviour, making more informed business decisions, improving business processes, developing business innovation, and better understanding the competitive market. In the following five sections I will discuss each of these value-creation opportunities in more detail.

2.3.1 UNDERSTANDING CUSTOMER BEHAVIOUR

The first key value-creation opportunity from big data lies in enabling organisations to better understand consumer behaviour. There are several ways big data enables organisations to better understand customer behaviour and they include: 1) understanding customer perceptions; 2) predicting customer preferences; 3) sales prediction; and 4) predicting customer demand. Each of these business value creation opportunities will be discussed in the following four sections.

2.3.1.1 Understanding Customer Perception

Big data enables organisations to better understand and track the evolution of customer perceptions, customer needs, and customer preferences (Du et al. 2015; Fróes Lima et al. 2016; Jin et al. 2016; Hajli et al. 2020). This is important because understanding customer perception means that organisations will be able to design market-driven products (Du et al. 2015), determine product success (Hajli et al. 2020), and assess brand performance in terms of brand awareness and meaning (Culotta and Cutler 2016; Pournarakis et al. 2017), just to name a few. The many distinctive characteristics of big data (i.e., the 3Vs) led to many conventional methods for customer understanding failing to handle such data (Jin et al. 2016). As such, many researchers have developed new tools, techniques, models, methods, and approaches that are more suited for the analysis of large, varied, and fast-moving consumer-generated data. Consumer-generated data is also known as "big consumer data", which can include social media data, online customer review data, and online search data. One example of a big data analysis tool is developed by Du et al. (2015). They develop an automated method that can analyse online search data (google trends) to better understand customer perceptions. Their proposed tool monitors the weights consumers place on the various product features. As a result, managers can leverage these trends strategically to make decisions on product features. To give another example, Jin et al. (2016) developed a tool that can analyse customer review data from Amazon.com in order to better understand the evolution in customer preferences. Their proposed technique can identify consumer sentiment towards different product features. As a result, product designers can leverage this valuable information on product features to develop a market-driven product design.

Research suggests that user-generated content about brands is an important source of big data that can be transformed into valuable information (Kauffmann et al. 2020). More specifically, within brand management, several tools have been developed to analyse consumer-generated data that provide useful information concerning brand performance. For example, Pournarakis et al. (2017) develop a model that analyses social media data to understand consumer brand perception. The proposed model analyses consumer-generated Twitter data to identify brand-related topics and attach consumer sentiment to each of the topics identified. As such, managers can utilise these insights to better understand customer brand perception, and in turn, be better able to assess brand performance. To give another example, Liu et al. (2020) develop an approach to analyse social media data to assess brand perception. The proposed approach analyses visual content posted to measure how brands are portrayed on social media. As such, managers can use these insights to monitor their brand perception in real-time. Along similar lines, Culotta and Cutler (2016) develop a method to analyse user-generated content on Twitter to understand brand perception. They argue that the proposed method offers managers a cost-effective way to analyse brand perceptions in real-time and offers them up-to-date information on the evolving customer perceptions.

2.3.1.2 Predict Customer Preferences

Big data can help organisations predict the behavioural patterns of consumers. In turn, this makes them better at offering tailor-made propositions to their customers (Stylos et al. 2021). Predicting outcomes from user-generated content can also be extended to election outcomes (Huberty 2015), the helpfulness of online reviews (Salehan and Kim 2016), or even predicting the to-be-improved-on product features (Zhang et al. 2019). Insights from user-generated content can offer electoral campaigners' new ways to reach out to prospective voters. It can offer companies the ability to sort and classify online reviews and display them based on customer preference, for example displaying the most helpful customer reviews at the top of the customer reviews page. It also presents product designers with an effective way to gain valuable insights into the product features that customers are not happy about, and how these can be improved.

As a result, several tools have been developed in the space of analysing user-generated content to predict future outcomes that are of value to organisations. For example, Salehan and Kim (2016) developed an approach that analyses the sentiment of online customer reviews to predict their helpfulness for other customers. As such, their approach can be adopted and used as a scalable automated system for sorting and classifying online customer reviews. To give another example, Zhang et al. (2019) developed a preference model that analyses online customer reviews for the purpose of identifying the product features that can be improved on. Such insights can suggest to managers several possible actions that can be implemented in their product design process.

2.3.1.3 Sales Prediction

Sales prediction is key in estimating future revenue and firm performance (Boone et al. 2019). As a result, several tools have emerged that can analyse big data for the purpose of predicting future sales whether that be hotel bookings (Yang et al. 2014; Büschken and Allenby 2016), TV shows (Liu et al. 2016), or consumer products (Chong et al. 2016; Schneider and Gupta 2016; Chong et al. 2017; Ma and Fildes 2021). All of which can provide valuable insights into understanding an organisation's future sales performance. For example, Büschken and Allenby (2016) develop a model that analyses customer review and rating data from two popular travel booking websites: expedia.com and we8there.com. They demonstrate that using the proposed tool, they were able to predict sales for hotel room bookings from analysing user-generated content. Moreover, they argue that consumer review data is superior to survey data because it provides consumers with the opportunity to express themselves naturally without being restricted by preselected items, available response items, and rating scales that survey design often incorporate. Relatedly, Schneider and Gupta (2016) develop a random projections approach that analyses customer review data on Amazon.com for predicting future product purchases. The proposed approach can analyse both numeric and textual data. As such, insights gained from analysing user-generated content can provide managers with valuable information regarding their sales performance. Finally, Liu et al. (2016) develop a method that combines cloud computing, machine learning, and text mining in order to analyse user-generated content on Twitter in order to predict sales of TV shows. They demonstrate that analysing user-generated content on Twitter can be an effective way to forecast sales, and managers can gain valuable insights into their future sales performance.

2.3.1.4 Predict Customer Demand

Big data can be used to not only predict sales but also to predict customer demand. This can range from predicting demand from air travel (Gallego and Font 2020), rail travel (Yang et al. 2021), tourist arrivals (Colladon et al. 2019) and electricity usage (Wang et al. 2016). All of which is important because such insights can help organisations with their future planning and allocation of resources in relation to their marketing strategy, management of passenger flow, and energy generation and demand management. For these reasons, several tools for analysing big data with the purpose of predicting demand in a number of areas have emerged. For example, Gallego and Font (2020) developed a methodology to detect a change in air passenger demand using consumer search data from Skyscanner, a popular meta-search engine and flight booking website. They found that they were able to predict and detect a change in air passenger demand using consumer search data especially in and around the COVID-19 crisis. Gaining such valuable insights concerning customer demand enables organisations to effectively target their marketing strategies and be able to capture and capitalise on early market demand recovery. To give another example, Yang et al. (2021) develop a model to predict rail passenger volumes by combining historical customer travel data with real-time network operation data. Using the proposed model, they were able to predict passenger volume in near real-time. Therefore, such insights can assist rail companies in their planning and management of passenger flows. Along similar lines, Colladon et al. (2019) develop a tool to analyse user-generated content on TripAdvisor (a popular travel forum) in order to predict tourist arrivals in different destinations. By using the proposed tool, they were able to predict tourist arrivals in seven European capital cities. Such insights can have important implications for policy makers and companies operating in the tourism industry. For instance, travel companies can inform planning and pricing decisions in accordance with the change in customer demand. Whereas policy makers can use such insights as decisions in relation to infrastructure investments and the formulation of the destination’s tourism strategies. Finally, Wang et al. (2016) develop a recency effect model that analyses temperature data in order to forecast consumer demand of electricity consumption. Predicting consumer demand for electricity is important because it can help energy companies make informed decisions in relation to energy generation and energy demand management.

2.3.2 INFORM BUSINESS DECISIONS

Big data enables organisations to make better and more informed business decisions (Pigni et al. 2016). By capitalising on new and emerging big data sources, organisations can make more informed business decisions in a variety of decision-making scenarios including 1) marketing budget allocation decisions, 2) targeting and advertising decisions, and 3) pricing decisions. All three decision-making scenarios will be described in more detail in the following three sections.

2.3.2.1 Marketing Budget Allocation

Big data can enable organisations to optimise their marketing budget allocation decisions by being able to better measure the effectiveness of different marketing channels (Fulgoni and Lipsman 2014). As a result, several examples of new tools to analyse big data for the purpose of informing marketing budget allocation decisions have been reported in the literature. For example, Harvey et al. (2012) develop a big data analysis tool that integrates and analyses household-level purchase behaviour data with television-viewing habits from over 2 million households in the United States. Using their proposed tool, they argue that organisations can make informed decisions regarding their marketing budget allocation by optimising the mix of television and in-store marketing. Along similar lines, Kannan et al. (2016) develop an attribution modelling and analytics framework that can automatically attribute appropriate credit to each customer touch point across different channels (e.g., search engines, social media, e-mail, display advertising, print, TV). As such, organisations can gain valuable insights for making informed decisions regarding the optimal allocation of marketing investments across channels.

2.3.2.2 Targeting and Advertising

Through analysing big data, organisations can gain valuable insights that can inform their targeting and advertising decisions (Martens et al. 2016; Li 2019). As such, the literature has reported on several tools being developed to analyse big data for the purpose of targeting and advertising decisions. For example, Trusov et al. (2016) develop a modelling approach to predict customer profiles from online surfing data. A customer profile is a summary of a consumer's interests and preferences revealed through their online activity. Using the proposed modelling approach, they were able to accurately predict customer profiles based on their online activity. As such, this provides organisations with valuable insights to able to effectively target the display of ads to suitable customer profiles. Along similar lines, Liu et al. (2017) develop a framework that analyses social media data on Twitter by automatically deriving brand topics and classifying associated brand sentiments to gain insights into customer brand perception.

2.3.2.3 Pricing

Big data can enable organisations to inform and optimise their pricing decisions and introduce price customisation strategies (Danaher et al. 2014; Steinberg 2020). As such, the literature has reported on several tools that analyse big data for the purpose of informing pricing decisions. For example, Danaher et al. (2014) develop a structural model that analyses consumer demand data (digital song and album sales) to suggest the optimal pricing strategies for music bundles that will generate the most revenue. They argue that the model helps firms determine the bundling strategies that are most profitable, whereby they found that tiered pricing coupled with reduced album pricing increased revenue to the labels by 18% relative to uniform pricing policies traditionally used. A more recent study highlighted that through using big data, organisations can offer consumers personalised as opposed to standardised pricing (Steinberg 2020). Whereby consumers are offered the highest price they are willing to pay, given their preferences and available income, a term they refer to as “individual reservation prices”. They argue that individual reservation prices can have benefits in terms of equality of welfare, equality of resources, and increasing social welfare.

2.3.3 IMPROVE BUSINESS PROCESSES

Big data can create significant business value to organisations by improving business processes which can result in superior firm performance (Côrte-Real et al. 2020). There are three areas which the literature has reported on in relation to business process improvement, and they include: 1) business operations management; 2) customer relationship management; and 3) customer experience management. Each of these business process improvement areas will be described in more detail in the following three sections.

2.3.3.1 Business Operations Management

Many companies have leveraged insights extracted from big data to transform their business operations including their supply chain operations (Sanders 2016), shipping (Lee 2017), vessel delays (Kim et al 2017), manufacturing (Babiceanu and Seker 2016), and healthcare services

(Malik et al. 2018; Galetsi and Katsaliaki 2020). This is important because utilising insights from big data can help organisations ship goods faster, reduce costs of vessel delays, improve manufacturing operations, and improve their business processes. As such, the literature has reported on several tools being developed to analyse big data for the purpose of improving their business operations. For example, Lee (2017) develop an algorithm-based optimisation model that can predict when a customer will make a purchase. This prediction helps trigger the process of shipping the product to the nearest distribution centre before the customer places the order online. Lee (2017) calls this process “anticipatory shipping” whereby firms can speed up the process of shipping through extracting insights from the integration of diverse data sources on purchase patterns. Along similar lines, Kim et al. (2017) develop a new method for early detection of vessel delays. This method combines historical shipping data with real-time shipping data from the sensors installed in the vessels. As such, these insights provide firms with opportunities to reduce costs related to vessel delays.

Babiceanu and Seker (2016) review the use of big data analytics for planning and control of manufacturing operations. They find that linking the capabilities of the physical world (i.e., operations data) with the cyber world (i.e., sensor data) can improve enterprise manufacturing and improve business decision support. In the field of healthcare, the literature has reported attempts for knowledge discovery from the big data to improve the delivery of healthcare services (Malik et al. 2018), whereby, big data and big data analytics have had an important role to play in improving healthcare processes such as patient diagnostics, fast epidemic recognition, and improvement of patient management (Galetsi and Katsaliaki 2020).

2.3.3.2 Customer Relationship Management

The literature includes several studies documenting how big data can improve the important process of customer relationship management. Several studies have highlighted the positive impact of big data on customer relationship management performance. For example, Bone et al. (2015) found that customer involvement in problem-solving communities, where customers can help themselves through posting/answering questions, can reduce the reliance on traditional customer service. As such, organisations can promote peer-to-peer customer interactions in these communities to increase the efficiencies and the effectiveness of their support services. To give another example, Lam et al. (2017), argue that the 3Vs of big data can enhance frontline employee management. Through integrating frontline employee-customer interaction data with big data from digital interactions, organisations can improve their customer service quality and reduce customer service management costs. Along similar lines, Hallikainen et al. (2020) examine the effects of using big data analytics in managing business-to-business customer relationships. They found that using customer big data significantly fosters sales growth and enhances customer relationship performance. Finally, Zhang et al. (2020) use survey data collected from 147 business-to-business companies. They found that big data enables superior mass customisation capability, which positively influences customer relationship management performance.

2.3.3.3 Customer Experience Management

Big data analytics creates new possibilities to unlock customer insights for customer experience management, which provides organisations with a sustainable source of competitive differentiation (Holmlund et al. 2020). As such, several tools have emerged to analyse big data for the purpose of customer experience management. For example, McColl-Kennedy et al. (2019) propose a framework that integrates value-creation elements (such as resources, activities, context, interactions, and customer role), with cognitive responses and discrete emotions at touchpoints across the customer journey. They highlight that analysing customer data in such a way can provide meaningful insights into customer experience management by uncovering at-risk segments, capturing a customer’s emotional and cognitive responses, and spotting and preventing decreasing sales.

2.3.4 DEVELOP BUSINESS INNOVATION

Another key value creation opportunity from big data lies in enabling organisations to develop or improve their innovation capability (Fayard et al. 2016; Bharadwaj and Noble 2017; Toubia and Netzer 2017; Petrescu and Krishen 2019; Wu et al. 2019; Mikalef and Krogstie 2020; Wu et al. 2020), whereby insights derived from big data improve a firm’s innovation competency (Ghasemaghaei and Calic 2019). The literature has reported on three key areas where big data contribute to an organisation’s innovation competency including process innovation, service innovation, and business model innovation.

First**, process innovation**. Process innovation involves creating or improving methods of production, service, or administrative operations (Khazanchi et al. 2007). Big data is viewed as a valuable asset that can improve an organisation's knowledge management processes. For example, Zhan et al. (2019) has found that analysing user-generated data content meant that firms could extract knowledge about their customer preferences, which enabled them to develop the right products for their customer and gain a competitive advantage. Moreover, big data has been found to accelerate the innovation process in a decentralised organisational structure by enabling existing knowledge to be identified, accessed, combined, and deployed to address new problem domains (Wu et al. 2019). Finally, Toubia and Netzer (2017) found that big data can improve the ideation process in a business by deploying a big data tool that automatically "reads" ideas and identifies promising ones.

Second, **service innovation**. Service innovation is the ability of an organisation to develop new or enhanced intangible offerings that are of benefit to the consumer (den Hertog 2000; Storey et al. 2016). Big data facilitates the process of service innovation by providing firms with more and better data about their customers (Troilo et al. 2017; Lehrer et al. 2018; De Luca et al. 2020). Through the process of sourcing, storing, analysing, visualising, and predicting big data outcomes, organisations are afforded with new opportunities for service innovation (Lehrer et al. 2018). For example, Troilo et al. (2017) found that big data enables an organisation to make decisions in real-time, to be more creative in their marketing strategy, and to identify data-driven solutions to problems or inefficiencies. All of which, lead to an enhanced firm ability at identifying and developing new service innovation opportunities. Moreover, Lehrer et al. (2018) found that big data analytics enables organisations with two sets of service innovation opportunities, those that are fully automated and those that are semi-automated.

Third, **business model innovation**. Business model innovation is defined as "*a deliberate process of reconfiguring one or more components underlying the business value logic for the company, its customers and the other stakeholders"* (Bucherer et al. 2012). Business model innovation is a process of finding and delivering on a new way to create, propose, and capture business value (Amit and Zott 2012). Research has found a positive link between utilising big data and business model innovation, whereby organisations can innovate their current business models or develop new ones (Sorescu 2017; Ciampi et al. 2021). For example, Sorescu (2017) demonstrate how organisations are able to generate new business models by leveraging their internal and external data (i.e., big data). Furthermore, Tronvoll et al. (2020) argue that new business models centred around big data are driving competitive advantage.

2.3.5 UNDERSTAND COMPETITIVE MARKET

The final key-value creation opportunity is that big data enables organisations to better understand and be more informed about the competitive market because unlike traditional forms of data, big data can provide timely insights on the changing marketplace, provid more accurate estimates on market status, and enables better visualisation of competition in complex markets. Nathan and Rosso (2015) argue that conventional datasets and typologies tend to lag real-world change when it comes to mapping businesses and industries. As such, they advocate an alternative analysis for all active companies in the UK. To do so, they develop a novel 'sector-product' approach and use text mining to enable the mapping of industries using innovative big data sources that mirror real-world change. They apply the approach to the information and communication technology (ICT) industry in the UK. Subsequently, they find that by using a big data analytics approach, the ICT production space is 42% larger than what conventional datasets had previously estimated. Additionally, the conventional datasets failed to account for 70,000 companies. Along similar lines, Ringel and Skiera (2016) develop a mapping approach to visualise asymmetric competition in large markets. As a result of using this visualisation tool, organisations can identify distinct submarkets that they can subsequently target. Visualising asymmetric competition in this way would not have been possible had they relied on the reduction of analysis to smaller representative product sets (i.e., non-big data analytics approaches), as this process generally obscures important information.

To summarise, the following (Figure 4) provides an overview of the big data value creation opportunities that big data technologies afford, as highlighted in the management literature on big data. In the following section, I will discuss the theories that have been utilised to study big data in organisations.

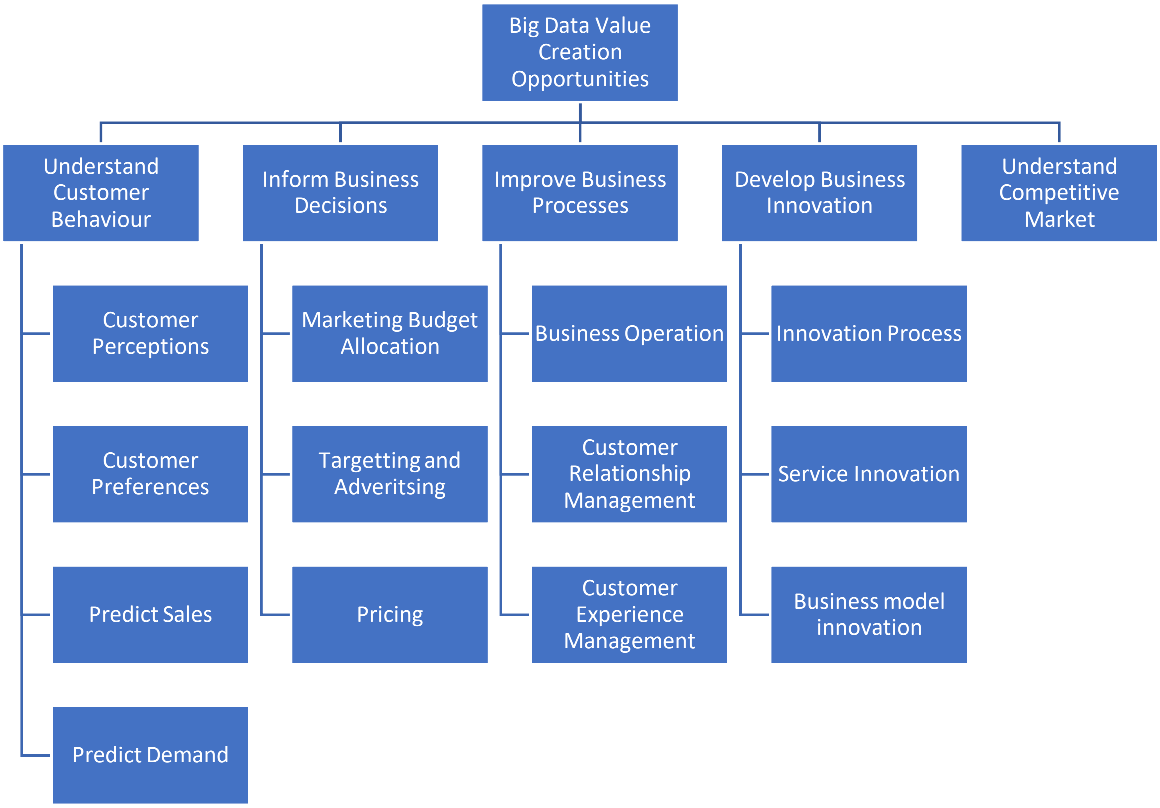

Figure 4. Overview of Big Data Value Creation Opportunities in Big Data Management Literature

2.4 THEORIES UTILISED IN BIG DATA MANAGEMENT RESEARCH

There are several theories utilised to study big data in management research including affordance theory, resource-based view, dynamic capabilities, absorptive capacity, and knowledge management theory. The table below provides an overview of the theories utilised to study big data in organisations (see Table 2 below). The table highlights the key theory utilised, the key authors, and the key research focus. This section is dedicated to describing and discussing how these different theories are utilised in big data management research. Further, I will elaborate on why affordance theory is the most suited theoretical framework for the present work.

Theory	Research Paper	Research Focus
Affordance Theory	(Lehrer et al. 2018)	Big data analytics and service innovation

Affordance theory focuses on understanding the IT-associated organisational change process when adopting a new technology by focusing on the relationship between the actor and IT artefact in context. Affordances represent possibilities for action: what organisations with certain goals and capabilities can do with a technology (Volkoff and Strong 2013; Strong et al. 2014; Volkoff and Strong 2017).	(Dremel et al. 2020a)	BDA affordance actualisation in the context of an automotive manufacturing company
	(De Luca et al. 2020)	Big data analytics and technology investments, marketing affordances and service innovation
Resource-Based View (RBV) Argues that a firm can be regarded as a bundle of resources and assumes that in order for a firm to be profitable, it must be able to exploit a bundle of resources that are valuable, rare, inimitable, and non-substitutable (VRIN) in a highly competitive market to achieve sustainable competitive advantage (Barney 1991)	(Gupta and George 2016)	Big data analytics, combinative organisational resources, and firm performance
	(Raguseo and Vitari 2018)	Big data analytics investments and firm performance
	(Grover et al. 2018)	BDA and strategic business value
	(Dubey et al. 2019) [3]	Big data analytics (predictive) and manufacturing performance
	(Vitari and Raguseo 2020)	Big data analytics and firm performance
	(Zhang et al. 2020)	Big data analytics (analytical intelligence) and customer relationship management performance
	(Mikalef and Krogstie 2020)	Big data analytics and process innovation, and the role of contextual factors
	(Cappa et al. 2021)	Big data characteristics (volume, variety, veracity) and firm performance
Dynamic Capabilities Theory (DC) The ability of an organisation to integrate, create and reconfigure their resources in constantly changing marketplace settings to achieve sustained competitive advantage (Teece et al 1997)	(Shamim et al. 2019)	Big data management and decision-making quality
	(Cao et al. 2019)	Identify the mechanisms through which marketing analytics can be used to achieve sustained competitive advantage
	(Gupta et al. 2020)	Big data predictive analytics and firm performance
	(Shamim et al. 2020)	Big data management capabilities and employee ambidexterity
	(Meriton et al. 2020)	Generative mechanisms of big data value in supply chain management
	(Mikalef et al. 2020)	Big data analytics capability and firm performance
	(Reis et al. 2020)	Identify the drivers of business value from big data analytics (i.e., machine learning)
	(Fosso Wamba et al. 2020)	BDA and organisational outcomes, with the mediating role of a big data analytics culture
	(Gu et al. 2021)	Big data analytics capability and firm performance
	(Ciampi et al. 2021)	Big data analytics and business model innovation
Absorptive Capacity (AC) The ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends (Cohen and Levinthal 1990).	(Mehmood et al. 2017)	Big data analytics and transport operations
	(Lam et al. 2017)	Big data and frontline management
	(Duan et al. 2020)	Business analytics and firm innovation

[3] This study integrates Resource-Based View, Institutional Theory, and Organisational Culture

Knowledge Management Theory (KMT) Focuses on structural, cultural and technological enablers to manage knowledge and knowledge processes to enhance the competitive position of an organisation (Hazlett et al. 2005)	(Côrte-Real et al. 2017)[4]	Big data analytics and business value, with the mediating role of organisational agility
	(Merendino et al. 2018)[5]	Big data and board-level decision making
	(Bag et al. 2021)	Big data analytics (artificial intelligence) and firm performance

Table 2. Overview of theories utilised in big data research.

Strategic management theories such as resource-based view (RBV), dynamic capabilities (DC), knowledge management theory (KMT), and absorptive capacity (AC) have been utilised to understand how firms achieve and sustain competitive advantage. More specifically within big data management research, the focus has been on examining the relationship between big data investments and superior firm performance by identifying big data as a strategic resource that firms must invest in to gain competitive advantage. In contrast, the information systems theory of affordance theory is utilised to better understand how organisations effectively actualise technology potential to achieve desirable outcomes. More specifically within big data research, affordance theory has been utilised to better understand how organisations realise the value potential afforded to them from the adoption of big data technologies. On the one hand, strategic management theories seek to understand *what* value big data investments bring to an organisation's performance by investigating the antecedents and outcomes of big data investments. On the other hand, affordance theory seeks to understand *how* firms realise the value potential from big data technologies by investigating the processes, mechanisms, and actions through which organisations realise the value potential from the adoption of a big data technology. In this section, I will discuss how each of these theories have been utilised to study big data in management research.

Affordance theory focuses on understanding the IT-associated organisational change process when adopting a new technology, by studying the relationship between the actor and IT artefact in context. Unlike strategic management theories that have been utilised from the very beginning of big data management research, affordance theory is a relatively new entry to the big data literature (e.g., Lehrer et al. 2018; De Luca et al. 2020). Affordances represent possibilities for action: they are what organisations with certain goals and capabilities can do with a new technology (Volkoff and Strong 2013; Strong et al. 2014; Volkoff and Strong 2017). Within the big data literature, affordance theory has been utilised to conceptualise big data

[4] This study combines knowledge management theory with dynamic capabilities view.
[5] This study combines knowledge management theory with dynamic capabilities view.

technology in terms of its possibilities for action (affordances) and the actualisation of the affordances within an organisational context. It has been utilised to study the impact of big data analytics on organisational benefits (Dremel et al. 2020a), and service innovation (Lehrer et al. 2018; De Luca et al. 2020). Examples of organisational affordances in the context of automotive manufacturing include establishing customer-centric marketing, provisioning data-driven services, enabling data-driven vehicle developing, and optimising production processes (Dremel et al. 2020a). Examples of service innovation affordances include service automation, human-machine service practices (Lehrer et al. 2018), while examples of marketing affordances include customer behaviour pattern spotting, real-time market responsiveness, and data-driven market ambidexterity (De Luca et al. 2020). All three studies utilising an affordance theory lens in big data management research have shed light on how organisations realise business value from big data technologies. They do so by highlighting the process through which organisational actions (Dremel et al. 2020a), big data investments (Lehrer et al. 2018), and marketing affordances (De Luca et al. 2020) enable superior firm performance.

The **resource-based view** proposes that in order for a firm to gain a competitive advantage, it must have the ability to exploit a bundle of valuable, rare, inimitable, and non-substitutable resources (Barney 1991). Within big data literature, big data is viewed as a strategic resource that is valuable, rare, inimitable, and non-substitutable (Grover et al. 2018); organisations must invest and exploit big data resources in order to achieve superior firm performance (Raguseo 2018; Vitari and Raguseo 2020; Cappa et al. 2021; Gu et al. 2021). Studies utilising a resource-based view have demonstrated that investing in big data can lead to improving an organisation's manufacturing performance (Dubey et al. 2019), their strategic business value (Grover et al. 2018), their customer relationship management performance (Zhang et al. 2020), and their process innovation (Mikalef and Krogstie 2020).

Dynamic capabilities emerged as a result of the criticism of the resource-based view that investments alone into big data resources and capabilities are not enough to create a competitive advantage (Shamim et al. 2019). In fact, many organisations still fail to reach their strategic goals despite investing substantial resources into big data technologies (Grover et al. 2018). Therefore, the resource-based view falls short in explaining how organisations utilise big data to achieve superior firm performance. As such, dynamic capabilities extend the resource-based view by arguing that in order to achieve superior performance, firms must not only invest in their resources and capabilities but also have the ability to develop and renew their resources and capabilities in response to environmental changes. As such, dynamic capabilities theory is defined as the ability of an organisation to integrate, create, and reconfigure their resources in constantly changing marketplace settings to achieve sustained competitive advantage (Teece et al. 1997). Within big data literature, dynamic capabilities theory has been utilised to study the impact of big data analytics on firm performance (Cao et al. 2019; Gupta et al. 2020; Mikalef et al. 2020) by enhancing a firm's business model innovation process (Ciampi et al. 2021), decision making quality (Shamim et al. 2019), and improving their employee-level ambidexterity (Shamim et al. 2020).

Dynamic capabilities theory has been utilised in big data management literature in three key ways. The first, and perhaps the most use common use, is viewing a firm's big data analytics capability as a dynamic capability that needs to be continuously renovated in order to seize market opportunities and maintain a competitive advantage in changing environments (Chen et al. 2015; Fosso Wamba et al. 2020; Gupta et al. 2020; Reis et al. 2020; Shamim et al. 2020). Within such studies, the organisational antecedents for the successful development and reconfiguration of an organisation's big data analytics capability are identified. Examples of these include top management support, organisational culture, technology and talent management, organisational readiness, and competitive pressure (Chen et al. 2015; Shamim et al. 2019; Reis et al. 2020). Additionally, the effect of industry size and type on achieving superior organisational performance has been examined (Gupta et al. 2020). A second approach is to view a firm's big data analytics capability as a facilitator of the organisation's dynamic capabilities. Here big data analytics is not a dynamic capability per se, but rather facilitates the development of dynamic capabilities within an organisation such as entrepreneurial orientation, organisational resilience, or organisational agility (Meriton et al. 2020; Ciampi et al. 2021). Third, some authors propose dynamic capabilities as a broad term that refers to a firm's overall ability to sense, seize, reconfigure its resources and enhance its capabilities to attain sustained competitive advantage. Here, it is argued that a big data analytics capability enables firms to generate insights that help strengthen their overall dynamic capability which positively impacts their firm performance (Cao et al. 2019; Mikalef et al. 2020).

With the increasing importance of the role of organisational learning in enabling superior firm performance, **knowledge management theory** emerged in order to emphasise the importance of building new knowledge and new insights for gaining superior firm performance (McElroy 2000). Knowledge management theory has been utilised alongside resource-based view and dynamic capabilities view to conceptualise the performance effects of IT investments (Côrte-Real et al. 2017; Merendino et al. 2018; Bag et al. 2021). Knowledge management theory focuses on "*the structural, cultural and technological enablers in managing knowledge and knowledge processes to enhance the competitive position of an organisation"* (Hazlett et al. 2005). It has been argued that the possession of knowledge resources gives a firm the basic foundations to renew or reconfigure its resource base and enhance its capabilities to achieve competitive advantage (Wu 2006). Therefore, knowledge management theory can be viewed as a subset of dynamic capabilities.

Knowledge management theory has been utilised in two keys ways. First, by viewing big data as a knowledge-based resource that enables superior firm performance (Merendino et al. 2018). Second, by viewing an organisation's big data analytics capability as a facilitator between the organisation's knowledge management resources or assets and firm performance (Côrte-Real et al. 2017; Bag et al. 2021). In the first instance, research has demonstrated that big data investments enable superior firm performance by supporting strategic decision making within organisations (Merendino et al. 2018). Whilst in the second instance, research has demonstrated that big data investments improved an organisation's ability to utilise their knowledge management assets and resulted in superior firm performance by facilitating the creation of organisational agility (Côrte-Real et al. 2017) or improving the decision-making style with organisations (Bag et al. 2021).

Finally, **absorptive capacity**. Absorptive capacity also emerged in order to conceptualise the performance effects of IT investments by emphasising the role of an organisation's potential capacity (recognition) and realised capacity (application) in enabling superior firm performance. Absorptive capacity has been defined as "*the ability of a firm to **recognise** the value of new, external information, assimilate it, and **apply** it to commercial ends of achieving competitive advantage"* (Cohen and Levinthal 1990). Similar to knowledge management theory, absorptive capacity focuses on the role of knowledge and information in enabling competitive advantage. However, it focuses on the external information use, and emphasises a distinction between potential capacity (through acquisition and assimilation) and realised capacity (through application and exploitation). Within the big data literature, the concept of absorptive capacity has been utilised to understand the role of big data investments in influencing firm performance through the process of acquiring, assimilating, and exploiting external information. Research has found that big data investments positively influenced a firm's absorptive capacity, their ability to acquire, assimilate, and exploit external information, in terms of firm innovation (Duan et al. 2020), frontline employee management (Lam et al. 2017), and city transport operations (Mehmood et al. 2017).

In the following section, I will develop the argument to justify the use of affordance theory as the most appropriate theoretical foundation for answering the research questions that this research seeks to address.

2.5 UTILISING AN AFFORDANCE THEORY LENS

Whilst strategic management theories (RBV, DC, KMT, AC) have sought to understand the antecedents and outcomes of big data investments on firm performance, affordance theory has sought to understand the processes and mechanisms through which organisations realise value from big data technologies. While strategic management theories seek decontextualised generalisations of the effect of big data investments on firm performance by using large datasets from UK (e.g., Cao et al 2019), European (e.g., Corte-Real et al 2017), or Chinese firms (e.g., Shamim et al 2020), affordance theory seeks in-depth contextualised explanations of the processes and mechanisms through which an organisation realises value from a big data technology. As such, research utilising an affordance theory lens tends to collect data in one organisation (e.g., Dremel et al. 2020) or a small number of organisations (e.g., Lehrer et al. 2018). While strategic management theories seek a strategic view of an organisation's investments into big data resources and capabilities to achieve superior firm performance, affordance theory seeks a more granular view by focusing on the relationship between big data adoption and organisational actors to uncover the processes and mechanisms through which firms realise big data value, whether that be service innovation, business transformation or other organisational benefits (Lehrer et al. 2018; Dremel et al. 2020a; De Luca et al. 2020).

The key research problem that this thesis seeks to address is: how do incumbent firms in the energy industry realise the value potential from the adoption of smart meters? Therefore, the aim of this research is not to measure the performance effects of IT investments, but instead to investigate the processes and mechanisms through which organisations realise value from big data technologies. As such, affordance theory is the most suitable theoretical lens to carry out this research enquiry. Affordance theory enables a practice-oriented and contextual understanding of how organisations realise value creation opportunities from big data technologies. It does so by enabling a researcher to identify the drivers of value creation that a big data technology enables in the form of organisational affordances. It also enables the researcher to understand the processes and mechanisms through which organisations realise big data value in the form of the affordance actualisation process. While strategic management theories have focused on the technological capabilities that enable organisations to realise superior firm performance from their big data investments, affordance theory allows for the exploration of a more complex set of organisational capabilities that enable firms to realise the value potential from big data technologies (see chapter 5). Due to its focus on the relationship between the actor and IT artefact, affordance theory enables the exploration of the rich and convoluted user experiences between smart meters and actors in organisations. As such, it is a suitable theoretical framework to not only identify a complex set of organisational capabilities for affordance actualisation but also to explore and explain the reasons why organisations are not able to realise the value from big data technologies, despite making significant investments in that direction (Grover et al. 2018). The affordance theory lens can enable the researcher to uncover the generative mechanisms that constrain the affordance actualisation process (see chapter 6).

In the following section, I will highlight the basic principles for adopting an affordance theory lens, and particularly for the adoption of new technology (e.g., smart meters) within an organisational context.

2.5.1 Basic Principles of Affordance Theory

> *"Using affordance theory in IS research is not simply an application of an existing theory but rather a new way of thinking about the artefact/user relationship that can be useful for generating new socio-technical theories."*
>
> (Volkoff and Strong 2017, p.10)

Gibson (1986), an ecological psychologist, developed the concept of affordances in his study of animals' perception of their surroundings. According to Gibson, humans, along with animals, orient to objects in their world (rocks, trees, rivers) in terms of what he called their *affordances*: the possibilities that they offer for action. The concept reflected his belief that animals and humans do not perceive the many minute details of an object, but directly and holistically perceive what the object will enable them to do. Gibson defined affordances as *"what is offered, provided, or furnished to someone or something by an object"*. For example, a fallen log affords a person the opportunity of sitting, or a smart meter affords a person to monitor their energy usage. Therefore, an affordance arises from the relationship between the ability of the person and the features of the artefact. Affordance theory offers the building blocks to provide explanations of a phenomenon we observe and want to understand by explicitly incorporating the IT artefact into the analysis. As highlighted in the quote above it is not simply an application of theory but rather a new way of thinking about the user-artefact relationship. It is also aligned with the way practitioners who are deploying and using IT think about the challenges they face (Volkoff and Strong 2017).

Volkoff and Strong (2013) borrowed affordance theory from the field of ecological psychology into the field of information systems. As such, they offer a more contextualised definition of affordances as *"the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artefact), and a goal-oriented actor or actors"* with the necessary capabilities (Volkoff and Strong 2013). Therefore, the focus is not on "*what features digital tools or artefacts possess, but how actors' goals and capabilities can be related to the inherent potential offered by the features"* (Nambisan et al. 2017). Affordances can operate at the individual level (one person) as well as on the organisational level (a group of people) because they can involve multiple actors doing different things to accomplish a joint goal (Volkoff and Strong 2017). Organisational affordances have been defined as *"the extent that the potential actions enabled are associated with achieving organisational-level concrete outcomes in support of organisational-level goals"* (Strong et al. 2014). Simply put, organisational affordances are the possibilities for action that organisations with specific goals and capabilities can achieve with the adoption of a new technology. Organisational affordances have also been referred to as "collective affordances" (Strong et al. 2014), and "high-level affordances" (Leonardi 2013).

Whilst affordances are the *possibilities for action*, affordance actualisation is the *action itself*. As such, in order for an affordance to be actualised someone must exist with the necessary capabilities and a goal that is served by actualising the affordance (i.e. actioning the possibility for action) (Volkoff and Strong 2013). On the other hand, organisational affordance actualisation is about the organisational actions taken by an organisation with the necessary capabilities to achieve organisational outcomes that serve an organisational-level goal (Volkoff and Strong 2013; Strong et al. 2014; Volkoff and Strong 2017). Whilst affordances can be

somewhat abstract and applicable across potential actors with a shared goal and associated capabilities, the affordance actualisation is specific and relates to a particular user group and details the specific action they will take or have taken place (Volkoff and Strong 2017).
To summarise, the four key basic principles of affordance theory are as follows:

1. Affordances are relational. They are not properties of the object nor the actor, but rather are the relationship between the abilities of the actor and the feature of the technology.
2. Affordances are possibilities for action. A user doesn't need to have realised or actualised the affordance for it to exist, but someone who could actualise it must exist (i.e., have the necessary capability).
3. The possibilities for action are not infinite. Certain possibilities are made available whilst others are not. In that sense, affordances are not only enabling but also constraining.
4. The potential behaviours/actions of an actor are goal-directed. The actor must have an intention or a goal that is served by actualising an affordance.

(Strong et al. 2014)

2.6 SUMMARY

Through systematically reviewing the literature on big data it seems clear to me that it can be structured along three key dimensions. The first being concerned with big data definitions, the second being concerned with the value creation opportunities that big data can afford, and the third being concerned with understanding and testing the relationship between big data investments and firm performance. In section 2.2, I cover the big data definitions which I categorise into three dimensions: a) big data technologies (BDT), b) big data analytics (BDA), and c) big data characteristics (BDC). In section 2.3, I highlight the different value creation opportunities that big data adoption can afford within organisations, these can range from understanding customer behaviour to improving business processes to developing business innovation. In section 2.4, I discuss how various theories (e.g., dynamic capabilities, resource-based view) have been utilised to examine the relationship between big data investments and firm performance.

It is worth noting that much of the literature on big data within management research is atheoretical meaning it does not rely on a theoretical background or foundation to inform its understanding of the phenomena of interest. Of the 116 papers included in this chapter, 88 papers were found to be atheoretical (75% of all papers). The contribution in these research papers tends to be geared towards the introduction of a new “big data” method, model, or tool that can help organisations realise a single value creation opportunity such as predict sales, predict demand, or forecast supply chain processes by utilizing this new volume, variety, and veracity of big data. In other words, the contribution is a methodological one. In addition to the atheoretical papers discussed above, a small proportion of papers in this literature review were found to adopt a theoretical lens or foundation. Of the 116 papers included in this chapter 28 papers utilized a theoretical framework (25% of all papers). Many of these papers were published in the last 2-3 years. At the time of carrying out the initial systematic review search in 2017, only three papers were found to be theory driven (Lam et al. 2017; Mehmood et al. 2017; Troilo et al. 2017). The focus in these theory-driven papers has mainly been geared towards testing the relationship between big data investments and firm performance. It is worth noting that much of the research within this category is driven by a positivist research paradigm which can help explain why research questions concerning the “why” and the “how” of big data value realisation were often overlooked. As clearly explained by Ackroyd and Karlsson (2014)“positivist research is based on empirical generalisations formulated as recipes saying ‘if you do A, B will follow’ independently of context. Whereas realist research is much more complex”. Having said that, it is worth noting that a small handful of studies, namely two (Lehrer et al. 2018; Dremel et al. 2020b), have contributed towards our understanding of how organisations realise value from the adoption of big data technologies. They do so by adopting an affordance theory lens. However, the limitations here is that both studies tend to focus on the technical aspect and capabilities associated with value creation. In addition, they only explain how big data affordances are actualised but fail to explain why many perceived big data affordances are not actualised.

This thesis extends previous research and fills a research gap in three key ways. First, it sheds light on a new way in which many of the value creation opportunities highlighted in previous research - namely the atheoretical papers - can be conceptualized and understood. In fact, many of the value creation opportunities highlighted by previous research can be viewed as possibilities for action and organisational affordances (see 2.3.1-2.3.3.). For example, sales prediction can be viewed as an organisational affordance that a big data technology can offer and studying it from an affordance theory perspective can enhance our understanding as to how and why these affordances are perceived and subsequently actualised within an organisational context. Second, whilst much of the previous research has focused on studying and testing the relationships between big data investments and firm performance. This research extends previous research by addressing the more complex questions of “how” and “why” organisations realise or are not able to realise the many value creation opportunities that the adoption of a big data technology can afford them with. Whereby, insightful and interesting research can be conducted under the auspices of critical realism (Ackroyd and Karlsson 2014). Third, this research extends previous affordance theory driven big data research by moving beyond the technical capabilities associated with value creation and realized to include a more complete and nuanced understanding of big data affordance actualization. In addition, this research helps explain why many organisations fail to actualise big data affordances by shedding light on the generative mechanisms that constrain them from doing so.

CHAPTER THREE

3 RESEARCH METHODOLOGY

RESEARCH APPROACH, DATA COLLECTION, AND DATA ANALYSIS

> *"The worse thing that contemporary qualitative research can imply is that, in this post-modern age, anything goes. The trick is to produce intelligent, disciplined work on the very edge of the abyss."*
>
> (David Silverman, Interpreting Qualitative Data)

This chapter describes how the research was conducted and outlines the decisions made at the research design, data collection, and data analysis stages. As Silverman argues, contemporary qualitative research is not a case of *"anything goes"* but a case of producing *"intelligent, disciplined work"* (Silverman 2015). Acknowledging the importance of research design and strategy, this chapter is concerned with highlighting the appropriacy of adopting a critical realist paradigm to study the actualisation of smart meter affordances in energy companies. It also discusses the suitability of a case study design and describes the experience in the field. It details how the data was collected and subsequently analysed. Figure 5 provides a summary of the methodological choices that were made throughout the data collection and analysis stages.

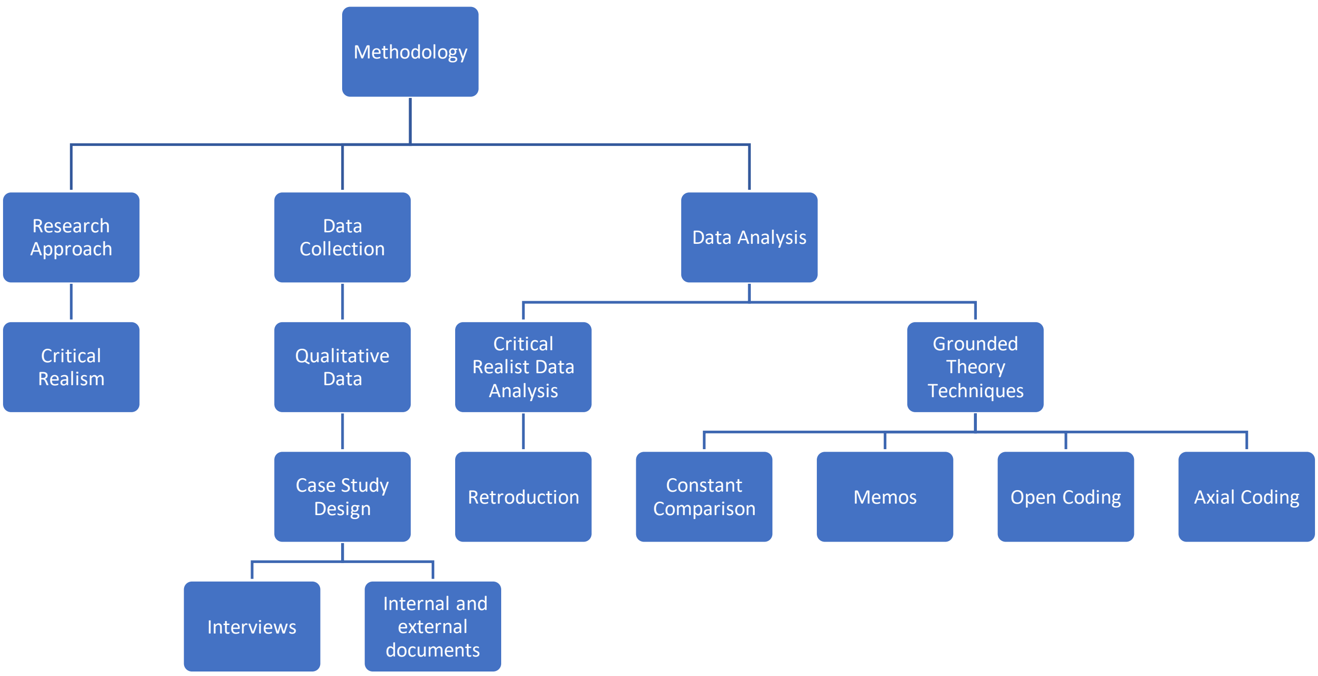

Figure 5. Summary of Key Methodological Choices

3.1 PHILOSOPHICAL STANDPOINT

For a researcher, ontology and epistemology are important because they have consequences for the possibilities and limits of the research methods, techniques, and analyses they employ (O'Mahoney and Vincent 2014). Researchers bring their own worldviews, paradigms, or sets of beliefs to the research project, and these inform the conduct and writing of the qualitative study. Consistency between ontology, epistemology, methodology and analysis is what matters for strong theory building, and good research requires making these assumptions, paradigms, and frameworks explicit in the writing of a study (Creswell, 2007, p.15). Moreover, consistency between philosophical orientation and the research design is pivotal for scholarly vigilance (Bryman 2016). Responding to these requirements, this thesis is driven by a critical realist philosophical standpoint.

3.1.1 Critical Realism

Critical realism is a philosophy attributed to the original works of the British philosopher Roy Bhaskar (Bhaskar 1975; Bhaskar 1979). Whilst critical realism philosophy had its origins in the 1970s, it has since gained popularity and become influential in a range of disciplines including economics (Lawson 1997; Ackroyd 2000), organisational studies (Ackroyd and Fleetwood 2000; Fairclough 2005; Fleetwood 2005; Edwards et al. 2014), criminology (Pawson and Tilley 1997), sociology (Sayer 2000), and information systems (Dobson 2001; Mingers 2004; Smith 2006; Mutch 2010; Wynn and Williams 2012). This growing popularity stems from critical realism's ability to transcend some of the classic dualisms in the social sciences: positivism versus interpretivism, and structure versus agency (Smith 2006). It has also been recognised as a promising philosophical tradition to overcome the objectivism-relativism chasms. Modern critical realism is positioned as an alternative to the positivist and interpretivist paradigms. It leverages elements of both to provide new approaches to developing knowledge (Wynn and Williams 2012).

Critical realism combines a realist ontology with an interpretive epistemology (Bhaskar 1998). It views the world as independent of human consciousness, and posits that knowledge about the world can be achieved through our observations of it; hence knowledge about the world is socially constructed (Eriksson and Kovalainen 2008). Therefore, critical realism agrees with positivists that there is an observable world independent of human consciousness. Moreover, critical realism agrees with constructivists that knowledge about the world is socially constructed (Eriksson and Kovalainen 2008, p.18). Ontologically, critical realism asserts the existence of an objective reality separate from us. Epistemologically, it asserts this reality is unknowable because researchers view it through their existing knowledge and biases (Volkoff and Strong 2017). Therefore, our knowledge of the world is socially constructed and fallible (Bygstad 2010). If so, how is knowledge about the 'independent world' created?

Our perception of the real is necessarily fallible as it depends on our interpretations of what we see. Researchers can only view empirically observable events, a subset of all actual events. They cannot directly view the generative mechanisms or the underlying structures that cause the events. However, from their observations of events, researchers can *retroduce* the underlying mechanisms that could logically have produced those events (Mingers 2004; O'Mahoney and Vincent 2014). Retroduction is defined as the process of working backwards from the empirical towards the mechanisms behind the observed events (Danermark et al. 2019). Critical realism does not take actions or events at face value; it searches for the conjunction of perceptions, ideas and intentions that underlie them to understand what caused the event to happen (Collier 2005). For critical realists, the truth is not simply the direct product of experiences (Smith 2006), but some theories approximate reality better than others, making methodological approaches to assess knowledge claims meaningful (Henfridsson and Bygstad 2013). As such, a critical realist study includes a critical examination of how we conceptualise the objects of our investigation (Sayer 1992).

Subscribing to critical realism as an appropriate philosophical underpinning for understanding organisations and how they operate means that the central task is to uncover generative mechanisms (Mingers 2004; Wynn and Williams 2012; Henfridsson and Bygstad 2013; Bygstad et al. 2016). The purpose of critical realist studies is not to find generalisable laws or to give a rich description, nor to identify discourses and interpretations (Easton 2010). The objective is to try to unmask the underlying and dynamic generative mechanisms that are hidden from our direct experience but that are essential to our explanation of how and why social phenomena emerge (or do not emerge) in a complex and interrelated world (Sayer 2000).

3.1.2 Principles of Critical Realism

Three core principles underlie a critical realist philosophical standpoint. Firstly, the nature of reality. Secondly, the distinction between structure and agency. Thirdly, the stratification of structures (Mingers 2004; Volkoff and Strong 2013). *Structures* are a collective term that refers to social structures, natural objects, material artefacts, and conceptual entities (e.g., language, opinion, goals). Structures enable or constrain human agency but do not determine it. *Agency*, on the other hand, refers to human actors who have properties such as self-consciousness, reflexivity, intentionality, cognition, and emotionality. They can formulate plans and pursue objectives (Volkoff and Strong 2013). When entering a pre-structured environment, human agents can either leave the structured reality unquestioned and maintained or transform and modify it (Bhaskar 1989; Carter and New 2004). In the following three sub-sections I briefly describe each of these three core principles.

3.1.2.1 Nature of Reality

Critical realism's view of reality is based on three interrelated premises: intransitivity, transfactuality, and stratified reality. *Intransitivity* alludes to the idea that reality exists independently of human pereception of it, whereby objects, entities, and structures exist perhaps unobserved in what is referred to as the "instransisitve domain" (Archer 1998; Mingers et al. 2013). These objects, entities, and structures can become objects of our knowledge through what critical realists refers to as the "transisitive dimension", whereby sociologists and social scientists can draw on existing theories, results, anomalies and conjectures to generate an improved knowledge of science's instransitive objects (Mingers et al. 2013). *Transfactuality* refers to the independent nature of generative mechanisms. Generative mechanisms are real, whether we observe them or not.

The premise of *stratified* reality is very closely related to *intransitivity* and *transfactuality*. Critical realism presupposes a three-layer stratification where reality is stratified into three nested domains: the real, the actual, and the empirical (Bhaskar 1975). This first layer is the *real* which is associated with mechanisms that generate events and outcomes. The real is much larger than what we can see or experience. The real is where the entities, context and multiple forces work at the same time giving rise to the generative mechanisms. Therefore, generative mechanisms are not the phenomena we experience but the conjuncture of the forces that produce these phenomena. The second layer is the *actual* associated with the events and outcomes that may not be observed. The third layer is *empirical* also referred to as the "experienced" (Archer et al. 1998), which is a subset of the *actual* where the events or outcomes are observed (Archer et al. 1998; Volkoff and Strong 2013). Figure 6 below highlights these three layers. The triangle shape is very much like an iceberg submerged in water with only the tip of the iceberg being above. The tip of the iceberg is what we can observe (the empirical), a subset of the actual and real.

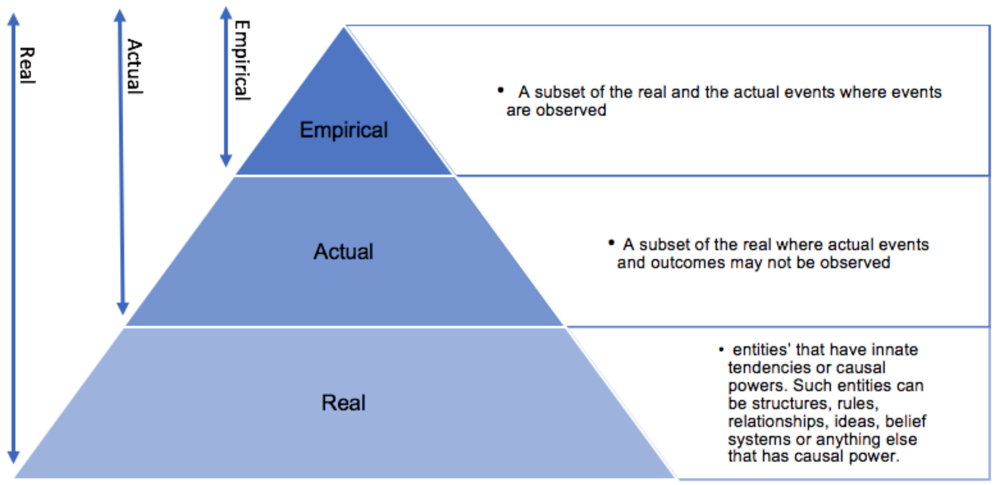

Figure 6. Stratified Reality in Critical Realism Paradigm

(Source: Volkoff and Strong 2013)

3.1.2.2 Agency and Structure

The second core principle of critical realism is the distinction between agency and structure. Critical realists view structure and agency as having different properties and powers, and as being temporally separate (structure pre-exists agency) (Carter and New 2004). Critical realists emphasise the fact that human agents always enter a pre-structured society; one that they did not produce, but one that they can conform to or transform. Structures pre-exist agents and create the conditions necessary for those actions to take place. The pre-structured environment both facilitates and constrains human agency, which turns such structures or systems into entities with innate tendencies and causal power (Archer 1998). The power of structures is not of *deterministic causality* (i.e., to determine action) but of *material causality*, namely creating the conditions to enable/constrain action. Agents have the power to modify structures around them. As a result of the action, new structures may or may not emerge. This is often referred to as *efficient causality*. The temporal separation between structure and agency means that critical realists focus on the interplay between the two through time. To deduce causal explanations, one must take into account the processes that occur over time (Volkoff and Strong 2013).

3.1.2.3 Stratification of structures

The third and final core principle of critical realism is the stratification of structure. The same way reality is stratified, structures are presupposed to be stratified or nested. Structures are viewed as consisting of various components. The causal properties (generative mechanisms) emerge from the interaction between the various components (DeLanda 2006). The causal properties are not simply an aggregation of the parts and an additive combination of their properties, but an assemblage of the interactions among these properties. Hence, the "*mechanisms that arise from these nested structures are a complex web of interpenetrating effects that can loop back on themselves*" (Volkoff and Strong 2013). Critical realists not only seek to uncover the core generative mechanisms but seek to understand how they interact to produce the observed events. They cannot be studied or understood in isolation from their environment, as greater explanatory power is to be found in understanding how different entities relate as part of a greater whole (Volkoff and Strong 2013; O'Mahoney and Vincent 2014). Volkoff and Strong (2013) argue that affordance-based theories informed by critical realism enhance our ability to explain IT-associated organisational change. As such, the following section explains how. Firstly, by providing a brief outline of affordance theory followed by an explanation of how the critical realism paradigm is aligned with the study of affordances.

3.1.3 Affordance Theory and Critical Realism

Affordance theory, like any theory, has underlying ontological assumptions about the nature of reality and underlying epistemological assumptions about what we can know. Although Gibson does not state his philosophical orientation, others have described the critical realist nature of ecological psychology in general (Volkoff and Strong 2017). With that in mind, the three-layer stratification of generative mechanism as highlighted in (Figure 5 below) is of significance to affordance theory. In fact, it is argued that properties of affordances and generative mechanisms are very similar in terms of their stratification of reality (Volkoff and Strong 2013). Just as generative mechanisms exist whether or not they are exercised (Sayer 2000), affordances exist whether or not they are actualised. Therefore, affordances arise in the domain of the *real* as a result of the relationship between the complex assemblages of organisations and IT artefacts and are actualised over time by organisational actors. These affordance actualisations lead to various effects that we observe in the domain of the *empirical*.

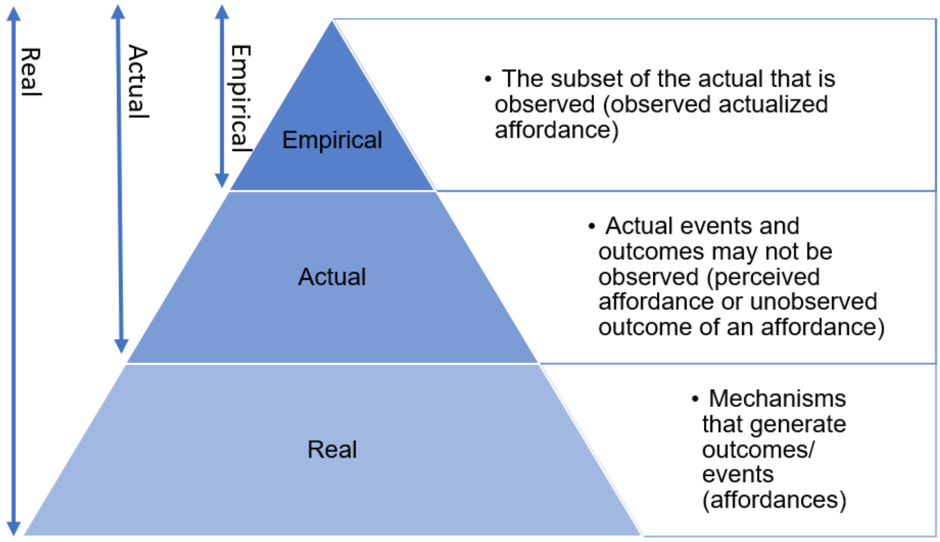

Figure 7. Affordances properties and the similarity to that of generative mechanisms.

As highlighted in (Figure 7 above), affordances reside in the domain of the *real* as they represent the potential for action rather than the action itself. While affordances exist in relation to the actor, they do not only exist in the mind of the actor. The extent to which the actor is aware of them (if at all) will affect the actualisation, but not the existence of an affordance (Volkoff and Strong 2017). The affordance will be brought into the domain of the *real* (i.e. actualised) only if there is someone who has the necessary capability and an intention/goal that is served by the actualisation of an affordance.

While generative mechanisms and affordances have similar properties, they also have distinctive properties that are inherent to each. The key element that distinguishes affordances from generative mechanisms is the role of the actor(s). As affordances arise from the relation between a structure or object and a goal-oriented actor or actors, they need to be triggered or actualised by an actor or actors. Whereas, for generative mechanisms, actors are not a necessary condition. Generative mechanisms can arise from structures alone and their causal powers can be triggered without the intervention of an actor. Table 3 highlights the key similarities and differences between generative mechanisms and affordances.

Distinctive Features	Generative Mechanisms	Affordances
Potential for an event/action	Described in terms of the potential for an event "the space for possibilities" rather than the event itself.	Described in terms of the potential for action rather than the action itself
Structural Range	Entities exhibit a certain degree of variability and still retain their identity as long as they meet the minimal compositional consistency requirements	A generic affordance applies more broadly to a variety of similar objects and actors with certain characteristics that result in a recognisable concrete outcome
Non-deterministic powers	Generative mechanisms are capacities or tendencies, not powers with deterministic effects. Generative mechanisms have the power to offer power or threaten liability; to motivate or discourage; to enable or constrain.	Affordances are non-deterministic of the outcome as different actors may actualise the same affordance differently. The IT artefact has different features that can be combined in different ways by a goal-oriented actor.
Enabling and constraining powers	Generative mechanisms simultaneously offer powers and threaten liabilities: they both enable and constrain action.	Affordances simultaneously enable and constrain users while not determining what the actors will do, nor what the outcomes of the use of such an object will be.
Exist within contextual conditions	Generative mechanisms do not occur in isolation but arise from the nested nature of structures. Contextual conditions such as other mechanisms that a mechanism interacts with will stimulate or restrain its progress or release associated constraints.	Affordances do not exist in isolation. Multiple affordances exist and may interact with each other. The actualisation of affordances occurs over time.
Empirical usefulness	Generative mechanisms can be identified at whatever level of granularity offers empirical usefulness. However, identifying mechanisms at a high level does not help us understand the details of how a specific technology is implicated in organisational change.	Affordances are a subset of the more general set of generative mechanisms. Because of the more focused nature of affordances, they provide a more fine-grained explanation of causality. Therefore, affordances are more suitable for understanding how the introduction of a new technology affects an organisation.

Table 3. Consistency and differences between generative mechanisms and affordances[6]

To summarise, Table 4 provides a summary of the overlap between critical realism principles, generative mechanisms, and affordances. In the following section, I will outline how this research was carried out.

Critical Realism Principles	Generative Mechanisms	Affordances
Stratification of reality	Generative mechanisms cannot be observed as they occur in the domain of the real. They generate events/outcomes that can be observed in the domain of the empirical or cannot be observed in the domain of the actual.	Affordances exist in the real, perceived in the actual, and actualised in the empirical. The immediate concrete outcomes in the domain on the empirical provides evidence of the existence of an affordance in the domain of the real.
Agency and structure	Generative mechanisms arise from a structure alone, or from the relations between structures, or from the relations between structures and actors. The causal powers of generative mechanisms can be triggered **without** the intervention of an actor.	Affordances arise from the relations between structures and actors. The causal powers of affordance can only be triggered through the intervention of an actor. This is because both the associated goal and actualising an affordance are tied to an actor.

[6] Sources: (Wynn and Williams 2012; Volkoff and Strong 2013; Bygstad et al. 2016; Volkoff and Strong 2017)

Stratification of structures	Generative mechanisms arise from nested structures that are a complex web of interpenetrating effects that can loop back on themselves. Therefore, generative mechanisms emerge from the interaction between parts and are not just an additive combination of the properties of the components.	Affordances can be actualised differently by different actors. This is because an IT artefact has different features that can be combined in different ways by different actors to produce different observed events/outcomes. The interplay between various structures (e.g., organisation; IT artefact) and actions lead to the emergence of new structures and new properties.

Table 4. Consistency between Critical Realism, Affordances, and generative Mechanisms.

3.2 QUALITATIVE RESEARCH

> *"For critical realist-guided researchers, the role of a research method is to connect the inner world of ideas to the outer world of observable events as seamlessly as possible. As such, their approach to research methods is highly flexible and adaptive by comparison with other researchers."*
>
> (Ackroyd and Karlsson 2014, p.2)

This thesis employs a qualitative methodology structured around a case study approach to understand how organisations realise the value potential from the adoption of a big data technology - smart meters. I do so by carrying out research in two case study organisations. Definitions of qualitative research are difficult to pin down (Van Maanen 1998), have no univocal meaning in the social sciences (Van Maanen 1979), and are most often described in contrast to quantitative research (Eriksson and Kovalainen 2008, p.4). Perhaps the reason for this is that qualitative research often incorporates several diverse research methods or approaches that differ from each other considerably (Bryman 2016, p.377). These can include narrative research, phenomenology, grounded theory, ethnography, and case study (Creswell 2007, p.6). As such, it is no surprise that attempts to specify qualitative research as a general approach with common underpinnings have faced considerable criticism (Silverman 1993).

Qualitative research often studies phenomena in the environment in which they naturally occur, uses social actors' meanings to understand the phenomena, and emphasises the processes and meanings that occur naturally (Gephart 2004). It is concerned with interpretation and understanding; therefore, it does not follow a structured, standardised, and abstracted mode of data collection and analysis (Eriksson and Kovalainen 2008, p.5), but instead allows for flexibility, exploration, and creativity to produce meaningful interpretations, explanations, and understanding of complex organisational phenomena. Adopting a qualitative research approach has allowed me to practice flexibility in the exploration process, and to produce meaningful insights. The following section describes the rationale behind my choice of a case study approach.

3.2.1 Case Study Methodology

As already indicated above, I chose to investigate using a case study approach. My concern here is in studying a new and emerging phenomenon (Siggelkow 2007), and case study research is often the preferred method of enquiry (Ragin 1997; Mahoney and Goertz 2006; Welch et al. 2011). Whilst Bhaskar did not recommend a specific research methodology, and critical realist-based research can accommodate a variety of methodological choices. Still, it has been argued that a case study approach is best suited for critical realist-based research for two key reasons (Wynn and Williams 2012). First, case studies offer a suitable vehicle for identifying and exploring causal mechanisms by providing a situation in which mechanisms can be isolated and studied (Ackroyd and Karlsson 2014). Second, case study design allows for a focus on causation. Through the in-depth analysis of a limited number of cases, case studies allow the researcher to tease out the ever-deepening layers of reality in the search for generative mechanisms and influential contingencies (Kessler and Bach 2014). Case study design is not only a popular research methodology amongst critical realist researchers, but also has become a commonplace methodology within affordance-based big data research (e.g.,Lehrer et al. 2018; Dremel et al. 2020).

Based on these premises, in this research, I follow the principles for case study design as outlined by Robert Yin (Yin 2014), as well as, the principles for conducting a critical realist informed case study research as outlined by others (Wynn and Williams 2012; Bygstad et al. 2016). In both instances, I aim to diffuse these guidelines in line with those that are most relevant for the research enquiry, rather than furnishing well-defined guidelines for the research process. In other words, instead of automatically following the disciplinary convention, I practice reflexivity in my use of case study research (Welch and Piekkari 2018). This is very much in line with the critical realist’s view that successful research depends on intellectual creativity and not on following methodological rules. Therefore, it is of no surprise that critical realists are often described as having a “beg, borrow, and steal” approach to research techniques (Ackroyd and Karlsson 2014).

A case study is a research strategy that examines, through the use of a variety of data sources, a phenomenon in its naturalistic context, with the purpose of ‘confronting’ theory with the empirical work (Piekkari et al. 2009). Case study research is defined as *“an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident”* (Yin 2014, p.16). It has also been defined as *“a research method that involves investigating one or a small number of social entities or situations about which data are collected using multiple sources of data and developing a holistic description through an iterative research process”* (Easton 2010). What is highlighted in all three definitions is that case research: 1) is in-depth and comprehensive 2) emphasises context 3) relies on multiple data sources, and 4) allows for flexibility and iteration in the research process, whereby the data gains wider relevance and meaning through being confronted with theory. In this study, I adopt what Yin (2014) refers to as an explanatory case study. According to Yin, a case study can be exploratory, descriptive, or explanatory (Yin 2014, p.42). An explanatory case study is best suited to fulfil the purpose of this study as it one *“whose purpose is to explain how and why some sequence of events occurred or did not occur”* (Yin 2014, p.287).

Whilst Yin (2014) provides guidance on the conduct of case studies generally, his approach can be limited when moving beyond the case study “design” element. Permitting his background in experimental psychology, and being naturally informed by the positivist tradition, it is no surprise that Yin favours a “design” logic in which fieldwork is preceded by the careful development of a “blueprint” (Yin 2014, p.21). Although I was informed by Yin’s approach for the design stage of the research, when it came to the analysis stage, I realised that his approach has certain limitations. For example, there is nothing more to know beyond what is confirmed through the data themselves, as such deeper levels (i.e., generative mechanisms) disappear from the analysis. Acknowledging these limitations, Wynn and Williams (2012) offer a set of methodological principles for conducting a critical realist-based explanatory case. Moreover, Bygstad et al. 2016) develop a framework for identifying generative mechanisms and offer guidelines for critical realist data analysis. Both works have inspired my data analysis process by moving beyond describing the affordances or outcomes in theoretical terms to explaining how and why affordances are actualised (or not actualised) in a particular context. Therefore, my aim here is not to seek patterns but to explain how and why affordances unfold in the two case study organisations.

There are several criticisms of qualitative research more broadly and case study research more specifically. However, these criticisms mostly stem from researchers advocating a positivistic stance in the pursuit of de-contextualised and predictive law-like generalisations (Gibbert et al. 2008). Having said that, this research does not seek to unearth universal truths, instead seeks to build explanations of why smart meter affordances are actualised or not actualised.

Three key elements are of significance when conducting critical-realist informed case study research: 1) specifying the research question, 2) case selection and 3) generalisation (Wynn and Williams 2012). In the following three subsections, I will discuss these three elements in more detail.

3.2.1.1 Research Questions

The first aspect of case study research deals with establishing the research questions. Given the epistemological principles of critical realism, and the focus on establishing causality, the research question must be of the form *"what caused events associated with the phenomena to occur?"* (Easton 2010). These forms of questions ask about the cause of specific events by targeting the how and why questions associated with the explanatory case research (Yin 2014). The key research problem driving this research lies in understanding: *How do incumbent firms in the energy sector realise the value potential from the adoption of smart meters?*

This research problem statement is the source of the following three research questions:

1. What are the organisational affordances that smart meters afford?
2. What are the key organisational capabilities that enable smart meter affordances actualisation? And how do they enable the actualisation process?
3. What are the generative mechanisms that enable/constrain affordance actualisation? And how are they manifested in terms of empirical outcomes?

Such questions explore the various human and organisational impacts associated with the implementation of a complex information system (i.e., smart meters). Through utilising a variety of data sources and analytical methods, the aim is to uncover the generative mechanisms that facilitate the actualisation of smart meter affordances. Through incorporating two case studies, the aim here is to uncover the mechanisms that can bring about the phenomena of interest (Wynn and Williams 2012).

3.2.1.2 Case Selection

The selection of cases was based on the premise of purposeful sampling (Kessler and Bach 2014), whereby the selection was made not only on the basis of how well the phenomenon is present and transparent in the case(s) of interest (Yin 2014) but also on the strong emphasis of the causal explanation and contextualisation that the cases can offer (Welch et al 2011). In other words, how likely will the case offer good insights relating to the underlying mechanisms that drive the phenomenon? How likely will the case enable us to reveal the “real”? In the total universe of large incumbent firms impacted by the implementation of a complex information system, the energy sector was identified as an appropriate setting to study the actualisation process of a big data technology due to the recent adoption of smart meters and the organisational change process that goes alongside such a technology adoption. The rationale behind utilsing two cases (a comparative case study design) as oppose to one case was made for the following three reasons:

1. It allows for the processes, outcomes, generative mechanisms, and conclusions about causes and outcomes to be drawn more effectively (Ackroyd and Karlsson 2014)

2. It enables one to move beyond locally contingent processes and outcomes. To tease out and examine wider patterns and their generative forces (Kessler and Bach 2014)

3. It allows the researcher to balance between context and situational factors and seek wider patterns and generative mechanisms without running the risk of disappearing into micro level case studies whose causal chain ends at the office door (Kessler and Bach 2014)

As such, the selection of cases was not made on the basis of generalisability or replication logic, but instead on the basis that they reflect the existence of events which are deemed as representative of the phenomena a researcher is attempting to explain (Sayer 1992). My aim is to expose the causal processes or mechanisms which have produced a unique set of events and the specific structural/contextual factors that combined to generate them (Wynn and Williams 2012).

3.2.1.3 Analytic Generalisation

Critical realist studies are concerned with generalising the findings through a generalisation to theory as opposed to statistical inference (i.e., statistical generalisation). Yin refers to generalising to theory as "analytic generalisation" (Yin 2018), while Silverman refers to it as "theoretical generalisation" (Silverman 2010). What analytic or theoretical generalisation means is that rather than thinking about the case as a sample, the case is viewed as an opportunity to shed light on some theoretical concepts and principles and to use theory to generalise lessons learnt from case studies. The generalisation happens at a conceptual level higher than that of a specific case. The aim of this research is to extend our understanding of how organisations realise value from the adoption of a big data technology – smart meters. By utilising the causal explanations of the mechanisms at work in the case studies, this study seeks insights into how and why smart meter affordances are actualised or not actualised. In essence, generalisability from the findings of the study will provide means to leverage existing statements of causal mechanisms to explain events observed within the specific context of the new setting (e.g., a new energy firm) as opposed to predicting outcomes based on the generalisation of theory to a new population or context (Wynn and Williams 2012).

3.3 STUDY CONTEXT

3.3.1 The Smart Meter Mandate

In 2008, the UK government passed the *Energy Act 2008*[7] which gave powers to the smart meter mandate to take place in the UK energy sector. A few years later, in 2011, energy companies were mandated to take part in this energy infrastructure upgrade by replacing every gas and electricity meter in all UK homes and businesses with a smart meter by 2020. The mandate came as part of an essential national infrastructure upgrade for the UK with the aim to make the UK energy system fit for the 21st century: reliable, cleaner, and more affordable (BEIS 2018). The smart meter adoption in the UK energy sector, otherwise known as "the Smart Metering Implementation Programme", is led by the Department for Business, Energy and Industrial Strategy (BEIS), regulated by the Office of Gas and Electricity Markets (Ofgem), and delivered by energy suppliers (BEIS report 2020). Since 2012, significant progress has

[7] Energy Act 2008: https://bills.parliament.uk/bills/259

been made with the installation of 21.5 million meters across the UK (BEIS 2020)[8]. However, a vast majority of smart meters are yet to be uninstalled – approximately 30 million of them. Additionally, the cost of the smart meter mandate is rising every year, with the current total sitting at £11 billion (BEIS 2016).

The adoption of smart meters in the energy industry is unique to any other technology adoption in organisations because usually a firm's motivation to adopt a new technology is driven by a desire to improve efficiency, to protect market share, to assist in innovative activities, and to increase productivity and profitability (DeLone and McLean 1992). However, in the case of smart meters, an energy firm's motivation to adopt this new technology is driven by a desire to adhere to a regulatory requirement – the smart meter mandate. Therefore, energy companies are installing smart meters to avoid receiving heavy fines from the energy regulator. Additionally, the adoption of smart meters is taking place in an industry that is not particularly well-known for being technology-oriented or at being apt in adopting new technologies. As a result, the adoption of smart meters has proven to be a complex and challenging process for energy suppliers in particular and the energy sector as a whole.

3.3.2 Smart Meters

Smart meters are advanced electricity and gas meters that can offer a range of intelligent functions to consumers, operators, and networks by providing the means to automatically record and communicate energy consumption data in near real-time (Hinson 2019). Smart meters accurately measure energy consumption and communicate the measured data to the energy suppliers, which gives them their smart functionality (Pereira et al. 2015). Smart meters look very similar to analogue meters but are functionally very different. The image below (Figure 8) showcases an analogue traditional meter on the left and a smart meter on the right. Smart meters are attached to two key elements: a communications hub otherwise referred to as a "comms hub", and an in-home display otherwise referred to as an "IHD". A communications hub is what provides the communication function to a smart meter, while a smart meter records energy consumption data, the communication hub stores, sends, and receives data from energy suppliers. Whereas, the in-home display (IHD) is a small screen that consumers usually have plugged in their kitchens or any other high footfall or visible area. The in-home display

[8] True as of 31 March 2020

provides the energy consumer with a visual representation of their consumption. As such, they can become more informed about their energy consumption patterns and behaviours, and even view their consumption in real-time (BEIS 2020). See Figure 9 for a visualisation of the smart meter, the in-home display, and the communications hub.

Figure 8. Image showcasing an analogue meter (on the right) a smart meter (on the left)[9]

[9] Source: Scottish Power Website: https://community.scottishpower.co.uk/t5/Blogs/The-Day-I-Had-A-Smart-Meter-Installed/ba-p/4750

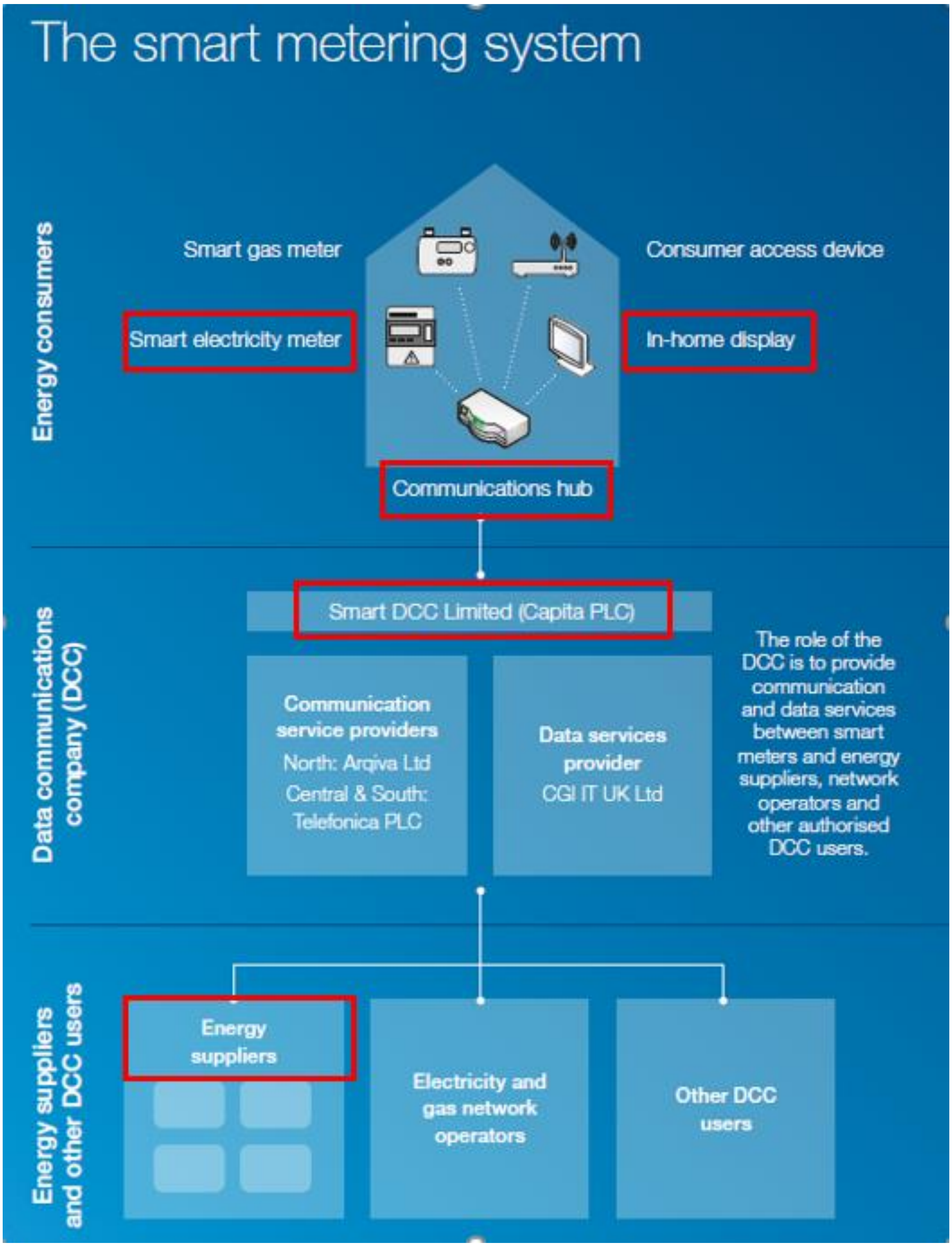

Figure 9. Smart Metering Infrastructure

Source: (BEIS 2018)

3.3.3 Types of Smart Meters

There are four main types of smart meters which are categorised based on two things: the type of energy it measures (gas vs. electricity) and the mode of payment (prepayment vs. credit). As such, the four main types of smart meters are: 1) gas prepayment meter 2) gas credit meter 3) electricity prepayment meter, and 4) electricity credit meter. With a credit meter gas or electricity, a customer will pay for their energy usage through a direct debit arrangement, whereas, with a prepayment meter gas or electricity meter, a customer is required to top up their meter manually.

It is also worth noting that there are two main variations of smart meters, often referred to as SMETS1 and SMETS2. SMETS1 stands for Smart Metering Equipment Technical Specification 1, whereas SMETS2 for Smart Metering Equipment Technical Specification 2. In essence, what this means is that SMETS1 is the first-generation smart meters, whereas SMETS2 is the second-generation smart meters. The key difference between SMETS1 and SMETS2 is the inter-operable functionality of SMETS2. Interoperability is the ability of a system to exchange data with other systems of different types. For example, if a customer has a SMETS1 meter installed, and then decides to change supplier, their smart meter will lose its smart functionality. In other words, the meter will not be automatically sending meter readings to the energy supplier, and they will not be able to view their energy consumption in real-time on the IHD. However, with the interoperable functionality of SMETS2 customers can change energy suppliers without losing the smart functionality meaning their energy consumption will still be automatically sent to the new energy supplier, despite the new energy supplier using a different system. This functionality was made possible through the setting up of the Data Communications Company, otherwise known as the "DCC" (see Figure 8 above)[10]. The role of the DCC is to provide communications and data services between smart meters and energy suppliers, network operators, and other authorised users. At the time of data collection, both GreenWorks and BlueHouse were working on adapting the head-end of their SMETS1 meters. This process will enable SMETS1 meters to become SMETS2 meters by adding the interoperable feature to their functionality.

3.3.4 CASE DESCRIPTION

3.3.4.1 GreenWorks

GreenWorks was formed in 1998 as a result of a merger and is one of the largest British-owned energy companies in the UK, part of the so-called "big six". GreenWorks is part of

[10] https://www.smartdcc.co.uk/our-smart-network/

GreenWorks Group, an operator and owner of low-carbon energy assets and businesses. GreenWorks supplies gas and electricity to its customers and offers phone and broadband packages, and boiler care and cover services (company website). The company emphasises its fair and comprehensive customer services and currently serves 5.7 million household customers. As of March 2018, GreenWorks served 3.9 million electricity customers and 2.6 million gas customers. With a 7.3% market share. Whilst GreenWorks Group generated a total profit of 31,226 million, GreenWorks generated a total profit of 260 million. In March 2018, GreenWorks Group employed 20,785 employees (Mintel 2013; Statistica 2018).

In early 2018, GreenWorks Group decided to sell GreenWorks in order to enable it to operate with greater day-to-day autonomy and independence. However, later that year, GreenWorks Group decided to step away from the planned sale as it was not in the best interests of the customers, employees, and shareholders of GreenWorks. This was due to the firms failing to agree on the level of capital injection required for the new company (IBIS report). Since December 2018, the group was actively considering a range of options regarding the future of GreenWorks including a possible sale, alternative transaction, or standalone listing as they were determined that GreenWorks' best future lies outside the GreenWorks group (Company website; BBC article).

In July 2019, it was confirmed that GreenWorks was considering a merger with a smaller energy supplier that has a high percentage of renewable electricity sources. The group were determined to enable GreenWorks to operate with greater autonomy and independence through transforming its operating model, as it will help GreenWorks regain its cost leadership position, by simplifying business processes and right-sizing to reflect customer demand. In January 2020 this merger was confirmed and completed (company website; BBC news article).

The rationale behind the decoupling is that it will help GreenWorks stabilise its overall customer base to help facilitate longer-term growth. Through leveraging their product offering they could offer their customers bespoke, value-adding propositions and bundled services, supported by targeted investment in marketing and incentives. GreenWorks expects to drive additional efficiencies by investing in digital to increase the proportion of customer service transactions completed online; to automate back-office processes, and to grow its data and analytics capability to provide smarter, tailored and more cost-effective solutions for customers through better customer segmentation, pricing more intelligently, and better tailor products and services to fulfil customers' changing needs (Company Website).

3.3.4.2 BlueHouse

BlueHouse was formed as a result of a demerger in 1997 and is part of the so-called "big six". BlueHouse is a subsidiary of BlueHouse Group, a multinational energy and services company. The company's strategy is heavily focused on excellent customer service as well as driving for higher returns on investment through greater efficiency. BlueHouse currently serves 12 million household customers. As of March 2018, BlueHouse served 5.5 million electricity customers and 6.9 million gas customers. Whilst BlueHouse Group generated a total profit of 29,686 million, BlueHouse generated a total profit of 556 million. GreenWorks Group employs 31,780 employees (Statistica 2018; company website)

BlueHouse have been developing their internet-based customer services where bills are sent to customer and customers send their readings electronically. BlueHouse has also invested in developing apps for smartphones and 25% of all website contacts are made through mobile devices. BlueHouse was one of the first energy companies to start installing smart meters. In 2012, one million BlueHouse customers had smart meters installed. In 2017, the new CEO promised to reinvent BlueHouse as a technology services powerhouse, and this transformation is still underway (Mintel 2013; Guardian article).

3.4 DATA COLLECTION

3.4.1 Gaining Access

Gaining access is highly important in qualitative research because the quality of access has a direct effect on the results of the study (Feldman et al. 2003). Obtaining access to the research field can vary to a considerable extent, depending on the kind of cases being investigated. In fact, researchers often spend a considerable amount of time on this task. As Van Maanen and Kolb (1985, p.11), observe "*gaining access to most organisations is not a matter to be taken lightly but one that involves some combination of strategic planning, hard work, and dumb luck*". The practicalities of gaining access to a closed setting are beset with several challenges (Bryman 2016, p.427) including convincing individuals to participate in the study, building trust and credibility at the field site, and getting people to respond. In addition to factors related to considering the appropriateness of a site need to be considered as well (Creswell 2018, pp.138-9). Companies and business people might be concerned about the confidentiality of information that has a link to their management, business operations, or future plans. They will find that research requires resources, most often time and information from the people who will be interviewed, which they might be unwilling to give up. Finally, they might not be able to see how the research will benefit the organisation and therefore may refuse to participate (Bryman 2016). These problems can be reduced by forming connections with gatekeepers, learning how to "sell" the research to an organisation, and offering a follow-up report detailing the main results of the study, or arranging a short meeting to discuss the results of the study (Eriksson and Kovalainen 2008, pp. 52-54). It is often argued that many researchers do not describe their access to the research field in their research reports. For this reason, the following section is dedicated to describing the process of gaining access to two case organisations. In the following subsections, I will refer to the two energy companies under the pseudonyms of GreenWorks and BlueHouse in order to protect the anonymity of the organisations.

3.4.1.1 Gaining Access to GreenWorks

Gaining access to GreenWorks started by arranging a meeting with a continuous improvement manager who was very keen on having a PhD student at the company, as she had previously hosted several master's students undertaking their dissertation projects and was used to students using GreenWorks as a case study. Although the continuous improvement manager was keen on getting me involved, when sending out follow up e-mails to approve my access, she was met with some resistance, as some of the business personnel could not see the value of undertaking the research. As a result, she arranged a follow-up meeting with the business director, as well as, several key business personnel. My supervisor and I explained the nature of the research and the topics involved and that the content of research interviews will not be of sensitive nature. Rather, they will consist of high-level issues around the organisational impact of the adoption of a big data technology and how this is unfolding. Additionally, that informants will be fully debriefed and will be able to review the findings before they go 'public' (i.e., thesis and journal submissions). Despite the initial reservation of some of the business personnel, the director was very keen on building relationships with the university and on getting me involved with my research. After this meeting, the logistics were solved very quickly. I received a non-disclosure contract to sign, a secure entry card, a company e-mail, a desk, and access to the intranet. I did not receive access to their SharePoint on which documents were shared, but relevant documents were sent to me via e-mail. The company did not hire me, but as I had to be registered on the internal system, I was categorised as a contractor.

Once inside the company, the continuous improvement manager acted as my point of contact to network my way in. I also applied to receive remote access. Being able to check my e-mail and arrange meetings remotely was very useful particularly when I travelled to offices in different geographical locations. I spent on average one day a week at the company. The first few months (May 2018-August 2018) were spent familiarising myself with the company structure and finding out who was responsible for what. I spent hours and hours navigating the company structure and sketched out my own version of it around those who were involved in smart meters (see Figure 10 below). The ones highlighted in blue are actors that have been interviewed. This enabled me to identify the so-called 'causal group' (Sayer 1992; Sayer 2000; Danermark et al. 2002). A causal group consists of specific, identifiable individuals that co-produce the social phenomenon under investigation. They are not known at the start of the study, which is why a considerable amount of time was spent identifying them. The causal group is not restricted to the executive level which is why the sample identified consists of business personnel from different hierarchal levels.

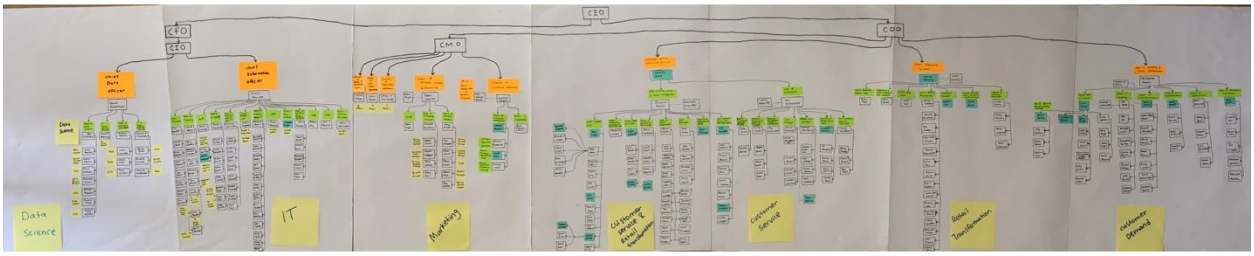

Figure 10. Sample of GreenWorks's Company Structure and Interviewed Respondents

After three months of fieldwork, my point of contact left the business to cover a senior management role in a different organisation. This was a crucial time for me, as I was starting to plan my first interviews and I was worried that her leaving the business might compromise my access to the company. However, she made sure to put me in touch with another manager who will act as my point of contact after her exit, and she assured me that my access will not be compromised. After a few weeks, I started arranging my first few interviews. This was difficult at first because I sent multiple e-mails that were simply ignored. I then asked my manager to introduce me to the respondents I was interested in interviewing. A short face-to-face meeting explaining what I intended to interview them about helped me secure my first few interviews.

After five interviews, I realised that the identified causal group extended beyond the office I had access to, such that arranging short face-to-face meetings prior to the extended interview was not possible. Similar to the first case, it was challenging to gain access to personnel outside the office I had access to because the e-mails I sent out explaining the purpose of the research and asking them to provide a convenient time for us to meet were left unanswered. This pushed me to re-think my data collection strategy. Having a company e-mail meant that I had access to everyone's diaries. I couldn't see the content of their calendar, but I was able to see when they had a free slot. As such, I decided to send my identified respondents' a calendar invite with a timeslot that fit into their diaries and provided a brief description of why I wanted to interview them. I also booked a meeting room for the interviews. 80% identified respondents would accept my calendar invites, 20% would ignore them. Of the 80% that did accept my invite, very few would respond. Therefore, I would often show up at a meeting room, hoping they would show up too, as we had very little correspondence prior besides the accepted calendar invite. This strategy proved a lot more successful than I had initially anticipated: I managed to secure a significant number of interviews. A total number of 28 interviews were conducted between September 2018 and March 2019.

3.4.1.2 Gaining Access to BlueHouse

BlueHouse had been on the radar of companies that operated within the same industry as Greenworks (i.e. the energy sector). From carrying out some initial research on BlueHouse, it was clear that they were undertaking a different journey in the actualisation of smart meter affordances. My supervisor who had previously undertaken some research on BlueHouse helped confirm this. Therefore, BlueHouse was identified as a suitable second case study, as it had the potential to offer rival explanations for the phenomena under study and fulfil the purpose of analytic generalisation (Yin 2018). Having a second case study would provide means of leveraging existing statements on casual mechanisms from GreenWorks that could explain observed events to that of a new setting: BlueHouse. By incorporating a second case study, my aim was to explain any such differences between the two settings not as occasions to invalidate the original causal analysis, but rather as an integral element of any proposed explanation or theory (Lee and Baskerville 2003). Thus, the aim was to validate and refine the current theories and explanations.

After identifying BlueHouse as a suitable case study, a meeting was arranged with the head of data science to explain the purpose of the research with the aim to conduct interviews with key personnel. He expressed an interest in the research and was keen to learn about the results of the research. Access was granted shortly afterwards in September 2018. The choice of the data science team as a gateway to the rest of the organisation was deliberate because they operated as a consulting team within the business where they worked on projects across most business functions. Therefore, they had good networks and were able to help identify 'causal samples' through their past and present experiences and projects. Unlike GreenWorks, I was not granted full access to the organisation (i.e. an access card, intranet, desk, e-mail), but I was given permission to interview personnel within the business and a data science associate acted as my point of contact and gatekeeper throughout the data collection process. The process of data collection was facilitated by having an established partnership between the university and BlueHouse that was set up a year prior to me carrying out my research. This established network and relationship further facilitated the data collection process.

The data collection process started with signing a non-disclosure agreement. The first few weeks were spent familiarising myself with the company structure and identifying a possible 'causal sample'. Because I did not have access to the company intranet, this search process was facilitated by the gatekeeper internally and by using LinkedIn externally. As a result of this, I sketched out my own version of those who were involved in smart meters (see Figure 11 below). This process was similar to that followed in GreenWorks in order to identify the so-called 'causal sample' (Sayer 1992; Sayer 2000; Danermark et al. 2002). Having learnt from the data collection experience in GreenWorks, a decision was made to use a similar strategy that previously proved to be successful. Respondents' diaries were checked to identify a suitable timeslot and a calendar invite was sent briefly explaining the aim of the research interview. The gatekeeper helped facilitate this process and book meeting rooms for the proposed timeslots. A total of 19 interviews were conducted in the period between October 2018 and March 2019.

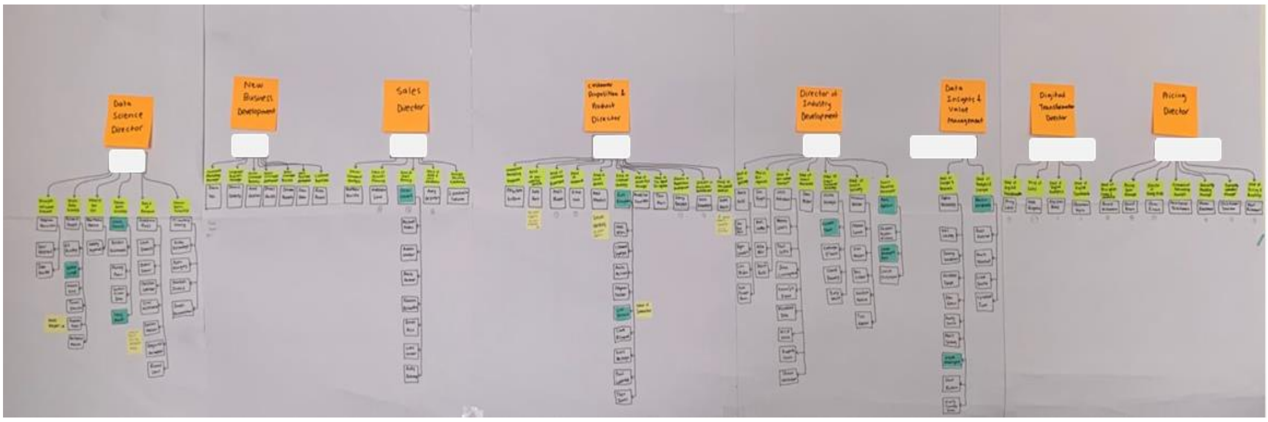

Figure 11. Sample of BlueHouse's Company Structure and Interviewed Respondents

3.4.2 Data Collection Process

"Interviewing gives us access to the observations of others. Through interviewing we can learn about places we have not been and could not go and about settings in which we have not lived."

(Robert S.Weiss, Learning From Strangers)

The data collection process followed a pathway of discovery, one which does not necessarily lend itself well to a standardised approach (Sayer 2000). The data being perused was not narrowly defined from the outset but instead, the choice of data collected depended on what was needed to find the best possible understanding and explanation of the phenomena under study. This included interviews, informal conversations, company documents, news articles, and publicly available government documents. This is very much in line with a critical realist approach, whereby the researcher will be interested in many kinds of data, especially at the outset of the research (Ackroyd and Karlsson 2014). Interviews did prove the most powerful source of information, and the reporting of findings in this study mostly rely on interview data. As Robert S. Weiss highlights in the quote above, interviewing can help us learn about places and settings we have been to or lived in (Weiss 1995).

Interviews offered a gateway to additional sources of information. Frequently, internal company documents were sent to me by participants in a follow-up e-mail. As a result of conducting an interview, I was included in mailing lists that were of relevance to my research topic. Therefore, it was of no surprise why interviews are considered the most important source of evidence and are most commonly used in case study research (Yin 2014). In addition to the interviews and company documents, I also kept an eye out for news articles referencing the energy sector and the energy companies that I was studying. We live in an age where companies are continuously disseminating information via social media platforms, so I followed both organisations on Twitter and LinkedIn. In the reporting of my findings, I mostly rely on the use of interview material; however, the multiple sources of data were used to abstract and corroborate my understanding of the causal factors and relationships and to explore rival explanations (Wynn and Williams 2012). The use of complemtary data sources was particularly useful as it allowed me to to establish a more assured basis for the identification of tendencies or demi-regularities through the process of data triangulation. It also played a key role in the process of retroduction in order to identify the generative mechanisms that helped explain empirical outcomes (Kessler and Bach 2014).

The fieldwork and data collection process lasted for a period of 10 months between May 2018 and March 2019, where the first few months were spent familiarising myself with the company culture, structure, and identifying the suitable business personnel to conduct interviews with. Interviews were guided by a semi-structured interview question see (Appendix B – Interview Questions). The interview guide was informed by the central research questions of what affordances do smart meters enable? And how and why are these affordances actualised or not actualised? In order to identify the affordances, immediate concrete outcomes the actors experienced or expected to experience needed to be uncovered. To do so, and in line with the recommendations from Volkoff and Strong (2013), the following questions were asked of the respondents:

1. What do smart meters enable you to do?
2. What do smart meters make more difficult to do?
3. What do you use smart meters for?
4. What happened once you started using smart meters?
5. Were there things you expected to be able to do that were not in fact possible?

(Adapted from: Volkoff and Strong 2013)

Although the ‘you’ in the questions above was addressed to the individual I was interviewing, I explained to the respondents that I was interested in what smart meters offer to ‘you’ as a business - using the part to refer to the whole. Each interview began with a brief introduction of the research objective and the interviewees were provided with an informed consent form. This was important for establishing rapport and gaining permission to record our conversation. During the interviews, the stream of questions being asked were fluid in nature, allowing respondents to talk openly and elaborate on issues that are important to them (Rubin and Rubin 2012). The interview guide was used as a prompt, as opposed to a script. As a result, not all questions in the interview guide were covered in all interviews.

Face-to-face interviews offer the interviewer the obvious visual cues of friendliness such as smiling or maintaining good eye contact, which is conducive to gaining and maintaining rapport (Bryman 2016). Because of this, and as much as possible, interviews were conducted face-to-face in the participant's natural work environment. Being in their natural work environment meant that interviewees were in an environment that was familiar to them, and one in which they felt comfortable. On the few occasions where face-to-face meetings were not possible, they were conducted via telephone or Skype. Interviews were either conducted in an individual or joint format. Individual interviews involve one researcher talking with one person about one phenomenon. In contrast, joint interviews involve one researcher talking with two or more people simultaneously about one. Joint interviews proved very useful for collecting differing or corroborating perspectives of one event particularly when informants worked in the same team. Having two or three parties present at the same time allowed them to fill in details that the others had omitted (Gray 2017).

Informants had busy diaries and were located in a number of offices in different geographical locations. A planning sheet and digital diary helped to organise this process, yet it was inevitably an intense and time-consuming process. To attain the sample of 47 interviews, hundreds of emails were sent and a total of 52 data collection days took place over the period of 10 months. All interviews were conducted in English, audio-recorded, and subsequently transcribed. Interviews lasted between 24 minutes and 87 minutes, allowing me to access 33 hours of interview material. This resulted in 581 pages of interview transcripts for analysis, of which 291 pages were a result of GreenWorks interviews and 168 pages were a result of BlueHouse interviews. See Table 5 and Table 6 below for a description of interviews conducted in GreenWorks and BlueHouse, respectively.

The transcription of recorded interviews takes a long time (i.e., approximately six hours transcription for every hour of recorded interview talk) (Bryman 2016). For this reason, I relied on the use of an automated transcription software service called Trint. Trint does not offer 100% accuracy of transcripts. Because of this, each transcript was later manually checked to ensure accuracy and completion. Although interviews took place over the period of 10 months, data collection of secondary material such as news articles, company documents, and informal conversations continued throughout the data analysis and writing up period. My access to GreenWorks remained ongoing until the end of the write-up period. As for BlueHouse, I remained in touch with key personnel there, whenever I needed clarification of any information during the data analysis phase. This process enabled a more holistic understanding of the phenomena under study and helped validate my findings against ongoing developments.

Table 5. GreenWorks List of Interviews

	Job Title	Duration	Date	Joint Interview	Format
1	Smart Customer Services Manager	1:27:59	18/10/2018		face-to-face
2	Smart Outage and Incident Manager	1:16:30	29/10/2018		face-to-face
3	Customer Services Manager	52:48	29/10/2018		face-to-face
4	Smart Team Manager	34:72	01/11/2018		face-to-face
5	Smart Integration Lead	46:10	06/11/2018		face-to-face
6	Billing and Smart Integration Quality and Performance Lead	24:30	14/11/2018		telephone
7	Smart Integration Lead	1:10:31	14/11/2018	*[11]	face-to-face
8	Business Analyst	1:10:31	14/11/2018	*	face-to-face
9	Smart Integration Lead	42:27	11/12/2018		face-to-face
10	Smart Integration Lead	36:26	11/12/2018		face-to-face
11	Retail Transformation Site Manager	42:13	11/12/2018		face-to-face
12	Senior Business Analyst	46:38	21/01/2019		face-to-face
13	Business Transformation Quality and Performance Lead	25:31	21/01/2019		face-to-face
14	Director of Strategy & Planning	22:24	28/01/2019		skype
15	Smart Business Design Manager	1:00:27	28/01/2019		telephone
16	Smart Governance Manager	45:14	31/01/2019		face-to-face
17	Head of Smart Transformation	51:31	31/01/2019		face-to-face

[11] Interviews marked with * or ** or *** are shared interviews.

18	Smart Project Manager	49:27	31/01/2019		telephone
19	Head of Industry and regulatory engagement	48:06	31/01/2019		face-to-face
20	Head of Smart Deployment and Projects Manager	45:22	11/02/2019		face-to-face
21	Smart Transformation Director	45:05	11/02/2019		face-to-face
22	Head of Customer Experience	49:39	11/02/2019	**	face-to-face
23	Smart Customer Experience Lead	49:39	11/02/2019	**	face-to-face
24	Smart Business Design Lead	42:42	11/02/2019		face-to-face
25	Smart IT Transformation Director	1:11:25	27/02/2019		face-to-face
26	IT architect	40:38	27/02/2019		face-to-face
27	Head of Smart Customer Demand	39:53	27/02/2019		face-to-face
28	Smart Design Project Manager	59:39	27/02/2019		face-to-face

Table 6. BlueHouse List of Interviews

	Job Title	Duration	Date	Joint Interview	Format
1	Insight Propositions Manager	39:50	08/02/2019		telephone
2	Head of Analytics & Insight	43:00	08/02/2019		face-to-face
3	Head of Customer Strategy & Innovation	31:01	08/02/2019		telephone
4	Head of Data Science	44:37	22/02/2019		face-to-face
5	Business Analyst	49:09	28/02/2019		face-to-face
6	Senior Customer Strategy Manager	45:48	28/02/2019		face-to-face
7	Technical Analyst	31:17	28/02/2019		face-to-face
8	Head of Smart Planning	26:30	28/02/2019		face-to-face
9	Head of Innovation	33:25	28/02/2019		face-to-face
10	Data Scientist	42:55	07/03/2019		face-to-face
11	Smart Analyst	1:13:43	07/03/2019	***	face-to-face
12	Smart Manager	1:13:43	07/03/2019	***	face-to-face
13	Smart Insight Manager	28:15	15/03/2019		skype
14	Head of Smart Sales	41:38	21/03/2019		skype
15	Senior Data Scientist	54:38	21/03/2019		skype
16	Head of Smart Infrastructure	36:30	28/03/2019		skype
17	Smart Project Manager	48:56	28/03/2019	****	skype
18	Customer Strategy Manager	48:56	28/03/2019	****	skype

19	Smart Service Manager	48:56	28/03/2019	****	skype

3.5 DATA ANALYSIS

"While premature closure is usually associated with leaving the field too early, it can also occur in situations where the researcher has collected a wealth of data but fails to move beyond describing what is in that data."

(Christina Goulding, Grounded Theory: A Practical Guide for Management, Business, and Market Researchers)

Unlike the analysis of quantitative data, whereby there are unambiguous rules on the handling of data analysis, the analysis of qualitative data has a few well-established and widely accepted rules (Bryman and Bell 2011). Having said that, it has been argued that having a codification of analytic procedures for the analysis of qualitative data is not necessarily desirable (Bryman 1994), as it is important for researchers to remain flexible and responsive to the data and research goal (Corbin and Strauss 2015). In this spirit and acknowledging the importance of data analysis procedures in facilitating the process of moving beyond merely describing to explaining the data, this research borrows from some of the principles of grounded theory for data analysis. In particular, I draw on *constant comparison, memos, open coding,* and *axial coding* to provide meaning and explanation of the data, and to avoid premature closure, as highlighted in the quote above (Goulding 2002, p.165). Grounded theory encourages a thorough and systematic scrutiny of the data and analysis and therefore helps overcome the risk of premature closure. As such, it is of surprise that grounded theory and grounded theory techniques have become a popular within critical realist informed research (Kempster and Parry 2014) and within affordance-based big data research (Lehrer et al. 2018; Dremel et al. 2020a).

It is important to note that grounded theory is adopted here as a data analysis tool as opposed to an all-encompassing research methodology. As such, data collection and analysis did not take place simultaneously with the aim of reaching theoretical saturation as would be expected from a grounded theory study (Corbin and Strauss 1990; Corbin and Strauss 2015), but rather data analysis commenced once all interviews were conducted and transcribed. However, reviewing news articles, company documents, as well as government reports continued throughout the data collection and analysis phase as it proved to be an important component of reaching a more nuanced understanding of the codes that were emerging.

The data analysis strategy was very much driven by the three key aims of the study. The first being the identification of smart meter affordances. The second being the identification of organisational capabilities for the actualisation of smart meters affordances. And the third being the identification of the generative mechanisms that enable or constrain the actualisation of smart meter affordances. The coding and analysis of interview data followed a structured, systematic, and detailed process and took place over several stages. The coding began in April 2019 and lasted for a period of 20 months.

To keep track of the data and analysis, I used Google Sheets to structure and organise the data and analysis (see appendix C for a sample of the coding). The reason for using Google Sheets as opposed to a software is that it enabled me to remain in close proximity to the data throughout the analysis. While using a data analysis software (e.g., NVivo) can be a useful way to manage and code qualitative data, I found that as the analysis progressed, the data disappears from sight and what remains in view is the higher-level view of the data in the form of codes or nodes. In contrast, using Google Sheets enabled me to view the data, the codes, labels, memos and reflections on the emerging data all at the same time. This is very much consistent with the grounded theory principle of *constant comparison*, whereby the researcher follows a process of maintaining a close connection between data and conceptualisation so that the correspondence between concepts and categories with their indicators is not lost (Bryman and Bell 2011).

3.5.1 Data Coding

The first stage of analysis entailed *open coding.* Open coding is the process of breaking down, examining, comparing, conceptualising, and categorising data (Corbin and Strauss 1990; Corbin and Strauss 2015). Open coding was carried out by reviewing interview transcripts line by line, quote by quote and assigning appropriate labels to them. During the process of open coding, secondary sources of data (e.g. news articles, company documents, government reports) were used to corroborate and triangulate the insights derived from the analysis of the interviews. This stage was mainly concerned with identifying the affordances that smart meters enable and the organisational capabilities that enable the actualisation of smart meter affordances. In fact, in order for an affordance to be brought into the domain of the real (i.e. actualised), an organisation must have the necessary capability and goal that is served by actualising the affordance (Volkoff and Strong 2017). Examples of the labels that were generated at this stage for smart meter **affordances** are "real-time understanding of energy demand", "offer flexible tariffs to customers", "disaggregate the different devices in the household", and "offer predictive maintenance". Examples of labels that were generated at this stage as organisational **capabilities** are "data science being able to disaggregate the data", "the ability to develop a predictive model for energy fraud", "having data management platforms to categorise, install and manage the data", and "having senior leadership that drive collaborative working to address business problems". Figure 12 below provides a snapshot of the open-coding for interview data (see Appendix C for a more detailed image).

Quote	Interview Reference	Perceived Affordance	Actualized Affordance	All affordances (percieved & actualized)	higher level affordance (7 thus far)	Organizational Goal	Capability?	Notes (my thoughts/ questions)
[00:08:54] Previously collecting data once a quarter and that moved to once every half hour. So there's a massive increase in the volume of data so that was the first big one. The second thing is actually what do you do with that data. And there again are a couple of different levels of thinking there. So with smart meter data as we got today the kind of half hourly data you can do some interesting stuff so you can look at demand what what is the demand on the grid in a particular area a particular time of day and you can you can start looking at flexibility offering interesting tariffs to customers around free use tariffs and helping to balance demand and that's that's really valuable. So you can do that with the half hourly level that gives you something new that you've never had before and that's something pretty fundamental. [00:09:45][51.9]	Interview 4 - Company B		- Flexible tariff - Balance energy demand	- Near real-time understanding of **energy demand** - Offer **flexible tariffs** to customers (e.g. free use tarriffs) - **Balance demand** on the grid	- Better understand energy usage - Better understand energy demand - Balance energy imbalance on the grid			better understanding energy usage leads and better understand demand can enable energy companies to nudge customers to change their behaviour from using energy on peak times to off peak times - changing consumer behaviour in order to balance the energy imbalance on the grid - thinking out loud I think SSE have specific meters (non-smart) that give different tarrifs however these meters do not have a smart meter replacement for it yet!!!
[00:09:45] The more interesting thing is that actually smart meters are probably just the beginning of connected connected energy devices where you can understand at a really granular level how much energy is being used. So we have some trials to look at 10 second data coming from fridges and that have second data so as you start to get more and more granular you can tell really interesting things like... is this fridge likely to break down? [00:10:09][23.9]	Interview 4 - Company B	Connected energy devices		- The start of **connected energy devices** - understand energy usage at a much granular level (every 10 secs) - **predict breakdown** (e.g. when a fridge is likey to break down)	- Better understand energy usage - offer new products and services			
[00:10:28] The 10 second meter won't give you the fridge. It will give you the whole energy reading from the house but you can disaggregate the different devices in the house. If you have a long enough time period. [00:10:39][10.8]	Interview 4 - Company B		Disaggregate a fridge in an enegry signal	- **disaggregate** the different **devices** in the house (e.g. fridge)	- Better understand energy usage		Data Science: disaggregate the data	Can we think of 10 second data as a capability. Since not both case studies have it. It also requires an investment in terms of getting customers to accept the chip, collecting the data, and analyzing it. In addition to the resources and skills needed to carry out each!
[00:10:44] There's like a background kind of energy reading in the house with all the devices that are always on pretty much the fridge being the obvious one. Yeah you can tell when lights turn on more or less can tell when a kettle turns on you know. No not perfectly but enough that you can get a regular kind of pulse out from some of these devices. So when you get down to 10 second level for such a predictive predictive maintenance which it becomes really interesting as a whole new set of products and services for customers it means that hopefully your fridge doesn't break down and ruin all your food anymore. You could kind of preempt it. So we're looking at that today. That's that's where I'm interested in what we can do with smart meters because it offers an awful lot more to consumers...to customers. [00:11:28][43.8]	Interview 4 - Company B	Predictive Maintenance		- **offer predictive maintenance** - **offer a new products and services** to customers	- offer new products and services			predictive maintenance is still under trial... does that make it a perceived affordance or an actualized affordance? It almost seems like an affordance goes from perception to ideation to testing until it is finally actualized.
[00:11:38] We're starting to look up energy imbalance. Grid imbalance where we are. Where we... like historically we've had these kind of four meter readings a year and you've got to make a lot of guesses and assumptions about how much energy someone is using. So now you can stop doing that. You can get that right straight away pretty much. There are tariffs and propositions that are based on smart meter data as well but that's probably the other interesting bit right now. So I mentioned a time of use tariffs. That we've started we've trialled a few we've done things like free saturdays. We are likely to do a lot more of that kind of thing with smart meter data so changing consumer behavior and to benefit them but really to balance the grid that's the kind of benefit. [00:12:28][50.4]	Interview 4 - Company B		Free energy Saturdays Balance the energy on the grid	- **Grid/ energy imbalance** - Make more **informed decisions** on energy usage - **Offer new tarriffs & propositions** - **Time of use tarriff** (e.g. free energy saturdays) - **Change consumer behaviour/** energy usage patterns - **Balance the grid**	- Balance energy imbalance on the grid			The motivation of getting customers to change their habits is so they can save money on their bills by using the cheaper energy tarrifs BUT the real incentive for the company is to balamce the enrgry on the grid.
[00:12:36] You try to incentivize people to use energy at times when the grid has got capacity. [00:12:44][8.6]	Interview 4 - Company B		- balance the grid	- balance the grid	- Balance energy imbalance on the grid			- offering customers free energy on weekends. The assumption might be that residential customers use more energy on weekends. However, the big industrial units are shut on weekends so incentivizing

Figure 12. Sample of Open Coding for Interview Data

Acknowledging the fact that qualitative data produces large and cumbersome amounts of data to analyse (Bryman and Bell 2011), (in this case: 581 pages of interview transcripts) I carried out a staged approach to data analysis. I commenced the first round of open coding with five interviews by assigning labels and documenting my thoughts and reflections in the form of notes, which in grounded theory is referred to as *memos* [12]. Following which I reviewed the labels that had emerged in the initial five interviews and took stock of my notes and reflections. This process was useful, as it insured the assigned labels would be consistent in the coding of additional interview data moving forward. Using *constant comparison*, a procedure in which each finding and interpretation that emerges from the data is compared with existing codes and categories (Strauss and Corbin 1990), I carried out open coding on an additional five interviews, following which I reviewed the labels, notes, and reflections. I repeated the process of open coding and constant comparison until all 47 interviews were coded in a similar manner.

The second stage of analysis entailed *axial coding*. Axial coding is a set of procedures whereby data is put back together in new ways after open coding, by making connections between categories (Strauss and Corbin 1990). This is done by linking codes to contexts, consequences, patterns of interaction, and causes (Bryman and Bell 2011). During the process of axial coding, secondary sources of data (e.g., news articles, company documents, government reports) were used to corroborate the insights derived from the analysis of the interviews. Because the process of open coding produced a large number of labels and codes, the aim of axial coding and constant comparison was to reduce these codes to a small number of categories. Organisational affordances were reduced to five key categories (see Figure 13 below), and organisational capabilities were reduced to seven key categories (see Figure 14 below). Examples of affordances categories were "customer-oriented affordances", "energy trading affordances", and "business process improvement affordances". Examples of capabilities categories were "big data management capability", "big data analytics capability", and "innovation capability". This process was very much an iterative one of moving between the data and the labels/codes, and the literature. Extant literature was consulted to ensure that my organisational capabilities labels were consistent with that of the extant literature.

[12] Memos are brief notes designed to capture emerging information (Bryman and Bell 2011, p. 581).

Quote	Interview Reference	Data Type	Perceived Affordance	Actualized Affordance	All affordances (percieved & actualized)	higher level affordance	Organizational Goal	Capability	Notes, thoughts, questions
00:08:54] Previously collecting data once a quarter and that moved o once every half hour. So there's a massive increase in the volume of data so that was the first big one. The second thing is actually what do you do with that data. And there again are a couple of different levels of thinking there. So with smart meter data as we got today the kind of half hourly data you can do some interesting stuff so you can look at demand what what is the demand on the grid in a particular area a particular time of day and you can you can start looking at flexibility offering interesting tariffs to customers around free use tariffs and helping to balance demand and that's that's really valuable. So you can do that with the half hourly level that gives you something new that you've never had before and that's something pretty fundamental. [00:09:45][51.9]	Interview 4 - Company B	30 minute data		- Flexible tarriff - Balance energy demand	- Near real-time understanding of **energy demand** - Offer **flexible tarriffs** to customers (e.g. free use tarriffs) **- Balance demand** on the grid	- Balance the grid - Change customer behaviour			better understanding energy usage leads and better understanding demand can enable energy companies to nudge customers to change their behaviour from using energy on peak times to off peak times - changing consumer behaviour in order to balance the energy imbalance on the grid - thinking out loud I think GreenWorks have specific meters (non-smart) that give different tarriffs however these meters do not have a smart meter replacement for it yet!!! I think they are called economy 7 & economy 9.
00:09:45] The more interesting thing is that actually smart meters are probably just the beginning of connected connected energy devices where you can understand at a really granular level how much energy is being used. So we have some trials to look at 10 second data coming from fridges and that have second data so as you start to get more and more granular you can tell really interesting things like... is this fridge likely to break down? [00:10:09][23.9]	Interview 4 - Company B	10 second data	Connected energy devices		- The start of **connected energy devices** - understand **energy usage** at a much granular level (every 10 secs) **- predict breakdown** (e.g. when a fridge is likey to break down)	- understand customer behaviour - offer new products and services			
00:10:28] The 10 second meter won't give you the fridge. It will give you the whole energy reading from the house but you can disaggregate the different devices in the house. If you have a long enough time period. [00:10:39][10.8]	Interview 4 - Company B	10 second data		Disaggregate a fridge in an enegry signal	**- disaggregate** the different **devices** in the house (e.g. fridge)	- offer new products and services		Data Science: disaggregate the data	Can we think of 10 second data as a capability. Since not both case studies have it. It also requires an investment in terms of getting customers to accept the chip, collecting the data, and analyzing it. In addition to the resources and skills needed to carry out each!
00:10:44] There's like a background kind of energy reading in the house with all the devices that are always on pretty much the fridge being the obvious one. Yeah you can tell when lights turn on more or less can tell when a kettle turns on you know. No not perfectly but enough that you can get a regular kind of pulse out from some of these devices. So when you get down to 10 second level for such a predictive predictive maintenance which it becomes really interesting as a whole new set of products and services for customers it means that hopefully your fridge doesn't break down and ruin all your food anymore. You could kind of preempt it. So we're looking at that today. That's that's where I'm interested in what we can do with smart meters because it offers an awful lot more to	Interview 4 - Company B	10 second data	Predictive Maintenance		**- offer predictive maintenance** - offer a **new products and services** to customers	- offer new products and services			predictive maintenance is still under trial... does that make it a perceived affordance or an actualized affordance? It almost seems like an affordance goes from perception to ideation to testing until it is finally fully actualized.

Figure 13. Sample of Axial Coding for Organisational Affordances

Interview Quote	Interview Reference	Summary	High level capability Aug/Sept 2020	Notes A few generative mechanismare noted Aug/Sept 2020	Generative Mechanism	Capabilities	Factor/ Barrier
[00:00:17] Basically my team is me and four other people. And we kind of do all sorts. So we were set up about two years ago to kind of try and transform the way that [our company] delivers props, so to be more kind of lean, agile, digital led, like get your buzzword bingo card out, we know all of them! And we kind of did that on a really small scale and piloted really well. So we did a couple of kind of design centered sprints. And we did three that worked really well. But then the props that came out of them we were like oh how do we actually go and deliver these props because they were in kind of adjacent markets so not really core to BlueHouse. [00:01:04][47.0]	Interview 9 - Company B	**Innovation Lab**: in charge of customer products and propositions - set up to do so in an agile, lean, digital led way	Innovation Capability	Generative mechanism: alignment with core of the business	Business alignment with core business	Development and commercialisation	alignment with core business
[00:01:16] So for the past kind of year or so we've been working out ways in which we would deliver them. So would they be by ventures? So setting them up as totally separate businesses outside of BlueHouse? Do we set them up has a ring fenced venture within BlueHouse? Or do we find a product team and a product owner to do it completely conventionally within BlueHouse. And that journey is kind of led us to a place now where we do experimentation. So we will help core product teams to experiment with brand new ideas that they have. So we will do smoke test for them where you do like a website with nothing behind it. And we can give them kind of propensity to buy Google Analytics that sits behind that. And so that's one service.[00:02:02][45.5]	Interview 9 - Company B	**Innovation Lab**: help teams experiment with ideas that they have; do a smoke test for them	Innovation Capability	...and the strategy around it.		Development Innovation Commercialisation Experimentation	
[00:02:02] Transformation where we try and do a bit of an education piece to get the rest of UK home working in this way. So when we do a sprint, we consciously bring other people in whether they're kind of connected or not. So they get a flavor of how we work. We will hold events that we hold tech talk events, where we can just get people from DTS into UK Home, so they can come and talk about what they do. And, we've got kind of other initiatives and then we've got the real innovation. So I did run five, I now kind of run four actual ventures from my team as well which are kind of like standalone businesses with a business case KPI. We take them to an investment committee once a quarter to see how we're doing it, so the KPIs and investment that we go against them. [00:02:46][44.6]	Interview 9 - Company B	**Innovation Lab**: educate different parts of the business, run tech talks, develop business cases that are taken to an investment committee. Innovation Lab: new business innovation (product/ service innovation)	Collaboration & Communication Capability	Collaboration & Communication Capability as part of the Innovation Capability		Cross-functional collaboration Development Innovation Commercialisation	
So that's one, we then have a couple of kind of just... I'm going to call them corporate failures so products that have been brilliant products, and the whole point of how we work is desirability, feasibility, viability which have been a massive win in desirability. So we believe kind of from our smoke test a 6% conversion rate is good. So if you get 6% of the people that reach your website will give you an indication to buy so they'll carry on the-call-to-action. That's good. If you get 6% percent one of our props got over 20%. And then once we took the website down had a viral effect of 7% so it got shared on social media. We've never seen that before. Unfortunately... [00:05:32][110.9] [00:05:35] So is this an actual website? [00:05:35][0.1] [00:05:35] Yeah. Yeah. So we put it all on Google. Not branded because that would be a struggle. So non-branded web site on Google. [00:05:49][13.4] [00:05:49] No adverts nothing? [00:05:49][0.1] [00:05:49] Google ads and PPC. So this was incredible. And unfortunately though it was in short term loans and the business had quite a adverse reaction to going into short term loans. So we pushed it forward. Through feasibility to see if we could actually do it. We were like Okay we get your concerns but it's unbranded. It's just a trial to like 900 customers we're going to do anyway and just see if we can do it. And then it turned into a	Interview 9 - Company B	- business having an adverse re-action to a certain type of product	Strategic Management Capability	Lack of data led innovation strategy and innovations not being aligned with the core of the business. Doing the things they have always done vs doing the things that are outside their comfort zone.			data-led innovation strategy

Figure 14. Sample of Axial Coding for Organisational Capabilities

For the identification of generative mechanisms, a critical realist focused approach of data analysis was utilised, because generative mechanisms cannot be observed as they occur in the domain of the real. They generate events/outcomes that can be observed in the domain of the empirical or cannot be observed in the domain of the actual. The critical realist method of *retroduction* was utilised to uncover the generative mechanisms that explain the empirical outcomes. *Retroduction* is the process of working backwards from the empirical events we observe to the underlying mechanisms that could have produced those events (Danermark et al. 2019). Volkoff and Strong (2013) argue that the identification of affordances helps researchers specify the mechanisms that explain the outcomes of the introduction of new technology in organisations. Having identified a list of affordances and capabilities during the process of open and axial coding, I was able to work backwards from the empirical events to uncover the generative mechanisms. Through the process of linking and moving backwards and forward between the codes on organisational affordances, organisational capabilities, and the data I was able to abstract the generative mechanisms that help explain why certain smart meter affordances are actualised whilst others were not. Table 7 below provides a summary of the data analysis tools and techniques that were utilised throughout the analysis process.

Open coding	The process of breaking down, examining, comparing, conceptualising, and categorising data (Corbin and Strauss 1990, p.61). This process of coding yields concepts that are later grouped and turned into categories (Corbin and Strauss 1990, p.61)
Axial coding	A set of procedures whereby data are put back together in new ways after open coding, by making connections between categories (Corbin and Strauss 1990, p.61). This is done by linking codes to contexts, to consequences, to patterns of interaction, and to causes.
Constant Comparison	A procedure in which each finding and interpretation that emerges from the data is compared with existing codes and categories (Corbin and Strauss 1990, p.61)
Memos	In grounded theory memos are brief notes designed to capture emerging information (Bryman and Bell 2011, p. 581)
Retroduction	The process of working backwards from the empirical events we observe to the underlying mechanisms that could have produced those events (Danermark et al. 2019).

Table 7. Summary of Data Analysis Tools Utilised

3.5.2 Research Quality and Trustworthiness

"Quality in qualitative research is something that we recognise when we see it; however, explaining what it is, or how to achieve it, is much more difficult."

(Corbin and Strauss 2015, p. 341)

Whilst explaining research quality and how to achieve it can be difficult, this section is dedicated to describing how research quality and trustworthiness was achieved. Assessing the quality of research is usually related to two main concepts: reliability and validity. Reliability is often treated in relation to the issue of whether a finding is reproducible at other times by other researchers (Brinkmann and Kvale 2015). On the other hand, validity pertains to whether a method investigates what it purports to investigate (Brinkmann and Kvale 2015). In qualitative research, the notions of reliability and validity as defined above cannot be demonstrated with standardised metrics as in quantitative research (Collis and Hussey 2013). As such, researchers have sought alternatives for measuring research quality. Lincoln and Guba (1985) provide an alternative to assessing the reliability and validity of qualitative research by proposing the concept of *trustworthiness* of research findings. *Trustworthiness* includes *credibility* (internal validity), *transferability* (external validity), *dependability* (internal reliability), and *conformability* (external reliability).

Credibility is concerned with ensuring that the study is capturing what is the study is intending to capture. To address the credibility of this research two key considerations were carried out. First, the interview guide was reviewed by an experienced academic[13] who is both an expert in the field of big data in organisations, an expert in utilising the affordance theory lens, and an experienced interviewer. Suggestions were made by the experienced academic, and the interview guide was adjusted accordingly. This ensured that the interview questions were capturing what they were intending to capture. Second, the type of questions included in the interview guide were informed by the suggestions provided by Volkoff and Strong (2013) which enabled me to ask the right questions to identify the smart meter affordances. From the interview responses, I was able to uncover the concrete outcomes the actors experienced or expected to experience (see Section 3.4 on data collection).

Transferability is concerned with the extent to which the findings of a study can be applied to other situations. To address the issue of transferability, I provide thick descriptions of the study

[13] An academic from a different institution and independent from the project/supervisory panel.

context, as well as a detailed description of the two cases: BlueHouse and GreenWorks (Geertz 1973; Bryman and Bell 2011, p.398). As such, "*the researcher enables the readers to transfer information to other settings and determine whether the findings can be transferred*" (Creswell 2007, p.209). It is worth noting that the aim of this study is not to seek statistical generalisation, but analytic generalisation (Yin 2018), whereby generalisation happens at a conceptual level. In essence, this study aims to enhance our understanding of IT-enabled organisational change and innovation. By incorporating two cases studies, the aim is not to seek patterns but to better explain the events being observed as opposed to the generalisation of theory to a new population or context (Wynn and Williams 2012).

In order to address the *dependability* of the research, Lincoln and Guba (1985) argue that researchers should adopt an auditing approach, whereby the researcher maintains complete records of all phases of the research in an accessible manner, in order for peers to act as auditors and establish how far proper procedures have been followed. However, auditing has not become *"a popular approach to enhancing the dependability of qualitative research within management and business, partly because... it is very demanding for the auditors"* (Bryman and Bell 2011, p. 398). Whilst complete records of all phases of the research were documented in an accessible manner, it was not feasible to engage with an auditor to confirm the dependability of the research.

Confirmability is concerned with ensuring that *"while recognising complete objectivity is impossible in business research, the researcher can be seen to have acted in good faith"* (Bryman and Bell 2011, p. 398). Throughout the research process, all efforts were made to ensure that personal values or inclinations did not sway the conduct of the research and the findings that were derived from it. This was done by practising reflexivity in order to be more aware of my decisions and biases in order to ensure that they do not impact the outcome of the research in any way. Reflexivity refers to *"a reflectiveness among social researchers, about the implications for the knowledge of the social world they generate of their methods, values, biases, decisions, and mere presence in the very situations they investigate"* (Bryman and Bell 2011, p.718).

Other considerations to ensure or increase the quality of the research included peer review or debriefing sessions (Creswell 2007), and training on how to conduct qualitative research (Corbin and Strauss 2015). In the first instance, Lincoln and Guba (1985) highlight the importance of having an individual, who acts as "the devil's advocate" who keeps the researcher honest and asks the hard questions about methods and interpretations. To me, this person was my supervisor who acted as both “the devil’s advocate” and “a critical friend”, throughout the data collection and analysis stages of this research. Figure 15 below provides a snapshot of this critical interaction. In column R, I provide notes, interpretations, and reflections on the coded data in the form of memos. In return, my supervisor would provide his reflections on the codes and interpretations as they were emerging. Whereby, any divergent or multifaceted interpretations were reconciled through returning to the data and re-assessing the logic behind the coding. This interaction proved to be a very important step in the conceptual and theoretical development of the research findings. In addition to having these debrief sessions with my supervisor, I also carried out punctuated debrief sessions with informants and gatekeepers, as well as utilised conferences, news articles and other information sources against which to indirectly validate my research findings

	A	B	D	E	F	G	R	S
1	Quote	Interview Reference	Perceived Affordance	Actualized Affordance	All affordances (percieved & actualized)	higher level affordance	Notes, thoughts, questions	LDL
9	[00:15:58] I expect I should make switching much quicker, much easier because you know you know the exact read you are not having to estimate reads anymore. You don't have to have people coming to your home to check reads. Your bill should always be right. [00:16:12][13.4]...[00:19:43] Oh I think I think probably the things we expect will be possible but maybe they're not there yet. So, faster switching we need we need to be able to switch customers much much more quickly than they are today. We need we need it to be all these...all the kind of typical things that happen in your life when you change house you know you change supplier, you get married, and you add someone else to your bill, whatever it might be. They all still take too long. Smart metera, one of the benefits should be that because you've got an instant up-to-date meter reading, you pretty can just change things as and when they happen. Not there yet but you know we're not all smart meters yet. [00:20:23][39.1]	Interview 4 - Company B	Quicker energy switching/ near real-time	Reducing the need for manual meter readers	- **Cut costs**: not having meter readers. - **Energy switching**: easier process and near real-time switching of energy suppliers.	- Drive efficiency: near real-time switching between energy suppliers - **Empower Customers**	Is cutting costs a feature? Although companies no longer need meter readers. The government still mandates that companies read the meters once every 2 years.	I agree on the efficiency affordance for the company. Another one here can be 'empowering customers', as you break down barriers and switching costs?
10	[00:34:59] We wanted to look up fraud energy theft where people are stealing energy so there's a team that you know that manage that today. They do it manually they do it based on their own best knowledge they use data but they use data you know in such, in maybe a more naive fashion. Naive is not the right word, they use Excel spreadsheets, I think. They've got lists of where there seems to be an anomaly you know, either it is too high or too low. But there's lots of manual work lots people having to look through that data. So we built a model based on smart meter data. If the meter, not even consumption data just the alarms and alerts that happen from those meters so if someone tampers with it, then it might give off a particular alarm. And we built a model that is as predictive as a whole team of people looking at smart meta data which has led to people getting arrested you know we've actually found genuine tampering happening. [00:36:03][64.0]	Interview 4 - Company B		Detect Energy Fraud	- **detect energy fraud** - **prosecute offenders for energy theft**	- Drive efficiency: detect energy theft & prosecute offenders	- might be worth getting more information about this project...	not sure fraud is related to driving efficienty. It's an undesirable customer behavior, such as churn, you can spot/prevent by using data. This may be discussed.
13	B: [00:16:26] The other thing that makes it kind of hard to work on these prospects. The other thing is like with insurance the pricing of this stuff and pricing of energy is extremely regulated too. So the whole idea behind Smart Meters right you get given a good price for your energy and you can actually start to go towards Pay-as-you-go or all these kind of things exposing customers to the market rate because the market moves on a half hour. That is very slow to change because of data hasn't come into the organization. The data is still being worked on in the organization to get it into a system where it can inform trading and the billing and the pricing. The other thing is when you're working under regulation you have to make sure all your systems are very secure. So it's very hard to feed new data into them because you are breaking these data rules [00:17:34][67.4]	Interview 15 - Company B	- Customers paying for their energy on a pay as you go arrangement - Time of use tarriff: exposing customers to the market		- **Real-time billing**: billing customers based on the energy price at the time of use	- **Price Customisation**	- adhering to regulation almost seen as an inhibitor towards leveraging smart meter data - to what extent is this objective, or is it socially construcuted within the company's culture that is becomes the truth / shared - choices about finances - where should the money be spent? Adhering to regulation is almost seen as more important than capitalizing on the value from smart meter data; therefore, installing meters and avoiding fines is on the top of energy company priorities.	both points are interesting. I agree that regulations are a constraint. But also, as you point out, the 'culture' of risk avoidance may be an interesting mechanism here. finally, I think adaptive pricing (or something like that) could be an additional affordance?

Figure 15. Example of Peer Reviewing to Ensure Research Quality

In the second instance, to enhance the quality of qualitative research, Corbin and Strauss (2015) suggest that the researcher should engage in training in qualitative research. They argue that receiving a sound educational foundation is important to be able to build well-developed themes, arrive at thick, rich descriptions, and integrate findings into theory. In order to implement this suggestion, I engaged in two one-week-long training opportunities provided by the European Institute for Advanced Management Studies (EIASM). The first was on *Case Studies in Business and Management Research* (Helsinki, Finland, December 4-9, 2017). The second was *on Qualitative Methods in Business Research* (Brussels, Belgium, May 14-17 2018). Both courses were instrumental in my learnings for undertaking a qualitative research project.

3.5.3 Ethical Considerations

Researchers must take measures to obtain consent, maintain confidentiality, and develop an atmosphere of mutual trust (Corbin and Strauss 2015). Additionally, researchers need to consider what ethical issues might surface during the study and to plan how these issues need to be addressed (Creswell 2018). To do so, ethical approval from Cardiff University's Ethics Committee was sought and gathered (see Appendix A – Ethical Approval). This process involved evidencing an awareness of relevant ethical issues and plans for addressing ethical issues related to three principles: 1) respect for persons; 2) concern for welfare, and 3) concern for justice.

Respect for persons encompasses *"the treatment of persons and their data involved in the research process"* (Creswell 2018, p.54). In order to do so, interviewees were provided with an informed consent form. The informed consent form detailed what the study was about, how the data will be stored, collected, and for how long, as well as the efforts taken to anonymise the data shared. Informants were assured that information shared will not be traced down to individuals. The form also highlighted the right of participants to withdraw from the study at any time. This was also repeated to them at the beginning of every interview. Following on, concern for welfare involves *"researchers ensuring adequate protection of participants*" (Creswell 2018, p. 54). All interviews took place in the interviewee's office or via skype and therefore took place in a location that is familiar to them and one which they were comfortable with. Finally, concern for justice refers to *"the need to treat people fairly and equitably"* (Creswell 2018, p. 54). To do so, I carefully considered the recruitment of participants, site selection, and sampling strategies.

A final ethical consideration was relating to the inclusion of secondary sources of data such as news articles and company reports that would inevitably compromise the anonymity of the cases. Therefore, when referring to secondary sources of data in the text, I refer to them as company documents or news articles to protect the anonymity of the cases. Additionally, these references are not included in the bibliography of the thesis for the very same reason.

3.6 SUMMARY

Table 8 provides a summary of the methodological choices that this research entails, as well as, provides a justification for each of these choices as outlined in this chapter.

Methodological Choices	Justification
Critical Realism	• Critical realism is most consistent with affordance theory's underlying ontological and epistemological assumptions (Volkoff and Strong 2017) • Critical realism aligns with my world view on knowledge creation: as a researcher, I view the world as independent of human consciousness, whereby knowledge about the world can be achieved through our observations of it, hence knowledge is socially constructed (Eriksson and Kovalainen 2008)
Qualitative Research	• This research aims to understand and explain a new and emerging phenomenon, (Siggelkow 2007), as opposed to testing a particular hypothesis or relationship between different organisational constructs; therefore, qualitative research is the most suited research strategy. • Qualitative research can be construed as a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data (Bryman 2016, p.27) • It does not follow a structured, standardised, and abstracted mode of data collection and analysis (Eriksson and Kovalainen 2008, p.5), but instead allows for flexibility, exploration, and creativity to produce meaningful interpretations, explanations, and understanding of complex organisational phenomena.
Case Study Research	• The case study design has become a commonplace methodology within affordance-based big data research (Lehrer et al. 2018; Leidner et al. 2018; Dremel et al. 2020a) • Case studies are a suitable vehicle for identifying and exploring causal mechanisms at work within a specific context (Ackroyd and Karlsson 2014). • Case studies provide a situation in which mechanisms can be isolated and then studied allowing abductive logic to be brought fully to bear (Ackroyd and Karlsson 2014) • The case study design allows for a focus on causation which makes them a distinctive methodological choice amongst critical realists. Through the in-depth analysis of a limited number of cases, they allow the researcher to tease out the ever-deepening layers of reality in the search for generative mechanisms and influential contingencies (Kessler and Bach 2014)
Comparative Case Study Research	• The inclusion of more than one case allows for the processes, outcomes, generative mechanisms, and conclusions about causes and outcomes to be drawn more effectively (Ackroyd and Karlsson 2014) • Comparative case study research enables one to move beyond locally contingent processes and outcomes to tease out and examine wider patterns and their generative forces (Kessler and Bach 2014) • Comparative case study research allows the researcher to balance between context and situational factors and seek wider patterns and generative mechanisms without running the risk of disappearing into micro-level case studies whose causal chain ends at the office door (Kessler and Bach 2014)

Observation and Secondary Data	• The use of complementary data sources allows for data triangulation and helps the researcher establish a more assured basis for the identification of tendencies or demi-regularities (Kessler and Bach 2014) • The different data sources become the basis for retroduction whereby attempts are made to infer patterns and causation (Kessler and Bach 2014) and help the researcher identify the generative mechanisms that explain empirical outcomes • Critical realist researchers are interested in many kinds of data, especially at the outset of the research. Moreover, changing attention to different kinds of data as knowledge advances is a feature of realist research (Ackroyd and Karlsson 2014)
Grounded Theory Techniques	• Grounded theory techniques have become popular tools to analyse qualitative data within affordance-based big data research (Lehrer et al. 2018; Dremel et al. 2020a) • Grounded theory has become a popular research methodology within critical realist informed research (Kempster and Parry 2014). In particular, because grounded theory research seeks to understand and explain a phenomenon within a particular context through systematically analysing collected data over several stages (open, axial, and selective coding)

Table 8. Methodological Choices and Justification

CHAPTER FOUR

4 FINDINGS I: The Organisational Affordances of Smart Meter Adoption

4.1 What are Organisational Affordances?

Affordances are the possibilities for actions that arise from the relationship between an IT artefact (e.g., smart meters) and a goal-oriented actor or actors (Markus and Silver 2008). Volkoff and Strong (2013) define affordances as *"the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artefact) and a goal-oriented actor or actors"*. Affordances can operate on the individual level (one person) as well as on the organisational level (a group of people). Organisational affordances have been defined by Strong et al (2014) as *"the extent that the potential actions enabled are associated with achieving organisational-level concrete outcomes in support of organisational-level goals."* Organisational affordances have also been referred to as "collective affordances" (Volkoff and Strong 2017), or "high-level affordances" (Leonardi 2013) because they involve multiple actors doing different things to accomplish a joint goal.

This study is concerned with identifying a specific set of organisational affordances: the possibilities for goal-oriented action afforded to energy companies from the adoption of smart meters. This research suggests that there are 17 smart meter organisational affordances afforded to energy companies from the adoption of smart meters, which I structure around five key clusters: 1) customer-oriented affordances, 2) energy trading affordances, 3) business process improvement affordances, 4) energy market localisation affordances and 5) service innovation affordances. In the following five sections, I conceptualise, describe, and discuss each of these five clusters. The findings reported in this chapter emerge from the empirical work carried out in the two energy companies: BlueHouse and GreenWorks. To differentiate the two cases, I use the symbol "A" for GreenWorks interviews, and the symbol "B" symbol for BlueHouse interviews.

4.1.1 CUSTOMER-ORIENTED AFFORDANCES

Customer-oriented affordances are the smart affordances that are specifically targeted towards creating value for the energy consumer, and they include customer education, customer empowerment, customer behaviour change, customer convenience, price customisation, payment customisation, and fast switching. All seven customer-oriented affordances will be described and discussed in the following seven sections.

4.1.1.1 Customer Education

Customer education is about companies offering their customers with information and skills that give them the ability to understand, evaluate, and use their product or service in a better, more informed way (Bell and Eisingerich 2007; Troilo et al. 2017). For energy companies, customer education revolves around better and more informed energy consumption by customers. As highlighted in the following two quotes:

> *Smart meters help customers to manage their usage and it does overcome a lot of the challenges that customers have with not understanding how much energy they are using.*
>
> (Interview 27A)

> *Smart meters help customers engage with their usage on their in-home display. They've got much better visibility of what they're using. If they use their in-home display, they get to understand how much does a kettle cost to run, how much does their fridge freezer run at a base run, so it gives them an opportunity to really understand their energy use in the home.*
>
> (Interview 20A)

Energy companies can further educate their customers by providing them with personalised information about the energy efficiency of their habits (e.g., setting a high temperature on the washing machine) or appliances (e.g., an old appliance using a lot of electricity) as the following quote highlights:

> *The energy efficiency advice would be more around "we think your washing machine is this rating…we can say, from a similar home, this is how much they are spending on their washing. Have you tried things like reducing your temperature?" Or identifying*

hydro appliances saying [to the customer] that they must be old or there's something wrong with it because it's using a lot of electricity.

(Interview 6B)

Through looking at consumption data, we can identify if their boiler is efficient enough if we know of how much usage is going up by, we can see their usage on a half-hourly basis. If their usage is significantly higher than the average usage of a similar boiler in that area, then we could suggest for them to look into changing their boiler, with the idea that it could enable to have this much savings per year.

(Interview 2A)

Additionally, an energy company's ability to combine different datasets in a meaningful way can provide further opportunities for customer education. For example, if a customer has a smart thermostat in their home, energy consumption data from the smart meter can be combined with thermostat data in order to detect the energy efficiency of the home. As such, customers can identify the need for better insulation. On the other hand, customers with installed solar panels can be educated on how much energy they are using via the solar panels, and how much they have an excess of. As a result, they can make decisions about storing the excess energy in a battery for later use or selling the excess energy to a neighbour. The following two quotes highlight two examples relating to customer education. The first relates to home insulation. The second relates to their use of renewable energy.

And then you overlay [smart thermostat] onto that [smart meter data] and it's suddenly …[telling the customer] did you realise that you've got [the smart thermostat] set at 30 degrees. Your house is never going to reach 30 degrees because it's not insulated well enough and you are using x amount of gas trying to get it to that.

(Interview 2B)

For a consumer, that's a really hard concept to grasp. Why do I need a battery? I've got solar panels and they don't really understand that. You know you don't use all of the energy that comes through solar panels and it goes back into the grid and the grid can't really use it. But if you had a battery, they don't get that, but what they would get is you've got a smart meter, and this is how much your energy is costing you. And here

> *it is. And actually, if you use it at this time it would be cheaper and if you sold it to your neighbour it would be cheaper. And here it is, all offered on your smart meter.*
>
> (Interview 9B)

4.1.1.2 Customer Empowerment

Customer empowerment has been defined as letting consumers take control of the variables that are conventionally pre-determined by the firm (Ramani and Kumar 2008). With the advent of increasingly sophisticated information technologies, firms are more frequently providing consumers with the opportunity *"to specify product features, to select a preferred channel of delivery, to control their exposure to advertising and product information, to learn about the experiences and choices of other consumers, and even to name their own prices"* (Wathieu et al. 2002). Customer empowerment is often linked with greater customer satisfaction, as empowered consumers will always reach a more satisfactory outcome.

The findings suggest that customer education and customer empowerment are often dependent on one another. Oftentimes, a customer is being educated first, following which, they are empowered to make decisions related to their energy use. The previous section highlighted educating customers about the energy efficiency of their homes, which can empower them to make decisions about the insulation of their homes. It also highlighted educating customers about the excess energy from renewables, which can empower them to make decisions about buying a battery for energy storage or selling their excess energy locally. In order to empower its customer about their energy usage, BlueHouse created a mobile phone application where their customers remotely view their real-time energy consumption; as well as empower them to set energy spending targets by sending them updates to ensure they remain within budget. The following quote is an excerpt from BlueHouse's marketing campaign:

> *Got a smart meter? Whether you're under the duvet or on the train, you can see how much energy you're using at home. And get energy insights tailored to you. If you're one of our smart meter customers, you can set yourself an energy-spend target for the month. And we'll send you handy updates you can stay within budget.*
>
> (company website)

Equally so, GreenWorks empower its customers to make decisions about their energy usage through helping its customers to set goals in relation to their energy consumption, as highlighted in the following quote:

> *We also work on targeting and incentivising our customers via the IHD with what we call goal-based consumption to help them to reduce their energy consumption or try and move some of their uses to different parts of the day.*
>
> (Interview 15A)

4.1.1.3 Customer Behaviour Change

Customer behaviour change is about modifying customer behaviour in a positive way that can successfully decrease customer-related costs to the firm without compromising on customer satisfaction and retention (Persson 2013). One of the key challenges for energy companies is related to the management of demand-side response. More specifically, the management of the two demand peaks often referred to as "the two-peak challenge". The two peaks take place in the morning when people wake up and turn on their appliances, and in the evening when people return from work and turn on their appliances. The two peaks relate to a period of time where there is an overconsumption of energy, which can be costly for energy firms. It can cost millions of pounds every year to meet peak demand (Pimm et al. 2018). Figure 15 below highlights the energy demand curve in a 24-hour period highlighting the two peaks, the first around between 6-9 am and the second between 6-9 pm.

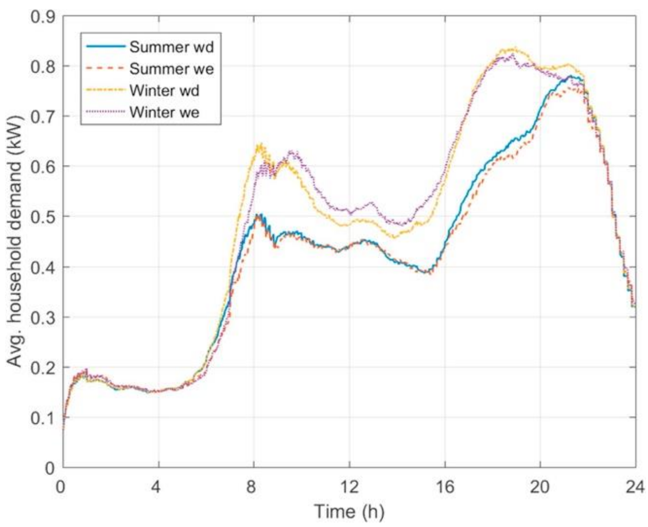

Figure 16. Average UK household electricity demand against the time of day for weekdays and weekends [14]

[14] Source: (Pimm et al. 2018)

Smart meters afford the ability to address the two-peak challenge by driving a change in consumer behaviour away from peak demand. Customer behaviour change can take place over several steps. First, by gaining a detailed understanding of customers consumption habits from smart meter data. Second, by identifying the customers who are willing to change their consumption habits. Third, by effectively incentivising the customers who are willing and able to change their energy consumption habits. GreenWorks incentivise their customers to put their devices on overnight in order to even out the supply and demand. Equally so, BlueHouse can effectively target customers to change their energy consumption habits by segmenting them based on a flexibility score and incentivising them accordingly as highlighted in the following two quotes:

> *We put together a flexibility score for customers, which given smart meter data you can tell how flexible the customer is. So, when are they using energy? Do they use energy regularly at the same time every day? Every week? or is their energy usage kind of spiky and patternless? (…) So we looked at this data and we built a flexibility score that scored customers between 0 and 1. Zero being they are exactly the same every single week, and one being there no pattern here at all... That then allows you to offer different tariffs to people. So the flexible customers are the ones you target for free use tariffs or change of use tariff. So you don't seem to have any pattern to when you put your washing on. So why don't you do it on a Sunday and we'll give you half off or for free? Whereas maybe people that have children in a regular routine, go to school. The same thing every morning. The kettle is always on at the same time every morning... Target them with something different, there is no point in trying to get them to change routines because you just to make their lives more difficult. That's where smart meter data is really interesting. You can get really detailed behavioural data about customers that you can start to offer interesting things to do with energy for them. That's probably the big thing right now that I'm looking at.*
>
> (Interview 4B)

> *I attended a project which did some analysis using R to work out different consumption patterns by different people... There were six different consumption patterns that people will fit into. You know they might be people who use a lot of energy in the morning and nothing else much. So what you see is a graph comes up in the morning then it tapers off other people you have a lot in the morning when they do their breakfast and then in*

the evening when they cook their dinner and then it goes down. Other people, you'll see it go up in the morning stay high-ish and then drop down, so that's perhaps people that are in all day. They implemented into time-of-use charging…And they basically wanted to encourage people to use more energy at the weekend and less in the week…they knew which customers to target with this type of time-of-use tariff…and it did actually, I've seen that results, it did push people to use their energy differently.

(Interview 7B)

4.1.1.4 Customer Convenience

Customer convenience is "*a judgement made by consumers according to their sense of control over the management, utilisation and conversion of their time and effort in achieving their goals associated with access to and use of the service"* (Farquhar and Rowley 2009). For example, smart meters make customers lives much more convenient by replacing the manual process of reading and recording energy consumption readings to become an automated process. Before having smart meters, customers were required to provide their energy suppliers with their energy consumption readings on a regular basis in order to be billed accordingly, however, with smart meters, customers no longer need to do so, because smart meters automate this process for them.

To give another example, customers with a smart prepayment meter can conveniently top-up their smart meter online, on a mobile phone application, or by calling the customer service top-up line. Whereas, prior to having a smart meter, customers with a prepayment meter would need to take their card or key to a local payment point to top up (e.g., a post office, local convenient store), following which they would need to insert the card or key into the meter for the credit to be transferred onto the meter. However, a prepayment smart meter makes the process of topping a lot more convenient for the customer, as highlighted in the following quote:

Customers can now top-up online which they never could do before. So they don't have to leave their home in which to top the meter up. It can be done from the comfort of their armchair. It is a much more customer-friendly way of being able to do it and you're not relying on pay points and post offices to be open in which the customer then *has to go to the outlet to top it up, take the device home and put it back into the meter. It can be done 24 hours a day.*

(Interview 4A)

4.1.1.5 Price Customisation

Price Customisation is about offering customers a personalised tariff and giving them a choice in how they pay for their energy. It is about pricing customers differently depending on their energy consumption habits and needs (Dolan 1995). Smart meters enable energy companies to offer their consumers new and innovative tariffs where consumers can choose the tariff that best suits their energy consumption needs. These new tariffs can be based on a pre-agreed schedule, or real-time price signals in the wholesale market (BEIS 2018), where consumers can be charged different prices at different times in the day or be charged different prices depending on the type of appliance they are using. For example, as highlighted in the following quote, with the increasing adoption of electric vehicles (EV) in homes across the UK, more and more energy companies are offering an EV specific tariff where customers are charged a set price per kilowatt-hour for charging their EV, and a different price for the use of their household appliances. They could also be offered a variable EV tariff depending on when the EV is being charged.

The technology opens the doors for all sorts of things… we're looking at building tariffs that are personalised to an individual customer on the way that they use their energy and charge them at different price points at different points in time. We're already dabbling in the EV world. So, you can have a separate tariff to charge your car at night if you've got a charger on the wall and all this is predicated on the smart technology being in the house already.

(Interview 12B)

The interviews suggest that there are lots of different tariffs that energy companies can offer to their customers, some of which include: i) pay-as-you-go where customers pay for what they use at a fixed price per kWh, ii) a fixed payment plan or a subscription-like service where customers pay a fixed amount regardless of how much energy they use, iii) a time-of-use-tariff where customers are exposed to the market and pay for the energy based on the cost of energy at the time of use. The following two quotes highlight how smart meters enable energy companies to propose customised tariffs:

> *When a customer has a smart meter, we would know at different parts in a day when they typically use their energy so we could come out with a tariff where we give the customer cheaper energy in the evenings between the hours of 6:00 in the evening until midnight or 8:00 in the morning. They very much would be **lifestyle tariffs** as opposed to what is in the industry now where it's just a capped tariff or a variable tariff you've got this added layer, they could be the more dynamic.*
>
> (Interview 7A)

> *There are loads of tariffs we could come up with…with a smart meter even if you wanted to go for a basic tariff where you pay this much money a month and you can use all the energy you want. That's something that could be informed with the smart meter data. Because you can say, I know roughly what you use. I know that from doing this experiment. It's likely to go up 10 per cent if you feel that you can use what you want. And I can work out a price per kilowatt-hour for you. This is your monthly price. This is all you pay. You can use whatever you want and we (the energy company) can still make a profit.*
>
> (Interview 15B)

4.1.1.6 Payment Customisation

Payment customisation is about giving the customer the choice and flexibility in how they pay for their energy (Basu and Muylle 2003), whether that be via direct debit or pay-as-you-go arrangement. It is also about giving customers the flexibility to change between different modes of payment. Interview data highlighted that smart meters enable what is referred to as a 'mode switch', whereby customers can shift between different modes of payment, from credit to prepayment and vice versa. Whereas, prior to having a smart meter, a customer would not be able to shift between different modes of payment unless they had their meters physically removed and replaced with a different meter by an engineer. As highlighted in the following quote:

There are customers that have a pre-payment meter who no longer want a pre-payment meter they want a credit meter but they're on a traditional meter. There is an opportunity to put a smart credit meter in for them if they wish and that opens up an opportunity for them in the future because to go back to pre-payment. They don't have to have their meter exchanged. They don't need an engineer to come out. They can do what is classed as a mode change. So, we've been working to enable those journeys. And very recently we've just enabled the reverse of that when a customer wants to go from a credit meter to a pre-payment meter.

(Interview 7A)

4.1.1.7 Fast Switching

Fast switching is about enabling customers to switch between energy suppliers quickly without the need for a time consuming and complicated process (BEIS 2018). Smart meters give consumers the ability to switch between energy suppliers in a timely manner (in near real-time) without the need for a lengthy process. The following two quotes highlight how smart meters enable fast switching between energy suppliers:

Smart meters make it far easier to switch suppliers. Who is to say you couldn't pay somebody to completely take control of the energy provisions in your home. I'll give you the authority to switch my supplier. Every 30 minutes. And that middle person then scans where it can get the cheapest energy and could just switch any supply every 30 minutes. And as a homeowner, doesn't matter, does it? It's all taken care of, it's hassle-free. Therefore, it completely changes the competitive dynamics in the industry.

(Interview 17A)

Smart meters enable fast switching. At the moment you know, the lead time of switching from a supplier is longer but with DCC [data communication company] it should be a lot shorter. Some people could just automatically switch. I think that's going to be a potential threat.

(Interview 6B)

The quotes also highlight the idea that fast switching may not be a favourable affordance, as it can be viewed as a potential threat to energy firms by losing customers more easily or making space for new entrants into the market that will capitalise on the fast switching affordance. Whereby, they will offer customers a new service that will automatically switch energy suppliers for the customer, based on which is the cheapest supplier at the time. However, enabling fast switching can also be viewed as a good indicator of customer satisfaction and loyalty. For example, when a customer chooses to remain loyal to one energy company, it is a good indicator that they are a satisfied customer. Also, fast switching can allow energy companies to win back customers they lost or acquire dissatisfied customers from other energy companies.

4.1.2 ENERGY TRADING AFFORDANCES

The second category of smart meter affordances is energy trading affordances. Energy trading affordances relate to how smart meters and smart meter data have afforded new ways in which energy can be traded. There are three key affordances for energy trading and include 1) calculating energy imbalance, 2) timely demand-side response, and 3) half-hourly settlements.

4.1.2.1 Calculating Energy Imbalance

Energy imbalance is the difference between what energy companies predict to use and the amount that they actually use (BEIS 2018). As a result, energy companies are priced differently based on how accurately they can predict their usage. For example, if their predicted usage is equal to their actual usage, then the price they pay for the wholesale energy will be cheaper than if their predicted usage is significantly higher or lower than their actual usage. The price that energy companies pay for the difference between their predicted and actual consumption is often referred to as "imbalance pricing" (Tribe 2019). Traditionally, predicted usage was based on assumptions from low-frequency consumption data; whereas, now with the high-frequency smart meter data, energy companies can get near real-time energy consumption and a much more granular picture of what energy consumption predictions are, and therefore "*get it right, straight away*" (Interview 4B). The following two quotes highlight this idea:

> *We're starting to look up energy imbalance. Grid imbalance. Historically, we've had this kind of four-meter readings a year and you've got to make a lot of guesses and assumptions about how much energy someone is using. So now you can stop doing that. You can get that right straight away pretty much.*

(Interview 4B)

I believe if we did everything properly if we informed our trades if we gave a time of use tariff, we would be able to give our customer a cheaper price but still maintain our profit. Because for all the profit margins that an energy company makes come on this guessing. If we price our customers the correct tariff that's going to meet the cost of the market, but you don't have to guess that now on a six-month basis or a quarterly basis because this all used to happen every three months when people's meters were read, and everything was guesswork. You can make the trade you know exactly how your macro portfolio is doing. You can make your trade, reduce your imbalance.

(Interview 15B)

4.1.2.2 Timely Demand Side Response

The demand-side response can be simply defined as the change in energy consumption patterns in response to a signal (Fell et al. 2015). It consists of a set of techniques, policies and market programmes that are designed to address the problem of peak energy demand and to enable a better balance between energy supply and demand (Torriti 2015). The near real-time energy consumption data means that energy companies have a much better understanding of energy consumption in near real-time, and therefore, can activate the signals in near real-time in order to trigger a change in energy consumption. This is key as it enables a much more timely response to demand-side changes by minimising the number of situations where there is an energy shortage or surplus. Thus, reducing the need to generate energy at short notice, which can be costly for energy generators, energy companies, and energy consumers. Research suggests that timely demand side response will support the realisation of up-to £40 billion of benefits (BEIS 2018). The signals that energy companies can use to trigger a change in energy consumption behaviour can include activating customer empowerment, customer behaviour change, and price customisation affordances, as highlighted in sections 4.1.1.2, 4.1.1.3, and 4.1.1.5 respectively. To give an example, the following two quotes emphasise the instrumental role that price customisation affordances play in better managing demand side response:

Smart meters will be able to support us to do demand-side response. We need that infrastructure in place in order to be able to do half-hourly billing. The intention is that in time you might be able to automatically switch appliances in the house on and off in *line with the energy supply and demand at that time. So, we can procure the energy that supports that sort of tariff and then we'll be able to turn off your consumption at these times where we can then balance that with other people who need it. So if the customer is willing to take the risk I suppose, you could offer customers a more attractive tariff.*

(Interview 8B)

Once you know people's usage to the half-hour you can say well, I can give you a reduced tariff overnight…you can start to change people's behaviour then, you can start to even out your supply-demand. So, encourage people to put devices on overnight. Encourage people to use more over the weekend.

(Interview 21A)

4.1.2.3 Half-hourly settlements

Half-hourly settlements identify a situation in which energy suppliers can buy and bill energy on a half-hourly basis, hence more accurately (Elexon 2017). In the past, energy companies would purchase energy on an hourly or daily basis from the grid but would not be able to bill customers on a half-hourly or daily basis. Therefore, the data they relied on to inform their trading was based on estimates. Now, with the adoption of smart meters, energy companies not only have accurate half-hourly energy consumption to inform their trades but also can use this data to bill customers on a half-hourly basis. As stressed in the following quote:

We have the reads, so we can settle half-hourly for domestic customers which is very useful means we only have to pay as the market moves. We only pay the going half-hourly rate and we will charge our customers half-hourly, which is great. But the industry processes and our settlements processes need to change for this to happen.

(Interview 24A)

Actualising half-hourly settlements affordance requires additional investment into organisational infrastructure and resources, but it improves the accuracy and the timeliness of the settlement process quite significantly, as described in the following two quotes:

Smart meters allow you to do different time-of-use tariffs. So, you can charge different amounts at different times a day which helps shift the load. Not until we start doing *half-hourly settlements which is a whole new story. But that's not until 2021 or 2023 when we can start to charge people on a half-hourly basis. We can put customers on elective settlements and say that we will get it down to the half-hour for you. And then, we feed that back to the network, the grid, saying this person has used this much energy down to the half-hour and we settle it like that for us. At the moment, we just do it by usage curves.*

(Interview 6B)

Currently ... pricing is done with load balancing curves and these load balancing curves usually come from Elexon, where they have taken a sample of 10,000 customers and they've plotted the graph, and you are priced based on whatever your energy use is closest to. So, we say if you're a pig farmer... okay you're on the farming curve if you're a bank you're on the bank curve you know if you've got two kids in a four-bedroom house you're on this curve and that's how it's done. It doesn't need to be done like that you can take people's actual consumption to inform the tariff.

(Interview 15B)

4.1.3 BUSINESS PROCESS IMPROVEMENT AFFORDANCES

The third category of smart meter affordances are business process improvement affordances. Business process improvement is about improving the effectiveness, efficiency, and productivity of business processes, which leads to better execution (Grover et al. 2018). Smart meters afford a number of business process improvement opportunities in billing, debt reduction, customer relationship management, field operations, and fraud prevention. These five business process improvement affordances will be described and discussed in the following five sections.

4.1.3.1 Billing

Billing errors, over-billing, or under-billing are some of the major problems faced by all energy consumers and energy companies today, and cannot be solved in the absence of credible data (Ramakrishnan and Gaur 2016). Smart meters offer timely credible data that enables energy companies to enhance and improve their billing process. Receiving accurate and automated meter readings means that energy companies no longer require manual checks by meter readers. Equally so, customers are no longer required to send their meter reads to energy companies, as an automated meter reading will be sent to the energy supplier. Smart meter data enables accurate billing, where customers are billed on their actual as opposed to estimated usage, and energy companies are being paid on a similar basis. Additionally, customers can start to receive monthly as opposed to quarterly bills for their energy consumption. Overall, smart meters result in a much more efficient billing process, as highlighted in the following quote:

> *The primary function of what smart enables us to do is that we get a very high percentage of actual readings, so we are able to bill our customers accurately every quarter or every six months which is better for the customer. From a company perspective, from a balance sheet, that is obviously a core driver for us.*
>
> (Interview 15A)

Interview data highlighted an important and interesting analogy that showcases the implications of energy billing based on estimated consumption. By hypothetically applying the concept of estimated billing to a different industry such as food retail, it showcases the limitation of estimated bills and highlights how smart meters data enables a more efficient, accurate, and seamless customer billing process.

> *The energy industry is really behind the curve in terms of technology. We've looked at how we provide a service to customers today versus how other parts of the business do, and we work with a UK wide group that promotes smart industry-wide and they summed it up with an advert that they pulled together where they showed what it would be like if you applied the energy billing principle to a supermarket customer. So they had a customer going to a supermarket, fill the trolley full of goods, go to the checkout and then the checkout person sort of looks at the trolley and says "Well I don't know how much is in your trolley but how does 85 pounds sound?" and of course in any other environment, it sounds absolutely absurd but yet in the energy environment that's quite often what we do it. We will estimate customer bills which is basically a posh word for guessing what they might owe us. And it's a very strange environment, we still have customers today who ring us up to give us meter readings, who ring up because their bills are incorrect. The sort of things that in any other industry, technology has removed the need for in the late 90s early 2000s. So I can't imagine there are many people today*

ringing up their bank to check their balance but yet the equivalent of that is still happening in the millions for energy customers with customers ringing up with meter readings. So, it's an interesting one.

(Interview 14B)

4.1.3.2 Debt Reduction

Smart meters replace estimated meter readings with accurate meter readings and replace estimated bills with accurate bills. Therefore, customers do not go long periods of time receiving inaccurate bills that could result in the accumulation of debt. As a result of billing accuracy, energy companies will be able to reduce their debt (i.e., money owed to the energy company by the customer), because the customer will only be paying for what they are using. In addition to that, the functionality of having a "mode change" as highlighted in (Section 4.1.1.4) means that energy companies can use this functionality to stop in-debt customers from generating an even larger debt amount by switching them into a pay-as-you-go mode so that they pay for the energy as they use it, as opposed to building up debt on credit mode. The following quote exemplifies this idea:

The benefit is the fact that you can switch the meter between a credit meter at a pre-payment meter remotely. If we've got a customer running over a large debt, rather than disconnect the supply, we will fit a pre-payment meter in. With a smart meter, you could remotely change it from one to the other, so that is a benefit from a collection point of view.

(Interview 4)

4.1.3.3 Customer Relationship Management

Customer relationship management refers to building relationships with the customer that can drive value for the firm over the customer-firm relationship lifecycle (Kumar 2010). New technologies can provide enhanced opportunities to both understand customers and co-create value with them (Payne and Frow 2005). Smart meters enable energy companies to manage the customer-firm relationship much more effectively:

At the basic level, smart meters enable us to run the supporting processes around how we manage a customer account far more effectively.

(Interview 17A)

For example, smart meters have resulted in a reduction of call volumes to customer service lines in relation to queries about billing or consumption. The reason for this is because smart meters enable the customer to understand their energy better by having all the information they need to hand, and are able to self-serve without needing to call a customer service agent, as highlighted in the following three quotes:

> *We really are looking to harness and drive the opportunities that come with smart for our customers, just because we want to make it easier for them. We want them to engage with the technology that's available to them. We know that customers with a smart meter, they call us less, they raise fewer complaints, and they are cheaper for us as a business to service. There are benefits for smart meters around having a more efficient operation which then allows us to invest more money in the future into other technology for our customers.*

(Interview 18B)

> *Smart customers tend to self-serve more because they have their online accounts. There is more functionality with their online account, they can see all their usage. They tend to call less because they don't need to call about an estimated bill, or to call to give us a mere read. Their direct debits are more accurate because the smart meter reads are coming through all the time.*

(Interview 7A)

> *We used to get a very high volume of calls from our prepayment customers pre-smart, mainly in the winter months, we used to get a lot of calls where the customers would say "I put six pounds on last week, and I put 8 pounds on this week, why is that", and that's where smart meters can help where the customer can look back and see where their usage has spiked. It can show them that last Tuesday their usage spiked, last Wednesday it dipped a bit but then spiked again. So, they can look and pinpoint exactly where they used the difference which has helped them a lot and has in turn significantly reduced our call volume from prepayment customers.*

(Interview 2A)

Additionally, customer service agents are better able to serve the customer that does call because they have a lot more information about the customer in relation to billing and consumption. As such, they can resolve a customer query far more effectively at the first point of call, as described in the following quote:

> *You can get information immediately so if a customer calls in you can get the information from the meter there and then. We can also get notifications from the meter. If something is not quite right. If the customer goes off supply. We have the ability to get all of these reports to come to us, and we can solve the issue whilst being on the phone with the customer, most times.*

(Interview 4A)

Another example where smart meters result in an improvement of the customer relationship management process is in relation to change of tenancy. Interview data highlighted that change of tenancy process has become a much simpler process, as highlighted in the following quote:

> *Things like change a tenancy if you phoned in and said I moved house two weeks ago. If you are on a smart meter, we could look back two weeks ago, and get your meter reading, and bill you accurately.*

(Interview 9A)

4.1.3.4 Field Operations

The concept of field operations relates to the management of the workforce that are in the field installing, servicing, and maintaining smart meters. Smart meters offer the functionality of being controlled remotely and therefore reduce the need for engineers to visit a customer's property. Thereby, improve the efficiency of field operations, as explained in the following quote:

> *You can do so much more for customers with a smart pay-as-you-go gas meter than you can in the heritage world. In the old world normally if the gas fails, it's an engineer that needs to go out. Whereas now, we can remotely talk to that meter and fix the issue without the need for an engineer. So that's solved an awful lot of problems. You don't really need to send engineers up very often, which is a good thing.*

(Interview 4A)

Through having access to smart meter data, energy companies can identify any meters that require maintaining much quicker, and therefore are able to service and maintain faulty smart meters much more effectively:

> *We are able to identify any faulty meters a lot quicker. So, we can go out and exchange them a lot quicker. And also, if we get what we call a non-communicating meter where we are not getting meter readings in, we can identify that and get out and rectify the situation.*

(Interview 12A)

Energy consumption data (both historical and real-time data) can also be used for effective scheduling of outbound calls based on the likelihood of the customer being at home, as highlighted in the following quote:

> *For example, if we do outbound calling to customers all I want to know is: are they in that day? And I can base that on historical data because I know that usually, they are out 9 to 5 on Monday to Thursday, but they are usually home on a Friday and things like that. But you can tell that on historical data or half-hourly. If you want to start doing, should I call them now? And are they home now? That's when you can use 10-second data.*

(Interview 6B)

4.1.3.5 Fraud Prevention

> *We use the data to make sure that the meters are secure, there are lots of security protocols and making sure that nobody is tampering with it or doing anything that they shouldn't be doing.*

(Interview 17A)

As highlighted in the quote above, smart meters capture information and send alerts to the energy company in relation to faulty meters (Ramakrishnan and Gaur 2016). Smart meters can detect meter tampering, glass breakage, or abnormal voltage. As a result, energy companies can better detect energy theft and prevent energy fraud from taking place. The following quote describes how BlueHouse improved its fraud detection process by building a model that identifies energy consumption anomalies using smart meter data:

> *We wanted to look up fraud energy theft where people are stealing energy. There is a team that manages that today. They do it manually, based on their own best knowledge, they use data… they use Excel spreadsheets. They've got lists of where there seems to be an anomaly, either it is too high or too low. But there's lots of manual work, lots of people having to look through that data. So, we built a model based on smart meter data… not even consumption data, just the alarms and alerts that happen from those meters so if someone tampers with it, then it might give off a particular alarm. And we built a model that is as predictive as a whole team of people looking at smart meter data which has led to people getting arrested and we've actually found genuine tampering happening.*
>
> (Interview 4B)

4.1.4 ENERGY MARKET LOCALISATION AFFORDANCES

The fourth category of smart meter affordances are energy market localisation affordances. Energy market localisation affordances are about transforming the energy infrastructure from a centralised to a decentralised one. At the moment, the majority of energy being produced and distributed in the UK is centrally managed, whereby power stations generate energy and the national grid subsequently distributes it to homes and businesses around the UK. However, the adoption of smart meters facilitates the process of decentralising the way in which energy is produced and distributed and making it more local. There are two key energy market localisation affordances. The first is local energy storage, and the second is peer-to-peer energy trade. Both of which will be described and discussed in the following two sections.

4.1.4.1 Local Energy Storage

The adoption of smart meters alongside new technologies such as energy storage (e.g., batteries) can enable energy to be stored more locally. Smart meters will enable the storage of energy locally by measuring and pushing data to the relevant sources. For example, smart meters will push a signal to the local energy storage (e.g., a battery) in order for the battery to action storing excess energy from the solar panels. Smart meters can also facilitate the process of purchasing energy when the grid has capacity (i.e., when energy is cheaper) to be stored locally in a battery for the consumer to use this stored energy when the grid is at peak demand (i.e., when energy is more expensive). Smart meters can do so by signalling to the battery to store energy when the energy is cheapest based on the pricing data it receives from the energy company. The following quote highlights the idea of local energy storage:

> *In today's world, things are a lot more dynamic. So, the fact that we can now break down the load into forty-eight half-hour slots and price each of those half-hour slots accordingly. Customers will move towards having a home battery storage, where they'll be able to take a load when it's cheap hold it in a battery and then push it back out into their home at more expensive times. So, all of these things will start to come through and that time of use tariffing will become a lot more critical.*
>
> (Interview 25A)

The following quote highlights how local energy storage enables the concept of vehicle-to-grid (VTG), whereby energy stored in a battery or an electrical vehicle can be used to feed into the grid when capacity is needed:

> *…something we are going to see more and more is VTG - vehicle to grid. Where you can even leave your car plugged into the grid. And if there is a spike and you need more energy you can sell energy from your battery pack into the grid. So that's something that we are currently seeing. You will be continuously plugged in. So that moment your supplier will need additional energy, they can get it from your battery from your car. Because imagine if you have millions of cars plugged into the grid and you have a peak, a hike in consumption. Just use that. It's perfect.*
>
> (Interview 5B)

4.1.4.2 Peer-to-Peer Energy Trade

The adoption of smart meters alongside new technologies such as Blockchain can enable peer-to-peer energy trade whereby customers are able to buy and sell energy locally. Peer to peer energy trade increases the distribution of self-generated energy by individual consumers. Smart meters enable peer-to-peer trade of energy by measuring and pushing the data with regards to energy generation from a local unit into a public space where other energy consumers could access and pay for it (Mazzola et al. 2020). Peer-to-peer energy trade shifts the trade process from being centralised between the grid and customers to being de-centralised and local between neighbours or energy consumers. The following quote highlights this idea:

> *Everyone will have a solar panel and a battery, and that's how it will work. But actually, I have a retired neighbour. If I had a solar panel on my house, she might as well pay me for the energy that my solar panel is generating in the middle of the day when I'm not in. And then when I pay for the grid, I've still got the money she has paid me to give me cheaper energy. I'm still taking from the grid but with the solar panel, there are no losses of selling that back to the grid. It's a localised market.*
>
> (Interview 15B)

4.1.5 SERVICE INNOVATION AFFORDANCES

Service innovation provides businesses with opportunities to create customer value and generate competitive advantage (den Hertog 2000; Storey et al. 2016). Service innovation is *"a new service experience or service solution that consists of one or several of the following dimensions: new service concept, new customer interaction, new value system/business partners, new revenue model, new organisational or technological service delivery system"* (den Hertog et al. 2010). This research borrows on two of the four service innovation affordances characterised by Lehrer et al. (2018)[15] to articulate the service innovation affordances that energy companies can actualise from the adoption of smart meters. The first service innovation affordance is based on automated trigger-based service action, and the second is based on trigger-based service interaction (Lehrer et al. 2018). Both service innovation affordances will be described and discussed in the following two sections.

4.1.5.1 Automated Trigger-Based Service Action

Automated trigger-based service action is about automatically triggering an action on a customer's behalf; these actions are automated and take place in real-time (Lehrer et al. 2018).

[15] Lehrer et al. (2018) propose four service innovation affordances enabled to an organisation from the adoption and investment in big data analytics: 1) Automated trigger-based service action (automatically takes action when triggered) 2) Automated preference-sensitive service action (automatically adjusts user interfaces) 3) Trigger based customer service interaction (provides trigger to service actor who proactively approaches and interacts with the customer) 4) Preference sensitive customer service interaction (provides customer profile & action recommendation then adjusts customer interaction). The first and third are relevant to the findings of this study and therefore utilised.

There are a number of service innovation propositions that are centred around automated trigger-based action that can offer customers flexibility in running their day-to-day lives and home. Examples of flexibility propositions include remote diagnostics, automated appliance usage, and automated home alerts, all of which require the disaggregation of appliance usage. Disaggregating appliance usage is about incorporating a method of disaggregation of total electricity consumption in order to distinguish the consumption of individual electricity appliances (Matsui et al. 2015). Having the ability to detect a kettle signal, from a washing machine or a fridge enables energy suppliers to examine the consumption behaviour of an individual electrical appliance (e.g., using too much energy). Having this information and understanding empowers consumers to make decisions about their appliances that are costly to run by either servicing them or replacing them with more efficient ones. The following quote highlights how the disaggregation of appliance usage can enable the **remote diagnosis** of an appliance malfunctioning, through being able to collect energy consumption data at 10-second intervals from the smart meter:

> *We try to get the fridge out of this household aggregate energy data. Once we identify the fridge, we then look, we do this across 7 days or 10 days. And then we've got a history of the fridge's operational norm. So then if one day the fridge is behaving badly because something is breaking down. The new fridge signal that we get out of it will be different from the norm. So we would say, this is an outlier. Your fridge might break down, so send an engineer around. That's the core principle behind the project. Identify when a fridge is going to break down by identifying the fridge and then comparing it with its historic data.*
>
> (Interview 10B)

The second example of a flexibility proposition is related to **automated appliance use**. Automated appliance usage is where electrical appliances in the home (e.g., washing machine, dishwasher, electric vehicle charging) are automatically managed by what is called the "home brain". This enables a customer to turn their appliances on, and for them to automatically run when it is most efficient to run (cheapest energy; grid has capacity). Actualising the home brain affordance requires a new technological capability that can manage the automated appliance use, but one that would not be possible without the adoption of smart meters. As the smart meter is responsible for managing and pushing consumption and pricing data to the "home brain". The findings suggest that actualising service innovation affordances enable the actualisation of several customer-oriented and energy market localisation affordances. The following quote highlights how the "home brain" can enable the change in customer behaviour, help balance the load on the grid, and enable peer-to-peer energy trade of energy:

> *In the world of smart home, you have a home brain that can turn on and off your appliances. And, depending on what the price is off the grid at that time. So, you have things like your washing machine. You can load your washing. You can say, I don't care when it's done particularly you just want it done within the day. You set your washing machine say I want it done within before this time. Your home brain will forecast when it's cheapest to do your washing and it'll run the washing machine at that time. So, there's two halves to this. So, this is energy saving because it balances the load on the grid. It means that we don't have to kick up power stations and buy energy in, and so renewables become more effective. It also means if you have a local market where somebody who has got solar panel or if you've got a solar panel, you can take the energy from your solar panel in a more effective way and then give it to a neighbour if they need it.*
>
> (Interview 15B)

In addition to automating the use of appliances in the household, customers could also automate the charging of their electric vehicle when the energy is cheapest, as highlighted in the following quote:

> *Smart meters are a necessity especially with the move towards electric cars, electric cars are big loads on the infrastructure. You're going to reinforce the country's infrastructure massively to allow people to charge their electric cars at their convenience because people will come home, plug them in that's that. At 6 o'clock suddenly there will be a massive surge in the use of energy which is already at the peak or customers could be convinced to go off-peak. So, the good thing about smart meter data, half-hourly data or even more granular is that we can have a clever switching arrangement. We understand from the customer all they actually want is that at 7:30 in the morning their car is charged, how and when that's achieved, they don't really care. Then of course that same battery can export back to us, if they're not using the car for a day, we can take energy from the battery back onto the grid when the grid needs it.*
>
> (Interview 19A)

The final example of a flexibility proposition is in relation to **automated home alerts**. Whereby, alerts are automatically sent to the customer when appliances are left on, or when someone has left or entered the home. However, this does require developing a new technological capability of collecting and analysing sub-second data that will enable an energy company to detect when for example an iron or a straightener is left on. This may be an unlikely proposition that energy companies would pursue, as one of the interviewees, a senior customer strategy manager expressed:

> *Getting sub-second data means putting a clamp on your meter which means that someone has got to go and install that, and the units could be up of 50 pounds a unit. And it's a lot, there's no business case that would ever be able to support that sort of technology. In the future, I think if you link it with a really strong proposition. To say if you want this then by the way you need this to get it.*
>
> (Interview 15B)

4.1.5.2 Trigger-based Service Interaction

Trigger-based customer service interaction is about providing service actors with trigger information that can lead to a customer service actor taking action (Lehrer et al. 2018). Whilst in the previous case both the trigger and the action take place in an automated manner by the technology, in this case, the trigger is activated by the technology, but the action is driven by the customer service actor. One key example that exemplifies how smart meters enable trigger-based service interaction is through an assisted living service proposition. The following two quotes highlight how through the analysis of smart meter data, energy companies can identify the typical routine of an elderly person, and subsequently be able to identify any anomalies to that routine. If for example, an elderly person always puts the kettle on at 9 am every morning but fails to do so in a given day, their carers can be alerted to the unexpected deviation from the routine; and therefore, the system will alert the carers to check up on the elderly person. In this instance the alert is automated, and the human action is triggered by the alert:

> *This is quite interesting that the consumption data could be used to identify if a vulnerable person was in trouble because they normally put the kettle at eight o'clock in the morning and they didn't put their kettle on at 8 o'clock in the morning. So there's*

lots of opportunities to offer enhanced services to customers particularly those that are vulnerable.

(Interview 20A)

The one that got more traction is assisted living... so for infirm people to remain in their own home... If an infirm person still wants to stay in their own home but they don't want to live with somebody necessarily and they can't have full-time care. The carers want some way of knowing that they are at home and are okay... and they want to this in a non-intrusive way. So, you think actually looking at an energy signal to see if someone's put a kettle on about the time they normally get up is really intrusive but it's less intrusive than having cameras all around the home to see if someone's fallen over, or pads around people's houses to check where they are walking. It's actually less intrusive than constantly using wearables…. They do want to stay in their own homes, so it might be a question of...well you know if someone's monitoring your energy signal to check that you've fallen over and can send your carer around.

(Interview 15B)

4.1.6 AFFORDANCES PATH DEPENDENCY

"Multiple affordances are present at the same time, so in addition to uncovering these affordances, we must understand the nature of their relationships."

(Elder-Vass 2010)

As highlighted in the quote above, multiple affordances exist and are present at the same time. Therefore, affordances tend to interact and are not independent from one another (Volkoff and Strong 2017). Multiple affordances can arise from the relation between the IT artefact and the actor(s), whereby *"affordances may support other affordances or may interfere with them*".
While in the previous five sections I have presented the different affordances as distinct from one another, they are in fact relational and linked to one another. As such, the findings presented in this chapter are consistent with the idea that the actualisation of one affordance can support - or interfere with - the actualisation of a different affordance. To give an example, the following quote highlights how the actualisation of an energy trading affordance (half-hourly settlements), can enable an energy company to actualise a customer-oriented affordance

(price customisation), which in turn can lead to the actualisation of yet another customer-oriented affordance (customer behaviour change):

> *Smart meters enable half-hourly settlements. So, we pay the distribution companies, they are called settlements, we pay for the use of the infrastructure to get the energy through to the customers from the grid, and we pay on a daily rate. So, if were to start paying the distribution company on a half-hourly rate and got charged different prices for those different half-hourly slots. So, when there was a lot of demand for energy the price could be higher when there's less demand the price could be lower. Then what we could do is we could offer those cheaper prices, pass that cheaper price onto customers. This allows us to say to the customer if you used energy at this off-peak time, we can offer you a cheaper rate, because we pay a cheaper price to the distribution company. So this encourages customers to use off-peak energy and get cheaper prices. And that's where it starts to become quite interesting. Without half-hourly settlements, while we are only paying a daily rate to the distribution companies there's no commercial advantage for us to offer customers a cheaper price. So that's when it starts becoming interesting... And with the electric cars that's when it really comes into its own. If you charge your electric car overnight, when it's off-peak, it's massively advantageous for the customer.*
>
> (Interview 27A)

To give another example, the following quote highlights how the actualisation of a business process improvement affordance (billing) due to the reduced need for a meter reader, can result in the actualisation of another business process improvement affordance (customer relationship management) due to customers calling less. This in turn can lead to the actualisation of yet another business process improvement affordance (debt reduction):

> *In terms of the consumption data, you're in a situation where you do not need to send out a meter reader. And so, it's improved the accuracy of how you understand consumption. Which then leads off into a number of branches. So the minute you're in that scenario there's the propensity to have less phone calls from customers because they're getting more regular accurate bills that they understand. Your bad debt position is likely to improve because you're not going periods of time where people don't*

understand that usage and you're not collecting. So it changes completely the way you run the dynamics of that part of the business.

(Interview 17A)

This concludes the first of three chapters on research findings aimed at answering the first of three key research question - *What are the organisational affordances that smart meters afford?* Figure 16 below provides a summary of these findings. In the following chapter, I will discuss the second set of research findings: the organisational capabilities that enable the actualisation of smart meter affordances.

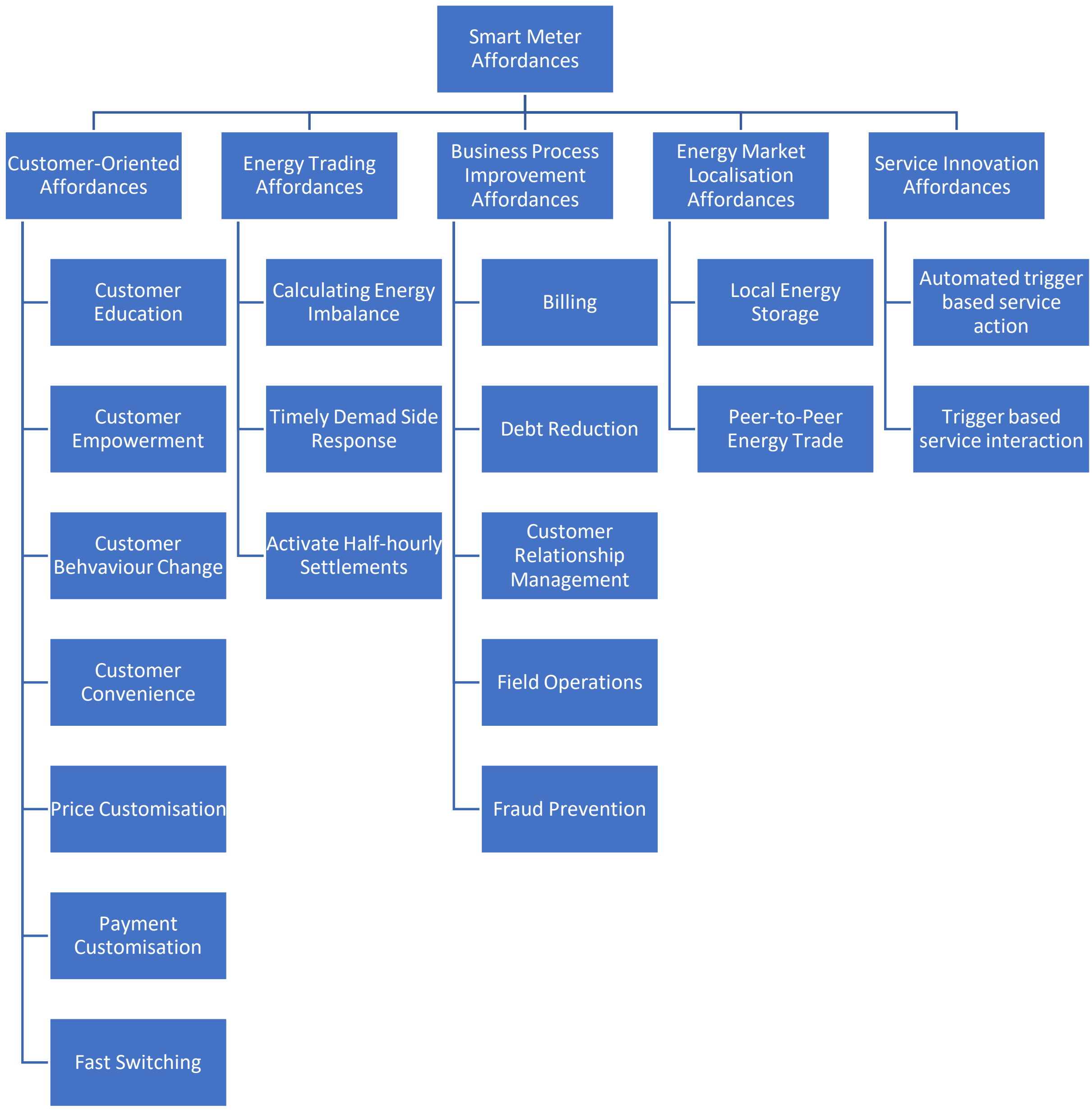

Figure 17. Smart Meter Organisational Affordance

CHAPTER FIVE

5 FINDINGS II: The Organisational Capabilities Needed for Smart Meter Affordance Actualisation

5.1 What are Organisational Capabilities?

Organisational capabilities are defined as *"an organisation's capacity to deploy its assets, tangible or intangible, to perform a task or activity to improve performance"* (Maritan 2001). Capabilities indicate the capacity of an organisation to perform a particular activity in a reliable and at least minimally satisfactory manner (Helfat and Winter 2011) and to perform a set of coordinated tasks, utilising organisational resources, to achieve a particular result (Helfat and Peteraf 2003). This chapter focuses on a set of organisational capabilities necessary for the actualisation of smart meter affordances. In some cases, the informants of this study were able to showcase the organisational capabilities that enabled the actualisation of smart meter affordances in their firms; in other cases, the evidence discussed here emerges from informants' description of how the lack of certain organisational capabilities meant that they have not been able to fully actualise the affordances offered by smart meters. Based on this evidence, this research suggests that there are seven key organisational capabilities (a combination of technical and non-technical capabilities) linked to the actualisation of smart meter affordances and include: 1) big data management capability; 2) big data analytics capability; 3) technology adoption capability; 4) customer engagement and communication capability; 5) innovation capability; 6) collaboration and communication capability; and 7) strategic management capability. I categorise the former three capabilities as technical capabilities, whereas, I categorise the later four capabilities as non-technical capabilities. Further, this research suggests that each organisational capability enables the process of affordance actualisation by providing an organisation with a number of actualisation enablers. In the following seven sections, I will conceptualise, describe, and discuss each of these organisational capabilities as well as the actualisation enablers for each capability.

5.1.1 BIG DATA MANAGEMENT CAPABILITY

Big data management capability involves processes and supporting technologies to acquire, store, prepare and retrieve data for analysis (Gandomi and Haider 2015). Developing a big data management capability enables an organisation to have efficient processes in place to manage high volumes of fast-moving and diverse data (Gandomi and Haider 2015). The adoption of smart meters in the energy industry has meant that energy companies are needing to acquire, store, prepare and retrieve energy consumption data that is collected once every 30 minutes - as opposed to once every 4 months - from every customer. This has meant that energy companies with millions of customers are having to record and store billions of data points. As such, they have needed to invest significantly in a big data management capability (infrastructure, processes, know-how) to acquire, store, prepare, and retrieve smart meter data for analysis. The following quote highlights the importance of big data management capability in enabling the development of new business propositions:

> *Data becomes king. Data is fundamental. Building a good data practice inside the organisation that can use the data and link it up with the product and proposition teams. The people developing the propositions and tariffs and so on. They have to be data-centric; they have to be able to deal with vast volumes of data so they can understand how to frame their propositions. That is a general organisational challenge for any industry that has suddenly got itself a load of data.*
>
> (Interview 4B)

It is worth noting that a big data management capability can be built to acquire smart meter data at 30-minute intervals, but it can also be built to acquire smart meter data at 10-second data intervals. Energy companies will usually evaluate their need for data frequencies and make infrastructure investments accordingly. The following quote highlights how BlueHouse have decided to undergo a change plan to benefit from the additional investment for a higher frequency of energy consumption data:

> *We are currently in the process of going through a change plan, we're in the early stages but we have to develop a whole new infrastructure for 10-second data. So, we've got the data science team, we've got our analysts and data insights team. To get access [to the 10-second data] we need to build the infrastructure and then we need to develop the data strategy around storage of that data as well. So that's in progress at the moment but we've got about a million-pound funding for that project.*
>
> (Interview 6B)

Big data management capability is an important and key capability for smart meter affordance actualisation because it provides firms with three key actualisation enablers (see Figure 17 below). First, the acquisition and recording of smart meter data. Second, the extraction, cleaning, and annotation of smart meter data. Third, the integration, aggregation, and representation of smart meter data with other sources of data (Gandomi and Haider 2015).

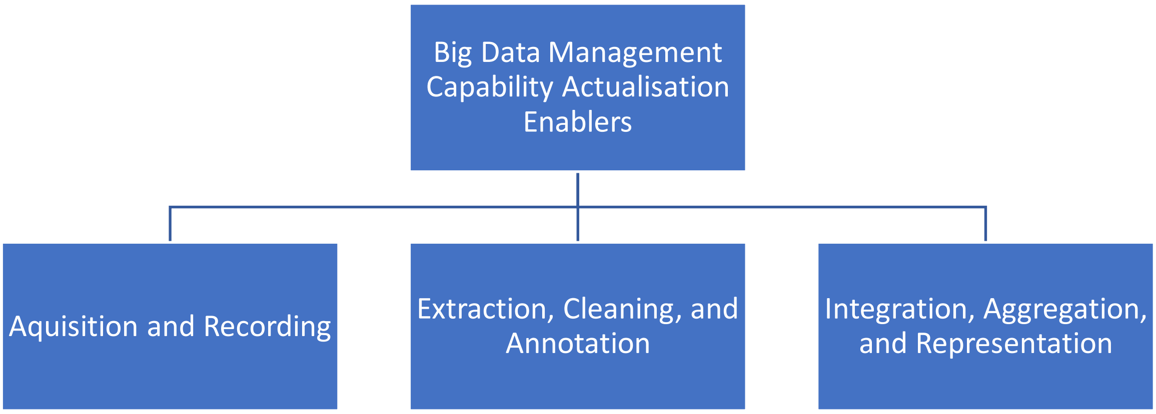

Figure 18. Big Data Management Capability Actualisation Enablers

5.1.1.1 Data Acquisition and Recording

Interview data highlighted that the acquisition and recording of energy consumption data on a 30-minute interval from millions of customers meant that they would need to invest in a new data management system to store such volume and granularity of data. This data management system is often referred to as a Meter Data Management System (MDMS). An MDMS is *"a system or application which maintains all information to be able to calculate the energy bill for a customer based on the meter data"* (Dusa et al. 2015). Energy companies did not have the knowledge and expertise to build the meter data management system internally. Therefore, they relied on data and technology companies to develop such a capability for them, as highlighted in the following quote:

> *So we started with SMETS1[16] in the transitional phase, and we all went off as suppliers and developed our own solution, and one of the things we realised really really quickly is that management of data was an issue. And all of a sudden it was almost a cottage*

[16] SMETS1 stands for Smart Metering Equipment Technical Specification (first generation) – i.e., the first generation of smart meters.

industry that was developed around MDMs, so meter data management systems. And they came on board and became the interface between our systems and the systems managing the smart meters. And they were SMSOs, a smart meter service operator. These companies started coming up and they are the usual companies you'd expect, the big I.T. companies. Logica, CGI, Oracle-based ones, SAP-based ones, IBM, Google showed up at one point, Amazon, and all to do with data.

(Interview 16A)

A meter data management system is a much more complex system than the ones that were previously used to store consumption data, the reason for this is the sheer volume and frequency of data that is transmitted from a smart meter, as explained in the following quote:

We have a meter data management system for meter reads and firmware upgrades (...) you have to generate half a million-meter records in your meter database. You also need to create a number of historical reads. So, the problem then becomes when you are doing 1 million it's not twice the data it's a factor of something quite large (...) So, one of the problems we've got is generating all of that data, and then we run a soak test which takes two days that runs through every business process, and it will run it through a number of times. And it would give us a baseline, what was the response time of the database, what was the response time of clicking this button and so on. So we can't test everything but we can test enough to give us an indication of what this journey looks like.

(Interview 26A)

Not having access to the smart meter data as well as other complementary data sources has implications for the various business activities that are dependent on it to progress. The following two quotes highlight this idea:

We haven't been able to have great momentum, because we haven't had the data. Now that we have we can start saying what is our vision? Where do we want to be? What are the opportunities?

(Interview 6B)

The current stage of the project is…we've got an algorithm that functionally works. But we can't test it formally because we haven't got the data. So in order to see if we can detect a fridge is broken down. We need examples of when a fridge has broken down with its smart data. I would like a hundred, at least. A hundred broken fridges just as a rough indicator that is very much a lower bound, a thousand would be great.

(Interview 10B)

5.1.1.2 Data Extraction, Cleaning, Annotation

Another key aspect in which a big data management capability enables the actualisation of smart meter affordances is its ability to extract, clean, and annotate smart meter data. Interview data highlighted that one of the key challenges of data being unusable is that the data is either not clean, or not accessible because it has not been annotated correctly. Therefore, business users are not able to extract the data in a timely manner. The following five quotes highlight this challenge:

The data is all there, but it's ***unusable****. So even if someone from marketing came up with a fantastic idea that would make a fortune it would take an amount of time a year maybe to get a database, build a good story in such a way that you could do minute by minute analyses. So that's the biggest problem I see here that it's not stored properly.*

(Interview 7B)

I need large volumes of data in order to be installed in a ***clean accessible*** *way so that I can do the analytics and drive new products on top of the data.*

(Interview 15B)

The biggest challenge is data and getting the correct data. Usually, the data is not available to us because the company doesn't have it or the company has it but it's ***hidden away*** *in this vast network of databases that only a handful of people know how to traverse. And even they don't do it confidently.*

(Interview 10B)

Our BlueHouse analytics team aren't the quickest and definitely haven't been the most helpful when it comes to a useful way to use this data. So even if you go and ask to see *the data or can we use the data. They say 'oh, it's not very* ***clean****'. It'll take us 10 weeks to get you an anonymised sample of the data. We physically cannot use the data to define props yet. What can we do with it? They are sat on all this data, and we can't get our hands on it.*

(Interview 9B)

As long as the data works, the data is easy to use, and we can present props that the customer actually wants. It's getting to that point; I think that is the difficulty.

(Interview 9B)

5.1.1.3 Data Integration, Aggregation, and Representation

The final key aspect in which a big data management capability enables the actualisation of smart meter affordances is in its ability to integrate, aggregate, and represent smart meter data alongside complementary data sources or systems. The following quotes highlight how data integration can be a challenge. It also highlights the importance of data integration from different sources (e.g., billing system, customer service management system) in order to inform business decisions:

What do you think is the biggest challenge towards exploiting the smart meter data? Business silos. My perception is that you've got data sitting in data management systems and some are in completely different business systems, you've got the rest of the business using the customer service system... And they're not currently talking [the systems] and it is work underway to do that.

(Interview 23 A)

It's about using all the data we have at your disposal to enable more informed targeted decisions and understand trends for us shape your business. So, we've got data stored across multiple systems. It's about being able to bring that data in a cohesive way together to empower us to make informed decisions which I don't necessarily think we have at the moment. We are trying to get there. So, I can get data from Oracle Systems together. But it's difficult to get data from our Oracle Systems with our billing system together. And you need that customer data to help inform some of your decisions *because it's not all about the metering data, so I could see we started on the process but we're not there yet.*

(Interview 20A)

We haven't got all the data yet. It's not all feeding through. There are still pockets of data in different systems. And trying to align is Mr Smith here with Mr Smith there. Are they the same person? Are they different people? So then actually we can pull everyone's individual data together with the right matching algorithms. So, I think we are getting there, working on it, but we are not quite there yet.

(Interview 1B)

There are different areas of the business that look after different types of customers, and primarily the customer level information is within our customer service system. But when they take a smart meter the actual meter data which is their usage data is stored within another system, so you're not able to necessarily able to put the two together at this point in time which is the work which we are trying to do.

(Interview 23A)

This concludes the findings on big data management capability. In the following section, I will discuss the second key capability that enables the actualisation of smart meters affordances: big data analytics capability.

5.1.2 BIG DATA ANALYTICS CAPABILITY

Big data analytics capability refers to the techniques used to analyse and acquire intelligence from big data (Gandomi and Haider 2015), in order to support different value-creating needs within an organisation (Grover et al 2018). The data analytics techniques can include text, audio, social media, and predictive analytics (Gandomi and Haider 2015). In the context of this study, big data analytics capability refers to the techniques used to analyse and acquire intelligence from smart meter data and complementary data sources. The techniques used to analyse smart meter data are predominantly predictive whereby a variety of techniques are used to predict future outcomes based on historical and current smart meter data by uncovering patterns and capturing relationships in the data (Gandomi and Haider 2015). Having a big data analytics capability is very much dependent on having a big data management capability to build the analysis on. However, the following quotes highlight that big data analytics capability is a unique capability that can be a challenge to develop despite having vast amounts of data:

> *We have vast amounts of data, but do we truly exploit it? Do we truly understand what we want to do with that data? to make the data big and meaningful or to drive our business differently. I don't think we're there yet with our data analytics platform.*
>
> (Interview 15A)

> *The big data is there because we have the half-hourly reads from the smart meters, but the big data capability to exploit that data and turning it into something meaningful is probably immature.*
>
> (Interview 27A)

> *We've got an awful lot of data, but I don't think that we sufficiently developed our BI capabilities our data abilities. I don't think that we necessarily monetise our data to its full potential.*
>
> (Interview 1A)

A key big data analytics capability in relation to analysing smart meter data is the ability to disaggregate energy consumption data. Disaggregating appliance usage is about incorporating a method of disaggregation of total electricity consumption in order to distinguish the consumption of individual electricity appliances (Matsui et al. 2015). For example, being able to detect a kettle signal, from a washing or a fridge, in the total energy consumption signal, as highlighted in the following quote:

> *The big topical thing is around disaggregation. That's the ability to understand not only how much you are consuming but on what. So how much of my energy consumption is used for the washing machine, used for the heating hot water consumption, all the big elements. It's one of the topical things which you can't really do with 30-minute granularity data because obviously, all you know is that you consume some energy at a certain point in the day.*
>
> (Interview 2B)

Informants have highlighted that one of the ways to build a big data analytics capability is by creating a specialised and centralised data science unit that operates in a consultancy-like fashion serving the wider business functions with their data needs. As highlighted in the following quote:

> *We are a little consultancy inside the company. We have to think like we are a consultancy. It has worked really well, when we started, we just had no funding. When we started, it came out of my boss's budget, so all of the money that I spent on my team came out from the IT budget which wasn't great because you know... now we are 30, 35 strong and we have become 50-60% funded, so people are paying us for our work. Which is good.*
>
> (Interview 4B)

As such, the data science unit can assist the various business groups and functions in exploiting their data by helping them "*level down with data and technology*" (Interview 4B). Having a big data analytics capability set up in such a way makes an organisation able to pull together the "*academically focused data scientists with the product people to help the businesspeople*" (Interview 4B). A few examples of data science use cases can include developing an answer to the following business problems/questions:

> *Can you build a churn model? Can you tell when a customer is likely to leave? Or can you tell when complaints are likely to happen?*
>
> (Interview 4B)

A data science unit uses a variety of data analysis tools and techniques and builds predictive models and algorithms. They adopt open innovation approaches, as one informant highlighted "*we have to tweak our approach and use different algorithms, different approaches to analyse the data*" (Interview 10B). By using publicly available algorithms such as those available from data analytics industry leaders such as Netflix or Spotify, they can adapt the algorithm in a way that is relevant to their own implementation of it.

Big data analytics capability is also about investing in the tools necessary to analyse and acquire intelligence from big data. These can include web, mobile, social media, and predictive analytics; rule-based systems, and visualisation applications (Lehrer et al. 2018). For example, GreenWorks invested in Tableau, a data visualisation tool to enable their employees to access the analysis to the data they need in real-time:

> *We're implementing Tableau which is a presentational tool so we can get information pushed out, to self-service so our staff can get information in real current time.*
>
> (Interview 19A)

Big data analytics capability is an important and key capability for smart meter affordance actualisation because it provides firms with four key actualisation enablers (see Figure 18 below). First, it enables the development of new business propositions. Second, it enables an organisation to maintain and improve its competitive advantage. Third, it helps foster a data-oriented culture. Fourth, it helps foster an innovative culture. All four will be described and discussed in the following four sections.

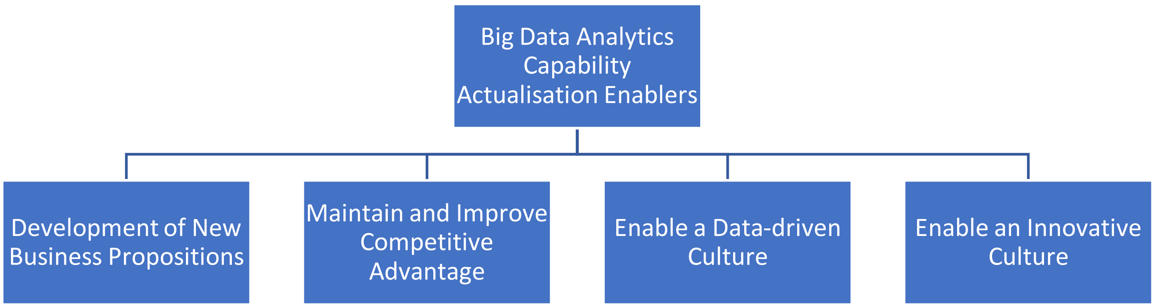

Figure 19. Big Data Analytics Capability Actualisation Enablers

5.1.2.1 Development of New Business Propositions

The interview data highlighted that there are three levels of competency when it comes to the analysis of smart meter data. The differing levels of competency are in relation to the varying abilities to analyse different frequencies of smart meter data (i.e., the third V in the big data 3Vs)[17]. The three levels of competency are: 1) the ability to analyse 30-minute data; 2) the ability to analyse 10-second data, and 3) the ability to analyse sub-second data.

[17] This capability focuses on the analysis of the smart meter data and assumes that the collection and storage of smart meter data at different frequencies has already been taken care of at the big data management capability level. The additional competency of 10 second data or even further sub second data requires an additional investment at the big data management capability level.

The capability to analyse 30-minute smart meter data would enable the actualisation of several smart meter affordances (e.g., price customisation, energy trading, business process improvement, energy market localisation). The capability to analyse 10-second smart meter data would enable the actualisation of several service innovation affordances (e.g., automated trigger-based action). As highlighted in the following quote:

> *The 10-second data will give us that foundation to create more services for customers. So it's not just about energy… it's about what we can tell, and what we can give you, and how you can be more in control of your energy and that control and management is going to be key in developing services.*
>
> (Interview 6B)

The capability to analyse sub-second data will enable a wider pool of service innovation affordances (e.g., being able to detect when a smaller electrical appliance has been left on such as an iron or a lamp; remotely controlling appliances). However, sub-second data requires a further investment in a technology that can collect such granularity of data at the sub-second level. This can be done by modifying the smart meter technology or investing in complementary technology in the form of a sensor that is installed on the main energy line to collect the sub-second data. The following quote highlights how BlueHouse were not able to realise the value creation potential from sub-second data, because of the additional investment it would require:

> *We wanted to do things around safety. If you've left your iron or hair-straighteners on. That is something we wanted to do but actually when we look into it further. We are unlikely to be able to do, because of the level of competence that you need and unique sub-second data to do that. Because of how they use energy, they heat up quite quickly, which means that it's harder to identify. That's the sort of thing we potentially could look at longer-term if we do it internally.*
>
> (Interview 6B)

Energy consumption data can be collected at different levels of granularity (30-minute, 10-second, sub-second intervals). The further investment in data collection and analysis at a higher granularity will further enable an energy company to realise more opportunities. However, investing in the collection and analysis of energy consumption data at the sub-second level is not a capability that energy companies are willing or able to develop.

5.1.2.2 Maintain and Improve Competitive Advantage

The interview informants highlighted that having big data analytics capability is of key importance in maintaining and improving the competitive advantage of the energy company within the wider ecosystem of technology and data giants and/or start-ups that are otherwise known as "digital upstarts". This threat is not unique to the energy sector, as a number of companies are finding their service business under threat by the new wave of digital upstarts that *"capitalise on changes in technology, customer behaviour, and the availability of data to create innovative, customer-friendly alternatives to the services incumbents offer"* (D'Emidio et al. 2014).

The adoption of smart meters and digitalisation of the energy sector represents a growing challenge to traditional companies that have not fully developed or carefully invested in their big data analytics capability. The following quote highlights how companies like Amazon or Google can threaten energy companies by capitalising on the changes in technology before energy companies do:

> *It opens up the fact that Amazon or Google can go and put a device in the home. I think some of the Amazon Echoes have got the chip in there so they could if they wanted to collect 10-second data from the home. So, it opens up a huge threat to us as a business because then Amazon could do that as well. And if you think of how popular smart speakers are. We could see that they could not only be the intermediary of energy. They could pick up all the insights and everything else that comes with it, which is why we need to make sure that we're establishing ourselves as diverse and with knowledge of the data and insights.*
>
> (Interview 6B)

5.1.2.3 Foster a Data-Oriented Culture

Big data analytics capability enables an organisation to foster a data-oriented culture, whereby the entire organisation recognises the value in data-driven analysis and decision making (Davenport et al 2012; Troilo et al 2017). Fostering a data-oriented culture helps challenge the long-held mental and behavioural routines within an organisation (Troilo et al 2017). The following quote highlights how valuable a data-oriented culture is for understanding customer trends:

> *It really sits with the data; it sits within our data strategy and data capability. That's where the real value sits because we need to be a business that understands that data better than the customer, and that can advise the customer and that can look at trends. That's just the real advantage and we can personalise for the customer.*
>
> (Interview 23A)

On the flipside, the lack of a data-oriented culture will often result in decision making following the highest-paid person's opinion "HiPPO" and with it come the inherent biases of human judgement (McAfee and Brynjolfsson 2012; Newell and Marabelli 2015). Not having a strong data analytics capability and subsequently, a lack of a data-oriented culture may result in situations where a business may either use the data to validate their own assumptions or dismiss the data entirely despite it speaking the truth. The mismatch between the varying data-oriented efforts across the organisation can result in interesting power dynamics between those who are data-oriented and those who are not. For example, a data science unit may produce a technical finding, or solution, or provide a list of recommendations that may get rejected by the business because the recommendations are not liked or not in line with their own expectations, as highlighted in the following quote:

> *The wider company don't always like the answers we give them. We'll tell them this is what the data says. We give them the answer they don't want but it's the truth. And then they ask us to redo it. They just want to validate their own assumptions, which is very rarely is the case… It just doesn't work out that way.*
>
> (Interview 10B)

To give another example where a lack of a data-oriented culture can result in situations where a business may dismiss the data entirely, despite it speaking the truth. The following quote highlights how a lack of a data-oriented culture (where not everyone in the organisation values data-driven analysis and decision making in the same way) can result in a missed opportunity for business process improvement in billing:

So, I run a lot of data and analytics for the director. We are setting up 5000 direct debit plans every week which are going to be underpaying by more than 100 pounds. That is costing you 1.9 million pounds in cash a week. You multiply that by 52 weeks. That's £100 million just on poor direct debits, when those customers get to the end of their plans, and we try to put them up, they all call and on 70 per cent of those calls, we reduce the direct debit by more than 15 per cent. That is another hundred million. So I tell the director this is a 200 million accelerated cash opportunity (...) So I presented the data, they laughed at me, and they said, oh no, it can't be that bad (...) so I used that as an example to show you the approach to data.

(Interview 13B)

5.1.2.4 Foster an Innovative Culture

Big data analytics capability enables an organisation to foster an innovative culture. An innovative culture - amongst many other things - is one that emphasises the importance of experimentation and the establishment of organisational structures and incentives that encourage it (Khanna et al. 2016). It is one that views failure as an integral part of exploratory learning, and advocates for the “fail fast, fail often” principle (Khanna et al 2016). The following quote highlights how not having a culture of “failing fast, failing often” will result in not knowing when to draw the line on a failing project or overfunding a project that may never become successful or come to fruition:

The project has been going for so long. And they've been funding it so long that they put too much money into it. So, they are not allowed to let it fail. So, they are just going to keep at it until it works. Whereas it might have been better a year ago to say okay we can't do this here. Let's stop it.

(Interview 10B)

This concludes the findings on big data analytics capability. In the following section, I will discuss the third key capability that enables the actualisation of smart meters affordances: technology adoption capability.

5.1.3 TECHNOLOGY ADOPTION CAPABILITY

"It was a really big change. We've had to procure new systems. We've got to train a new metering field force. We've had to review all our business processes, pull up everything from the drains up basically. It is all going to have to change. Smart will impact every single thing we do."

(Interview 1A)

Technology adoption capability is about the efficacy in the implementation, integration, and augmentation of a new and advanced technology within an already existing organisational routine by putting it into practice within an organisational context (Meyer and Goes 1988; Woiceshyn and Daellenbach 2005; Damanpour and Schneider 2006). It is about the adoption, routinisation, and institutionalisation of a new technology (Zhu et al 2006). As highlighted in the quote above, the adoption of smart meter technology is a big change for energy companies where all business processes, systems, and ways of working will need to be adapted. It is worth noting that the technology adoption process is not a one-off process, but a complex and adaptive one (Denis et al. 2002). The following two quotes highlight the dynamic nature of technology adoption, whereby new forms or variations of a technology are constantly emerging, as well as new issues and problems, and subsequently, the organisation needs to adapt and manage the process accordingly:

You have to be pretty adaptable because things change every two minutes. There is quite a lot of problems that we get with Smart Meters that aren't known until we get them. We have to react to them as they come along. But we have teams now that we didn't have in the past. For example, we have a smart faults team. They would relay that information to a specialised team that have ties with the experts at the technology so we can understand. Because some of these issues or problems are brand- new, we may have not come across these things before or realised they were happening.

(Interview 8A)

I don't expect the instability to change between now and then, it might start calming down towards the back end of the mass rollout. Every few months there's a new technology landing, new type of meter that's landing and our people in the field have got to do different things. And so undoubtedly, we will solve the problems with *integration. So, we're beginning to solve the problems on SMETS2. From what came out a few months ago. But now we are going into prepay, so there will be a new set of problems, and you move into the next challenge. So, this instability will endure for some time yet. What we need to make sure is that we are keeping on top of achieving stability on what's being delivered as we then get into the next thing.*

(Interview 17A)

Technology adoption facilitates or hinders a firm's experience in the adoption of a new technology (Woiceshyn and Daellenbach 2005). Some firms may experience a relatively efficient adoption process with positive performance implications, whilst others may encounter significant difficulties, costs, and diminished benefits. The findings of this study suggest that technology adoption capability is the foundation upon which energy companies can further build additional capabilities such as big data management capability and big data analytics capability.

The findings of this study suggest that new digital players in the energy market (i.e., Purple Energy[18]) tend to have a more efficient technology adoption process, whereas incumbent energy firms such as those studied in this research encounter significant difficulties and tend to find the technology adoption process more challenging. This is due to the need to integrate a new technology within already existing systems and organisational routines. For example, GreenWorks has a unique customer service system which is home-grown. However, by being a legacy system, with time, less and less people will have the knowledge to understand how it works, which can create challenges when adopting a new technology such as smart meters, as it can create challenges for integration with new systems:

GreenWorks always have taken a different view on that and try to gain a strategic advantage from doing differently. So we got a customer service system which is a homebrew. It took years and years to build, and we can make changes very very rapidly in that system. So, we were the first who could churn tariff changes and various other things very quickly. That's kind of paid its way many times over. But now we're in a landscape where actually that's part of our legacy and not many people understand the

[18] PurpleEnergy is a technology-based energy company that specialises in sustainable energy and software services with operations in the UK, Germany, and the USA. PurpleEnergy forms part of Purple Capital Group. PurpleEnergy was founded in 2015, and as of 2021 has over 2 million customers, and generated a revenue of £2billion in 2020.

true in-depth logic of how that runs. It's a complex beast written in COBOL which is an ancient language. It's kind of a millstone. It features in the landscape as an immovable object. People have tried to move and it's very very difficult.

(Interview 26A)

Contrary to incumbent energy firms, newer energy firms can build their systems, processes, and routines to be compatible with the smart metering infrastructure from the get-go. The following quote highlights this idea:

In a start-up or newer energy company, you build your platform from the get-go to handle smart meters and you don't have this problem of having to ensure security in a legacy platform with new data…the biggest challenge is to connect an old system with something that is built in a very different way and then connect them.

(Interview 15B)

Acknowledging the limitations that come with an incumbent legacy-oriented energy company, BlueHouse has, more recently, decided to set up a new digital energy company as a sister company to BlueHouse within BlueHouse Group (News Article, June 2020). This decision was driven by a desire to capitalise on the efficiencies of technology adoption capabilities that come with newer energy firms and to compete with the new digital rivals in the market.

Technology adoption capability is an important and key capability for smart meter affordance actualisation because it provides firms with five key actualisation enablers (see Figure 19 below). First, it enables the training and recruitment of engineers for smart meter installation. Second, it enables the management of customer demand. Third, it enables the management of the engineer workforce operations. Fourth, it enables the understanding and improvement of customer experience. And, finally, it enables the training of customer service advisors to manage smart customers.

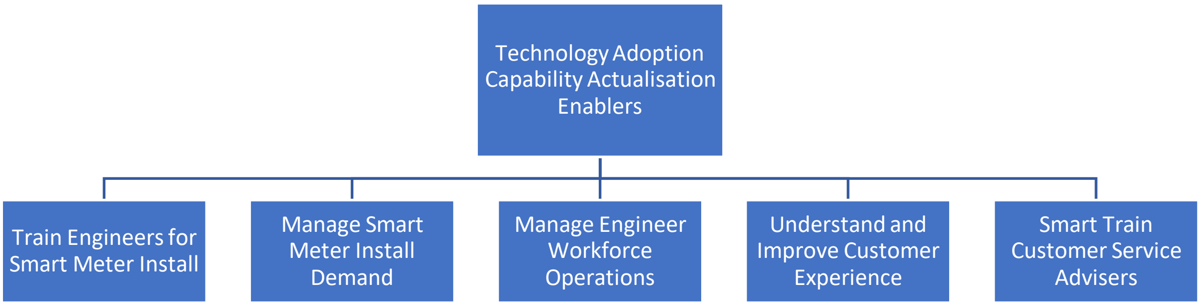

Figure 20. Technology Adoption Capability Actualisation Enablers

5.1.3.1 Train and Recruit Engineers for Smart Meter Install

The following quote highlights how training the engineering workforce requires a significant investment of time and resource, but one that both BlueHouse and GreenWorks view as an important investment to make. As highlighted in the following two quotes:

> *It takes 21 weeks to train to become a smart installer and then you are shadowing someone for another six months before you go out on your own. There's a lot of training that goes behind it but people don't know that. So you get that bad story and then that's it. And I think we are the only supplier that has our own force installing. Other suppliers subcontract out to third parties and with that, you lose the quality and the visibility, and everything like that. Our engineers are one of the best biggest advantages within BlueHouse because they are like our shopfront. We know we've got these reliable and trained engineers. It is a lot. It's really heavy to make sure that we keep that standard up because it's our biggest trust generator really.*
>
> (Interview 6B)

> *It's about working with third party suppliers and internally in the business to work out where we're going to bring people in from, how many we're going to bring in, and then sharing that profile with training to make sure that they've got the resources and the capabilities and capacity to be able to train in those sorts of numbers. And then co-ordinating with the onboarding team to make sure that they're aware of the plans and they can do all forecasting and ordering of the PPE and the equipment and tools that the operatives would need. So the whole end to end on onboarding process uniforms (…) then it was about tracking and monitoring those individuals through their training*

and mentoring to when they were fully qualified and signed off to be able to be released into life operations to start solo working. So, it's the management of the whole end to end process.

(Interview 18A)

Training engineers for smart meter installation plays an important role in meeting the government mandate. However, interview data highlighted that the pace of smart meter installation can be comprised by the maturity of the smart metering technology and infrastructure. Therefore, planning and managing the recruitment and training of smart meter engineer workforce can become a particular challenge and an unproductive cost to the business, as highlighted in the following three quotes:

The whole technology roadmap to smart has been quite a challenge. This is a technology project, in an industry that's not necessarily well-known for being strong in terms of technology, relied on lots of interventions from government and decisions there. What we've found is things that we thought we might be installing in 2012/13, we weren't actually installing until 2018/19. So, it really has been a much shorter slower rollout of smart.

(Interview 14B)

The biggest challenge is the maturity of the technology is a major issue. We have a lot of external dependencies, all be it on DCC (data communication company), the meter manufacturers. So, we have a huge degree of dependency on those stakeholders and the technology that we depend on isn't even developed yet. So, when we're trying to drive outcomes to a particular program around particular dates it poses real challenges (…) We are working between both a commitment to the government and a technology that's very very immature and unstable... And of course, we've recruited many many many hundreds of thousands of people who we need to keep busy to remain productive and commercially viable. Otherwise, we have a costly unproductive workforce. So, we've got to navigate between those three things. There is lots of ambiguity to try and draw up the best outcome for our customers, our shareholders, and our people.

(Interview 17A)

5.1.3.2 Manage Smart Meter Customer Demand

In addition to training the engineering workforce, energy companies require the ability to manage smart meter customer demand. The following quote highlights how BlueHouse manages their smart meter demand through relying on both inbound channels(where a customer reaches out to them) and outbound channels (where they reach out to a customer), and how they track their progress against their target for the year:

> *Being the head of smart planning performance and channel development, I have a commitment to deliver a mandate to every year in however many installs. My job is to make sure we book those operations with the customers. As to however many we say we are going to install and deliver in a year. Last year we installed 1.4 million meters. We have 20 channels or so. Some of which are outbound channels where we specifically campaign to target customers. Others are inbound channels where the customers are contacting us, and there is an opportunity there to offer them a smart meter. We use all the different channels to maximise the opportunity to book the operations we need to for smart meters. There's planning around through the year with specified planning and budget cycles. There is performance management week-to-week with all our channels in our trading activity. Then there's the working with the field operations to balance supply and demand. So, when I have a view, we make the plan of the year of all the booked ups we're going to get.*
>
> (Interview 8B)

One of the ways in which GreenWorks manages their customer demand for smart meters is through developing a tool that can help customer service advisors offer eligible customers a smart meter, as highlighted in the following quote:

> *We have this new tool which is built on a number of propensity models that offers a next best action, and up to three different options of the next best action. Then idea is that when customer service advisor gets a call through from a customer, when they enter the customer details into the system, this tool will offer the agent up to three different options to offer the customer. So, if the customer is eligible for smart they haven't been offered it in the last three months. It will propose that the advisor can offer it. And it can do that amongst a lot of other offers that we have, so it will offer tariffs,*

it will offer products, it will offer services, all sorts of things as well. ***But smart is our number one priority.***

(Interview 8A)

5.1.3.3 Manage Engineer Workforce Operations

In addition to training the engineering workforce and managing customer demand for smart meters, energy companies require the ability to manage the operations of the engineering workforce. This can include booking the install and managing engineer diaries in relation to the geographic location. Managing the engineering workforce for smart meter has meant that energy companies have had to significantly invest in digitalising the workforce operation processes. Such investments included a new mobile workforce management system (MDMS) for scheduling. It also included updating a paper-based system to a digital one by equipping each engineer with a touchpad to manage their installations and provide them with the training to be able to use the technology effectively. As highlighted in the following quote:

> *It's brought a lot of change into our organisation over the last 10 years because not only is smart about new meters and new technology… The first thing we had to do when smart came about was to bring in an MWM (meter workforce management) scheduling system and our MDMS (meter data management system) which were a huge technology delivery for us. But from an end-user perspective, the whole field force that had paper taken away from them, they had a mobile device in the form of a touch pad given to them and their work was being scheduled differently. They use the touch pad to receive their work and to complete their work on, and to scan the meters. This was probably one of the biggest wholesale changes was bringing in both the new scheduling platform but the training and rollout of those touch pads across all metering field force because that took a while to imbed, but we knew without that we would never be able to do what we needed to do and carry out the smart installations.*

(Interview 15A)

Managing engineer workforce operations is also about managing and responding to smart meter appointment cancellations. The following quote highlights how smart meter booking cancellations seem to be a common occurrence, and how they can be managed in such a way to minimise their impact on the business:

We have a set workforce in the field of engineers who are all over the country and I can only give them as many as they can handle. And there's always dropout because customers cancel…There could be myriad reasons why you have drop out so then it's about how do you balance, where do you move people? But it's a continual conversation around: Where am I getting demand? Do I have enough? Can we move people? Can we generate more demand there? and I have to balance where I'm generating demand in places where customers are eligible. So, we model what that looks like, we manage our channels to deliver that, then we can make changes to try and steer that demand where I need that demand to be.

(Interview 8B)

5.1.3.4 Understand and Improve Customer Experience

Technology adoption capability enables an organisation to better understand and improve on their customer experience through being able to analyse the data from the multiple consumer touchpoints, whether that be pre-install, during install, or post-install. By analysing data in the pre-install phase, firms can better understand customer awareness and the effectiveness of the different marketing channels. By analysing data during the install phase, firms can better understand the areas of the install process that can be improved. By analysing data in the post-install phase, firms can better understand the level of customer engagement with smart meters, and look at ways to improve their customer engagement levels. As highlighted in the following two quotes:

We look at the customer journey pre-install so anything up to the install. So marketing, booking appointments, and installation. And then our output was journey maps to show the customer journey at that point with some targeted actions to improve. We also look at the post-install and retention side of smart, and then we've come out with some actions and improvements for there. At the moment at a high level what we're looking at is being able to measure the smart journey from a whole journey point of view. So that's right from awareness all the way through to in life and smart customers leaving GreenWorks. So, being able to give one single view to the business of the customer experience and then how that relates to commercial value.

(Interview 22A)

We map out the journey that the customer is on from the moment they raise their hand wanting a smart meter, what does that look like? What does that feel like from a customer's perspective? Even prior to the install that includes correspondence that goes out to them, and that enhances any conversations that we have with customers as well.

(Interview 18B)

5.1.3.5 Smart Train Customer Service Advisers

Energy companies require the ability to train and upskill their customer service advisers to be able to handle smart meter queries and bookings. The following two quotes highlight how the smart meter customer service advisers used to be a specialist unit, and as the number of smart meter installs increased, customer service advisers became multi-skilled where they could serve both smart and non-smart customer. They also highlight that having two separate business processes for serving smart and non-smart customers does add to the complexity of transitional adoption of smart meters:

Initially, they were a specialist team. Following which the customer service advisers became multi-skilled where they can handle queries from smart and non-smart customers. Initially what we would do is once a customer had a smart meter, they were going to a ring-fenced group of customer service agents and they would be specially trained to deal with all things smart and then a couple of years ago as we reached that tipping point where smart needed to become the business as usual, teams became more multi-skilled and able to deal with both smart and standard inquiries. We still have smart specialist teams today that tend to work on the more complex inquiries and the specialist technology type inquiries.

(Interview 14B)

The business had to be able to operate with X million customers with smart meters and Y million customers without smart meters and be able to operate those two processes seamlessly. During the transition period, it does create quite a lot of complexity and change for the business as it moves from an operating model in the standard world to an operating model in the smart world.

(Interview 14B)

This concludes the findings on technology adoption capability. In the following section, I will discuss the fourth key capability that enables the actualisation of smart meters affordances: customer engagement and communication capability.

5.1.4 CUSTOMER ENGAGEMENT AND COMMUNICATION CAPABILITY

Customer engagement is *"the degree to which a company succeeds in creating an intimate long-term relationship with its customers"* (Voyles 2007; Sashi 2021). Customer communication is about using traditional and digital methods of communication "*to serve customer' needs for knowledge and understanding relating to a product, service, or any phenomenon that renders value-in-use for their needs"* (Finne and Grönroos 2017). Customer engagement and communication capability is about the extent to which an organisation utilises different forms of communication to provide their customers with knowledge and understanding about its offerings in order to create a long-term relationship with its customers. With the advent of big data technologies, organisations can utilise the increasing availability of data on how customers behave, communicate, and respond to effectively communicate and engage with its customers.

Both BlueHouse and GreenWorks have articulated the importance of a customer engagement and communication capability as a key capability in enabling them to actualise the affordances that smart meters have to offer, as highlighted in the quotes below. On the one hand, GreenWorks acknowledges that they are lacking in such a capability, and without developing a customer engagement and communication capability they *"won't have much of a future"*. On the other hand, BlueHouse, has both acknowledged and acted on this realisation by making a commitment towards customer-centricity in their strategy (one informant calls it 'customer obsession'):

> *We seem to be in this new phase of using this phrase around BlueHouse Group now customer obsession. It's about delivering on our strategy and doing the right thing for the customer. Now if the benefits of smart are doing the right thing for the customer, then arguably, we should be doing that, irrespective of the cost but you have to keep one eye on the cost.*
>
> (Interview 6B)

Going forward the real advantage of smart is around what can we do to engage with our customers differently? It's a very different skill set and very much about that digital marketing, customer-focused approach, what do our customers really want? Which is not a skill GreenWorks has... We won't have much of a future if we don't get better at giving our customers what they want, and then being able to charge them for it.

(Interview 6A)

Customer engagement and communication capability is an important and key capability for smart meter affordance actualisation because it provides firms with four key actualisation enablers (see Figure 20 below). First, it enables the generation of customer trust. Second, it promotes a customer-technology interaction. Third, it educates and informs the customer. And, lastly, it helps identify meaningful value proposition opportunities. All four will be described and discussed in the following four sections.

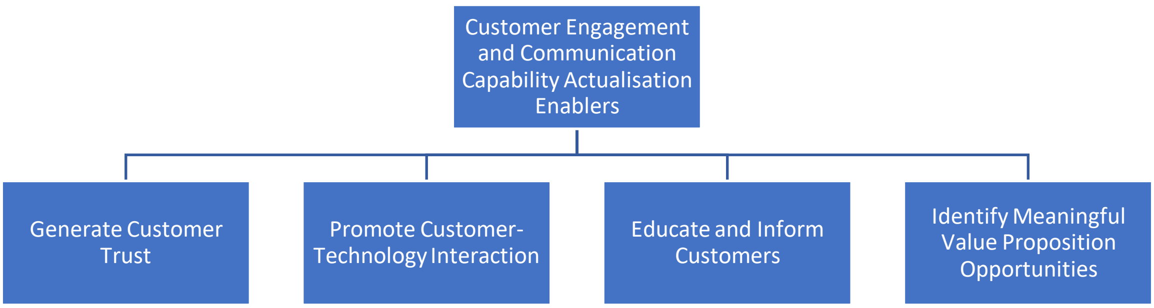

Figure 21. Customer Engagement and Communication Capability Actualisation Enablers

5.1.4.1 Generate Customer Trust

Interview respondents highlighted that, increasingly, energy companies have come to realise that energy consumers have a negative impression and a general lack of trust in energy companies and the energy industry. So much so that energy companies wanting to offer smart meters to customers for free can be faced with reluctance and suspicion where "*people feel suspicious about why an energy company would want to do something nice for them*" (Interview 14B). The following two quotes highlight how the energy industry has acknowledged the need for the shift towards becoming more data-driven in customer engagement and communication as it will enable energy companies to generate and gain the trust of its consumers:

> *It should change the way that customers perceive the energy industry. They should be able to trust that because that their usage is more visible to them that their bills are more accurate. It should change the way customers perceive the energy industry because it will be more transparent. It should. If it's done the right way.*
>
> (Interview 23A)

> *There is a real shift for the industry, and I think it will take a while before we actually start to work out in the industry how we best make use of that information. But doing that is key to actually engaging with customers and gaining their trust. You look at people like Amazon who are really good at taking data interpreting what their customers are interested in, what they want and actually seem to have the trust of their customers in what they do. All the monitoring of your shopping history in the background which you don't really think about or pay any attention to. They seem to have a great deal of trust with their customer base, and you go back to them for more.*
>
> (Interview 13B)

5.1.4.2 Promote Customer-Technology Interaction

> *A lot of people have their IHD in the kitchen where they can see it. What we tend to find is that customers will look at it for a few weeks and then over time, they will switch it off put it in a drawer.*
>
> (Interview 6B)

The interview data highlight that there is a problem with the long-term engagement of customers with the smart meters and in-home displays (IHD). Energy customers tend to engage with the technology for the first few weeks, following which they turn the IHD off and put it away. Customer communication and engagement capability enables an organisation to encourage its customers to have a positive and long-term interaction with the technology by continuously providing their customers with the information that is both relevant and interesting in relation their energy consumption:

We need to continue to engage customers with their smart data post-install to help them proactively manage their usage. So, things like you've used more today than you did yesterday, have a think about what you did differently so pushing information out to them to help them because not many people have got the time to sit there and dissect the smart meter data, so we are supposed to be the experts. We should be feeding this information out to customers to help them make those decisions. And I think that's where it becomes quite powerful… to help them manage their spending and hopefully reduce their bills.

(Interview 27A)

The findings have suggested that incumbent energy firms tend to have a static view of the customer. For example, "*customers find energy boring*," "*they don't want to engage with energy*," "*they are happy with things as they are*," "*they aren't aware of their energy consumption any more than before having a smart meter*" all indicate a static view of the customer, where an energy firm believes that they have no influence in shaping the customers' attitudes or perceptions. This seems to be the shared understanding in relation to the view of the customer at both BlueHouse and GreenWorks. An interesting counterexample is offered by PurpleEnergy[19]. Purple energy is a technology-based energy company that was founded in 2015. PurpleEnergy, contrary to GreenWorks and BlueHouse decided to adopt a more dynamic view of the customer, whereby they view customer perception and behaviour as something that can be influenced and changed using the appropriate triggers or incentives. PurpleEnergy demonstrated having a strong customer engagement and communication capability by encouraging their customers to shift their energy consumption behaviours from peak times to off-peak times by targeting them with a variable hourly tariff.

The chart below (see Figure 21) showcases their successful attempt at shifting energy consumption behaviour in response to the actualisation of a price customisation affordance. The red line highlights consumption when using a smart meter on a standard tariff, whereas the green line highlights consumption when using a smart meter on a variable hourly tariff. The X-axis is the time of day, whereas the Y-axis is the percentage of energy usage. What we see here, with the red line on the standard tariff, there is very little consumption during the night between

[19] PurpleEnergy is a technology-based energy company that specialises in sustainable energy and software services with operations in the UK, Germany, and the USA. PurpleEnergy forms part of Purple Capital Group. PurpleEnergy was founded in 2015, and as of 2021 has over 2 million customers, and generated a revenue of £2billion in 2020.

the hours of 12 am and 5 am and a lot of consumption between 3 pm and 8 pm. Whereas, with the green line, for customers on the variable hourly tariff, there is a lot more consumption between 12 am and 5 am, and a lot less consumption in the peak hours between 3 pm and 8 pm. Indicating a shift in energy consumption away from on-peak times. This shows that energy consumers can and do engage positively with the price customisation afforded to them by having a smart meter. The outcome of shifting energy consumption away from peak times is beneficial for the customer because they save money. Equally so, it is beneficial for the energy company because they are better able to balance energy demand on the grid, and can procure energy at much more affordable rates.

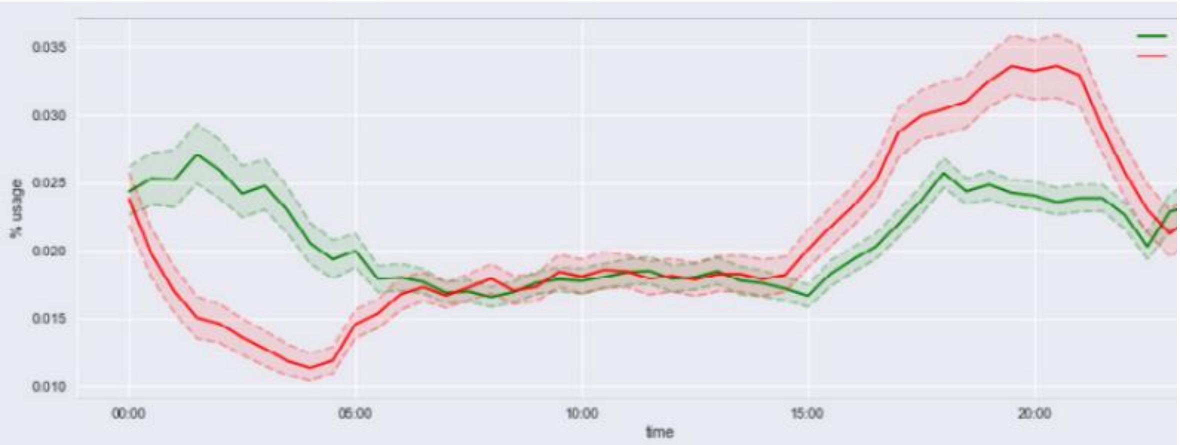

Figure 22. Purple Energy influencing a change in energy consumption behaviour through price customisation affordance.

5.1.4.3 Educate and Inform Customers

Interview data shed light on two main problems that can be addressed through educating and informing energy customers. The first is in relation to customers having unjustified fears on the health or data security of smart meters; in most part, this is influenced by the negative press coverage of the technology. The second is in relation to customers misunderstanding of what smart meters do, or what they offer, which can negatively impact their experience. To showcase this, the following three quotes highlight how smart meters have not been actively embraced in the same way that other forms of technology; how the various stories in the media have negatively affected the adoption of smart meters in the energy industry; and how customer education is key in overcoming some of these challenges:

The energy industry has so many problems with engaging its customers in a positive way. Smart meters are not a technology that has been actively embraced by the world in the same way we see with the likes of mobile phones and tablets. Technology and energy seem to be treated with quite a lot more suspicion: "So what are you doing with my data?" "How safe is this?" "Who do you sell this data to? "How can it be used?"… There's nervousness from customers. It's an interesting challenge simply because it's met with a wall of complete indifference…right through to nervousness some of it poorly informed which make people feel suspicious about why an energy company would want to do something nice for them really.

(Interview 14B)

There's been a fairly solid campaign from media and pressure groups to find fault with smart meters and that's ranged from concerns about the ability to switch between suppliers right through to concerns about the safety of smart meters and the risk of causing fires and things like that. So, it's been a combination of an indifferent environment and a hostile environment. So, what we tend to find is when we are booking a smart meter appointment you are quite often starting from a customer having no idea what a smart meter is right through to having a negative view of what a smart meter is, as they may have read an article in The Daily Telegraph or Daily Express.

(Interview 14B)

Across the industry, there have been challenges and there has been reluctance from some customers and concern and worry about having small meters in the home and what that might mean for their data and is it safe and secure. Does it increase the risk of fraud? There was a general education piece with customers that the industry is trying to tackle. A lot of the work that the smart meter team has been doing is part of the whole education piece. Addressing some of those concerns and pain points and educating our colleagues and in turn educate customers has been a challenge.

(Interview 3B)

The first problem is in relation to information or misinformation circulating in news media outlets containing headlines such as smart meters leaving users in debt, smart meters causing cell damage, smart meters being a scam, smart meters spying on its users, and so on (see Figure 22 below). Customer engagement and communication can enable an organisation to inform and educate its customers by clarifying any misconceptions or unjustified fears that they might have.

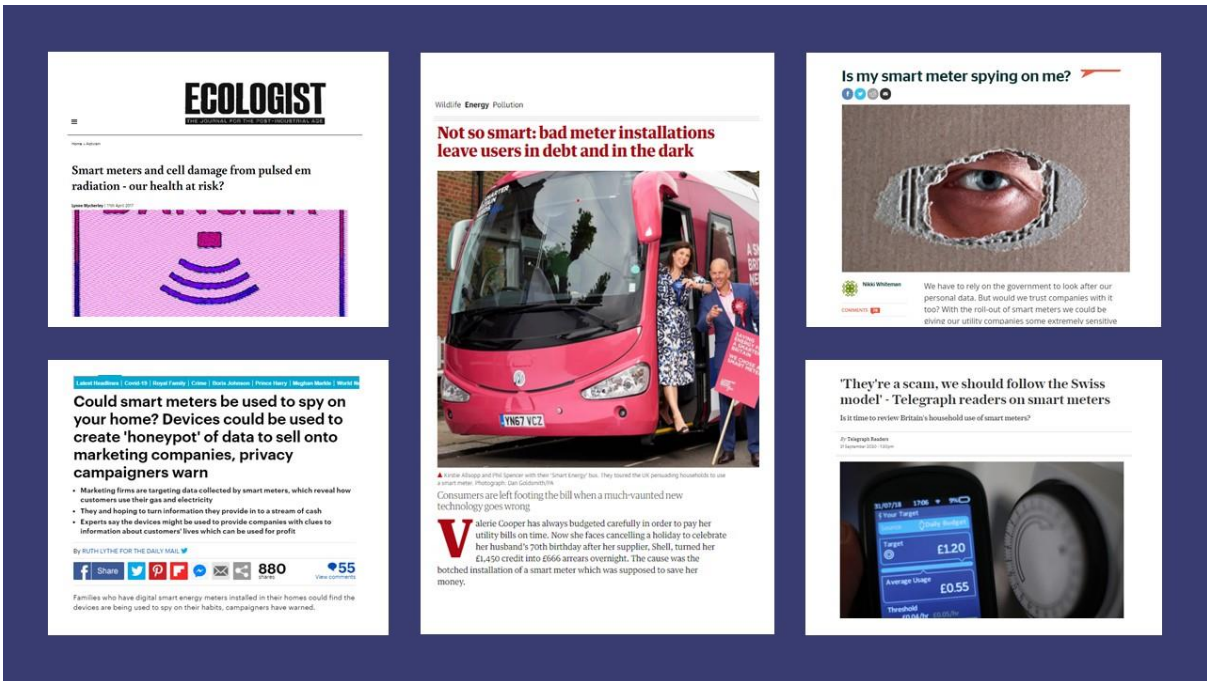

Figure 23. A sample of negative news articles on smart meters[20]

To give an example, Smart Energy GB[21] carried out a myth-busting campaign[22] to educate and inform energy customers about the misconceptions around smart meters. Through a series of videos and articles, they set the record straight by busting the myths on the key concerns in relation to smart meters posing a risk to health or privacy. They did so by verifying the information provided from reputable sources such as Public Health England.

The second problem is in relation to customers having misunderstandings about what smart meters do, or what they offer to the customer. To give an example, interview data highlighted that some energy customers think that they will save money simply by having a smart meter installed, when in fact, they can only save money by changing their energy consumption behaviour. Through having a customer engagement and communication capability energy companies can inform and educate their customers that energy saving comes from changing their energy consumption habits and not simply from having a smart meter installed:

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[20] Sources: Ecologist 2017*(top left);* The Daily Mail 2019*(bottom left);* The *Guardian* 2019 *(center)*; Which Magazine 2011*(top right)*; The Telegraph 2020*(bottom right)*

[21] Smart Energy GB is a government backed organization tasked with informing the UK about the benefits of the smart meter rollout

[22] https://www.smartenergygb.org/en/about-smart-meters/mythbusting-smart-meter-problems

The idea that customers are going to save money from having a smart meter, that was misunderstood from the customer perspective. I don't think the message is clear that to save money really you have to change your behaviour, the smart meter won't automatically do that for you. There are some things like that whereby in time it will catch up… It will take some time for those things to come through.

(Interview 14A)

To give another example, interview data highlighted that some customers who have been on estimated bills for years may receive what is referred to as a "bill shock" after having a smart meter installed because they have been underpaying for their energy due to being reliant on estimated bills. Through customer engagement and communication, energy companies can educate and inform their customers that their bills are more expensive after having a smart meter because they have been undercharged in the past, and not simply because they had a smart meter installed:

There's a lot of customers who when they get smart meter will find that they've been underpaying on estimating bills for a long time and therefore they end up with a catch-up bill and so they end up in debt straight away which isn't great for anybody. So that's an issue and that's something we have to support customers to try and resolve and try and recognise when customers' bills suddenly increased massively pre and post smart installation and help them to manage to pay those bills.

(Interview 27A)

5.1.4.4 Identify Meaningful Value Proposition Opportunities

Customer communication and engagement enables an organisation to identify new services and value propositions that customers want and/or need. Through a better understanding of the customer, an organisation can have an enhanced ability at imagining customer propositions that will fulfil the customer's wants or needs by "*removing friction from their lives and making things simpler and easier*" (Interview 3B). The following quote highlights this idea:

It would enable us to be able to offer a different tariff offering, more adaptability, be more customer-centric and more adaptable for customers. Things like connected homes *being able to connect to your other smart devices, being able to manage and monitor all your devices in one place.*

(Interview 22A)

The lack of such a capability will result in developing new services that customers do not want or need. Or it could result in a missed opportunity to actualise on a perceived affordance, because a competitor firm may be the first to do so. The following quote highlights how a lack of understanding of the customer has resulted in a lack of engagement in a new value proposition namely around price customisation:

When these ideas around tariffs were tested, what we tended to find is that customers level of engagement with energy companies is so incredibly low that these things just didn't create the level of excitement that we internally as sort of energy nerds found that we were seeing. We could get excited about the idea of this…But from a customer point of view, it is a really low engagement product. It isn't something that the mainstream were looking to actively engage with. These products which were quite clever and innovative, never really quite matched the engagement of some of the more boring products such as if you switch to BlueHouse we will give you a £50 voucher which feels very old fashioned, but I think that sort of speaks to the interest of the customers.

(Interview 14B)

As such it is important to invest in a customer engagement and communication capability in order to have a better understanding of the customer and deliver meaningful value proposition opportunities that customers will want and need:

What does the business think is worth doing? What would customers want? Because at the end of the day, you've got to sell something. So, you've got to create things that customers want. My view is that customers find electricity and gas boring, as I did before I started working here. So how do you excite people or impress them in engaging with those sorts of products? It has got to make their lives easier or cheaper. Or it has got to be like an Apple product and be irresistible for some reason.

(Interview 8B)

This concludes the findings on customer engagement and communication capability. In the following section, I will discuss the fifth key capability that enables the actualisation of smart meters affordances: Innovation Capability.

5.1.5 INNOVATION CAPABILITY

Innovation capability is about the resources possessed by an organisation that are devoted to identifying and creating new value creation opportunities by transforming knowledge and ideas into new products, processes, and systems for the benefit of the customer, the firm, and its stakeholders (Lawson and Samson 2001). Becoming an innovation-driven company is not without its challenges, and especially in a incumbent utility-based firm. The interview data highlights how becoming an innovation-driven company requires a big cultural shift and massive organisational education piece where employees are educated on what innovation is, how it is evaluated (away from traditional metrics), and the value that innovation can bring to the business. The following quote highlights the value of investing in innovation opportunities on staff retention and staff satisfaction, which is very different to traditional organisational metrics in evaluating investment opportunities in terms of profit and return on investment:

> *It's a massive education piece. And it's more than money, the value of innovation. Things like employee retention go up if you are an innovative company. And people feel more valued. They get in their learning; they are more fulfilled in their roles and they become more creative on their day-to-day products because they've seen what you can do in their innovative products. How do you monetise that?*
>
> (Interview 9B)

Becoming an innovation-driven company also means embracing the "failing fast, failing often" principle that lies behind any innovative culture. The following quote highlights how overcoming the fear of failure in a large traditional utility firm has been a challenge:

> *Personally, I don't think as a business we're always great at failing. If there's any sniff of something not working, we are like "no, we are not doing that anymore". Whereas actually, we are a big company, and in some instances, we've got the money to be able to do it. Because all sorts of projects come in, and as soon as there is a slight sniff of them going into the negative, they get shut down.*

(Interview 11B)

Interview data highlighted that whilst BlueHouse were willing and able to invest in an innovation capability, GreenWorks were less able to do so. This was due to the costs involved in investing and developing an innovation capability. Interview data highlighted that despite the desire and ability to develop an innovation capability at GreenWorks, they were not able to fund developing an innovation capability because of the high costs involved in the mass adoption of smart meters (i.e., developing a technology adoption capability). This was further exacerbated by the price caps imposed by the government that reduced their profit margins, as highlighted in the following quote:

> *As much as we try and drive innovation and want to do all these fun things. Us and other suppliers are in one dilemma, we only have so much money we can spend every year especially when we get pressurised at how much money we charge customers, when you make 2.6%, I wouldn't call that profiteering. The problem we have is to get a benefit from smart will cost money and while we're still trying to deliver smart and meet mandates and these really hard pressures. The desire is there, but the ability of us to do it is there but the budget isn't. Until we get the smart technology accepted by at least 50 per cent of customers, then we can invest in innovation. That's where I think our dilemma is, we only have so much money and so much time, today is about spending our money and time on delivering the must, the mandate, and we will worry about innovation later.*

(Interview 24A)

Innovation capability is an important and key capability for smart meter affordance actualisation because it provides firms with three key actualisation enablers (see Figure 23 below). First, it enables the conceptualisation of smart meter service innovation affordances. Second, it enables the experimentation of smart meter service innovation affordances. Third, it enables the commercialisation of service innovation affordances. In the following three sections I will define, describe, and discuss all three.

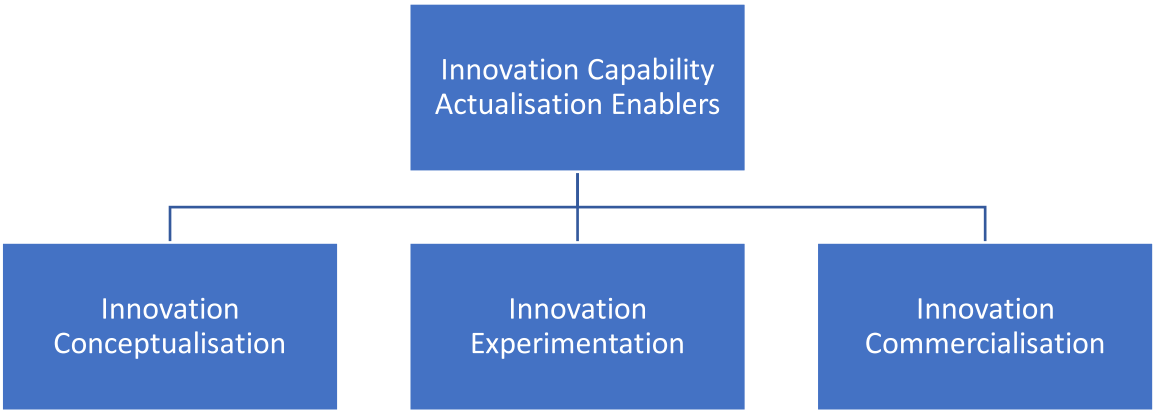

Figure 24. Innovation Capability Actualisation Enablers

5.1.5.1 Innovation Conceptualisation

Innovation conceptualisation is about the creation, recognition, elaboration, and articulation of innovation opportunities (O'Connor et al. 2018). One way to incentivise innovation conceptualisation at the individual/employee level is by encouraging employees to allocate slack time to exploratory innovation. At BlueHouse, employees are encouraged to spend employees spend 80% of their time on core projects and use the remaining 20% of their time on innovation activities that speak to their personal interests and passions. This facilitates the development of an organisational innovation capability because it allows for creativity in the recognition, creation, and articulation of innovation opportunities. As highlighted in the following quote:

> *If we have any ideas which are are not directly related to a problem that the business is currently facing it goes into our research work. The example I was looking into an idea related to EV charging, the business was not asking for it. It was an idea internal to the data science team. As a result, the first proof of concept and trial has been developed through our team. Following which, we can look into getting funding from the business.*
>
> (Interview 10B)

A key aspect of innovation conceptualisation is the ability to research and understand the competitive marketplace. As well as, engage in the process of external hunting for innovation opportunities. One way to achieve this is by setting up a competitor intelligence team for market intelligence generation whose key focus is to conduct environmental scanning for innovation opportunities, and communicate these findings in the form of regular workshops and weekly newsletters, as highlighted in the following quote:

> *We have an ecosystem of partners that we work with to gain our competitor intelligence. We do a mix between the partners and also scan social media and receive updates as soon as a competitor is doing something. Every channel that's available to us, we use, even as simple as doing a Google search. We distribute this information through weekly newsletters that we produce. We also set up workshops on a regular basis where we have a partner come in and we do a presentation on the latest consumer trends and explain where the market going and how it could impact BlueHouse's market.*
>
> (Interview 5B)

5.1.5.2 Innovation Experimentation

Innovation experimentation is about evolving a customer-centric innovation opportunity into a business proposition (O'Connor et al. 2018). Interview data highlighted that one way to develop such a capability is by building an **Innovation Lab** specialised in the development and testing whereby "*ideas can be quickly tested"* (Interview 4B). There are three key competencies of the innovation lab. The first lies in their ability to understand both the technical and non-technical aspects of a product. They do so by having user experience designers (UX designers) to complement the technical work of the data scientists and analysts. The following quote highlights how UX designers are able to look at the non-technical aspects of the product by understanding the psychology of using a product:

> *We've found that actually the most useful skills to have there [in the Innovation Lab] is UX people. User experience people because they are very good at testing. They understand how to set up studies, and some of the other non-technical facets involved. The psychology of using a product. So, we have the innovation lab, it's got a mix of UX, data scientists, data analysts in it.*
>
> (Interview 4B)

The second key competency lies in their ability to develop a minimal viable product (MVP) in order to demonstrate that a product does work, before fully developing it. This process usually includes several iterations, before it reaches a point where it can be deemed fit for its purpose.

For example, the innovation lab was tasked with developing a recommendation system for increasing sales, within which customer information and sales history would be automatically analysed in order to recommend a product or service to the customer in real-time. The following quote highlights that in order to do so, they first developed a minimal viable product in the form of an algorithm, following which they tested it with real-life data, and then they scaled the testing with a field study:

> *We've made a minimal viable product, so we've got something that has worked. We're just waiting for the people who are hosting the challenge to give us their data, so we can put their data in our system and then we can tweak it…So they give us the data, we run an algorithm, then we evaluate the algorithm. At the moment, our algorithm will be able to increase sales by X per cent, theoretically. And then we need to test it with their data. If we reach the development stage, we would then do a field study and see how well it works. It would be the evaluation period. And then if they like our results, we move onto a field study.*
>
> (Interview 10B)

The third key competency lies in their ability to demonstrate that a product achieves the desired outcome at scale, through a process of rigorous testing. This process usually requires vast amounts of data to be collected. BlueHouse did so by setting up a simulation lab within the innovation lab to be able to rigorously test innovation propositions at scale. The simulation lab has been used to simulate boiler failure and white goods appliance failure. This is a necessary step to be able to use this data to build – for example – new algorithms and models for new services based on predictive maintenance.

5.1.5.3 Innovation Commercialisation

Innovation commercialisation is about ramping up the innovation opportunity to stand on its own (O'Connor et al. 2018). Interview data highlighted that one way to develop such a capability is by building an **Innovation Accelerator** specialised in scaling and commercialising on innovation by *"launching them out into the world*" (Interview 4B). The following quote highlights how the innovation accelerator was set up to transform the way in which BlueHouse delivers its propositions for innovation commercialisation:

We were set up about two years ago to transform the way that [our company] delivers props, so to be more lean, agile, digital-led, get your buzzword bingo card out, we know all of them! And we kind of did that on a really small scale and piloted really well by doing a couple of design centred sprints…Our key focus since was to work out ways in which we would deliver them. So, would they be by ventures? So, setting them up as totally separate businesses outside of BlueHouse? Do we set them up as a ring-fenced venture within BlueHouse? Or do we find a product team and a product owner to do it completely conventionally within BlueHouse? So, we help core product teams to experiment with brand new ideas that they have. So, we will do a smoke test for them, and give them the kind of propensity to buy Google Analytics that sits behind that.

(Interview 9B)

Innovation acceleration is a relatively new competency to BlueHouse, one in which they are still learning their ways in the world. However, one of the successful examples of innovation commercialisation involved setting up a collaboration between BlueHouse and a health and social care company to deliver on a proposition to digitalise a traditionally paper-based system in the care sector. This innovation opportunity was set up in the form of a start-up that capitalises on the gig economy business model to deliver a service that can automatically connect carers with those who need it in a transparent, personalised way. As highlighted in the following quote:

We helped set up a start-up in the care sector. So, it's connecting patients to carers. And it's digitising a traditionally paper-based system that links into the whole connected care agenda and is based on a partnership between BlueHouse and Carers UK. It's got 1.6 million pounds of funding behind it, which we actually pitched for it and won.

(Interview 9B)

While the examples provided in this section on innovation capability are broader in scope than the actualisation of smart meter service innovation affordances, they do underpin the actualisation of smart meter affordances because innovation capability is an important and key capability that enables an organisation to deliver on its service innovation affordances. Specifically, this happens through the processes of conceptualising, experimenting, and commercialising new business propositions that are afforded to them by the adoption of smart meters, whether that be automated trigger-based service action affordances or trigger-based service interactions.

This concludes the discussion on the innovation capability. In the following section, I will discuss the sixth key capability that enables the actualisation of smart meters affordances: communication and collaboration capability.

5.1.6 COMMUNICATION AND COLLABORATION CAPABILITY

Communication and collaboration capability is about a firm's ability to exchange information between individuals, teams, or departments in such a way that thye can work together, have a mutual understanding, a common vision, and share resources to achieve a collective goal (Kahn and Mentzer 1998). Such exchange of information can take place via meetings, newsletters, conferences, and the exchange of standard documentation. Whilst collaboration capability is often distinguished and thus viewed as separate from a communication capability in an organisation (Griffin and Hauser 1992; Davis 2016; Valtakoski and Järvi 2016), this research views communication and collaboration as two sides of the same coin. As such, communication and collaboration together are viewed as one key organisational capability that plays an important role in actualising smart meter affordances. Some of the ways in which an organisation can develop their communication and collaboration capability is through a) through setting up a structured way for different parts of the business to meet, and b) through enabling greater job rotation for individuals amongst teams.

> *I really believe in smart data. I truly believe that smart will underpin the future of our company or at least the data that we get from it… It's going to be our differentiator however well someone who can use that data is going to define how well you perform… I think a coordinated approach to how do we use this data and getting some focus on it would just be immense. I think it'd be so powerful.*
>
> (Interview 9B)

As highlighted in the quote above communication and collaboration capability is an important and key capability for smart meter affordance actualisation because it provides firms with four key actualisation enablers (see Figure 24 below). First, it enables a data-driven organisation. Second, it enables the development of new competencies. Third, it enables the ability to tap into external competencies. And, lastly, it enables the promotion of business alignment. All four will be described and discussed in the following four sections.

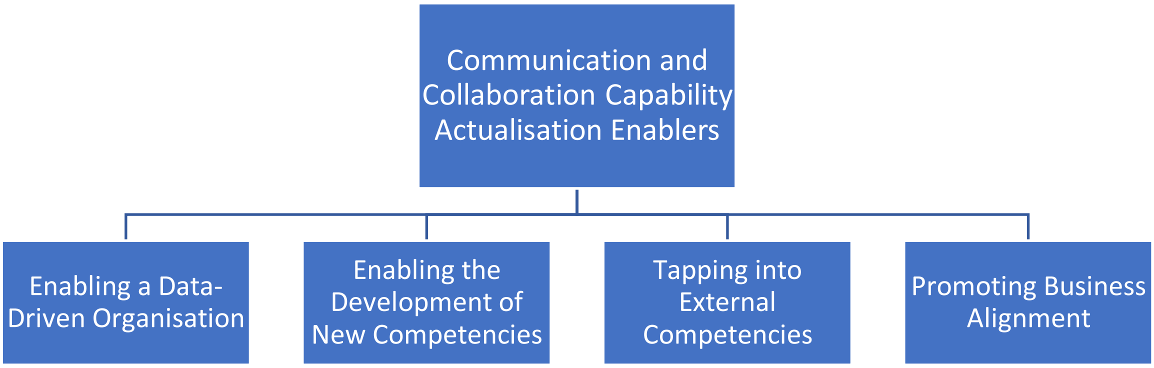

Figure 25. Communication and Collaboration Capability Actualisation Enablers

5.1.6.1 Enabling a Data-Driven Organisation

Communication and collaboration capability enables the non-data-driven parts in an organisation to become data-driven by communicating and collaborating with the data-driven parts of the organisation. For example, the following two quotes highlight successful communication and collaboration between data science and the HR and Operations business functions, which helped the latter become more data-driven. What this quote highlights is that when an initial attempt at communication and collaboration is successful, it sets a precedent for a successful ongoing partnership in working together towards achieving a common organisational goal, such as actualising smart meter affordances:

> *We've had people from non-technical backgrounds come work with data scientists or the [innovation lab] to build some really interesting stuff. A really nice example in our organisation is with group HR. They came to us and asked us to look at some data problems for them. We delivered a live piece of work a couple of months ago, and now we have a backlog of another 10 items, so we now have an ongoing collaboration with them. We're both finding it really useful to work together and collaborate, and especially with the HR department, you wouldn't expect an HR department to be particularly data-savvy.*
>
> (Interview 4B)

In field operations we now have a two-year multimillion program where we are working with them to look into how they manage engineer workload, to figure out how to do scheduling, how to do rostering, how to build simulations, all that kind of stuff. So, in that part of the business, they've accepted that they have to use data. It's going to make them succeed or fail. Other parts of the business I think we'll get there bit by bit.

(Interview 4B)

The opportunity to communicate and collaborate does not just happen by chance, it requires a sustained effort to inform and educate the non-data-driven parts of the organisation. Interview data highlighted that this is often facilitated through internal marketing and PR events, where the data-driven departments (e.g., data analytics, data science, innovation lab) showcase to the rest of the business what they can do with data, and with time "being data-driven" becomes an integral and routine part in every department. As such, effective communication is key in kickstarting collaboration opportunities that will in turn enable the actualisation of smart meter affordances. The following two quotes emphasise this idea:

We tend to do show and tells, lots of PR, lots of marketing. And then we will get people to come and find us. So, we use the network. I'd like to get to the point where we have something structured where we build data science and innovation into different business functions. But it depends I suppose on what incentive they have got, in the part of the business that they are in.

(Interview 4B)

We have been using our internal network but and also doing things on LinkedIn, so doing things externally as well. So, you get external validation and we have been using external PR firms as well. So, producing things like videos or poster campaigns. Initially were limited to just doing our own internal thing with the show and tells, the conferences, and VIP visits. Now we do things both internally and externally.

(Interview 4B)

Not having a communication and collaboration capability in the organisation means that there is a lack in sharing learnings across departments. This could potentially mean a duplication of effort which can be both inefficient and resource-intensive. The following quote highlights how having a communication and collaboration capability will help in setting up an overarching process for becoming data-driven across the organisation, and the sharing of data-driven practices and learnings across departments:

> *There are some areas in the business that are doing it but not sharing how they do it. For instance, you have certain areas that are being able to visualise that data in ways because they found manual ways to process to get it out and get it done. But it's not an overarching process that's then used across other is areas of the business. Our digital side of the business are actually very much using the data and surfacing that and the digital data but also aligning that. And they want to be able to use it to start connecting the behavioural data with the physical meter data. it's not being done yet. But different areas of the business are at different levels of where they're at with things.*
>
> (Interview 22A)

5.1.6.2 Enabling the Development of New Competencies

> *It tends to start with senior leaders in whatever function that is. It will be either the HR, or the operations director, or similar. So, the senior personnel will then get their people to come and meet with us, and then it'll filter down.*
>
> (Interview 4B)

The quote above highlights that collaboration opportunities are often facilitated through communication between senior personnel in the business, indicating a top-down approach that facilitates communication and collaboration. However, interview data highlights that when communication and collaboration capability is widespread across the business, it enables the utilisation of both top-down and bottom-up approaches towards the development of new competencies for the actualisation of smart meter affordances. A good example of this is the setting up of both the **innovation lab** and the **innovation accelerator**, both of which started off conceptually with a small group of people, who then went on to capitalise on their communication and collaboration capability to bring their ideas to life, as described in the following quote:

> *We started thinking about it seriously a year and a half ago. It's [innovation lab] only really launched properly. It took about a year for it to brew together. It has really launched over the past few months. So, it now has formal branding inside the*

organisation. We are doing the comms on it and it's got projects that are pumping through it on a regular basis, but it's been around conceptually for a little while before that, where the business would come to us to test something before, they spend a lot of money on actually building it.

(Interview 4B)

Interview data highlighted that through setting up external collaborations with technology and IT companies, energy companies can bring the learnings in house and develop their own competency. For example, GreenWorks set up a collaboration with an IT consultancy to help them with the technology adoption process of smart meters. This capability was later moved in-house. By doing so, they were able to develop a new IT competency internally that will benefit them in the long term beyond the remits of the project that was initially set up:

There was an Oracle lead from [a leading technology consultancy] So we got we've put a lot of work in [a leading technology consultancy]'s way so they're sort of a system integrator for us. And they used to be more prolific than they are now we've taken a lot of these things in-house.

(Interview 26A)

To give another example, GreenWorks collaborated with several innovative companies in the field of application development. This resulted in them being more involved in innovation activities and it influenced their thinking on innovation, as one respondent highlighted: *"we need to champion this"* (Interview 28A). As such, the outcome of the collaboration and communication moved beyond the development of the outcome (the application) to the longer-term effect of fostering an innovative culture within a traditional energy firm. This helped the energy company to perceive and actualise smart meter affordances such as customer education, customer behaviour change, and identify service innovation affordances (e.g., energy alerts), as highlighted in the following quote:

So, it was a really interesting trial. I got involved with various third parties that were in innovation around smart which was a real eye-opener for me. So, I became very much embroiled in this way of... we need to really champion this. The trial was about developing an app where you could monitor your electricity and gas usage in real-time. It was using half-hour data but it would give you a good view of what you were *spending. It was really interesting because, for instance, I was shocked at how much my electric shower would use, and you can see that in monetary value. And, over time you could see a pattern against other appliances for instance. So I would know when my mom was at home because she used to look after kids and had flung the kettle on or had put the heating on, or the tumble dryer, and so I quite quickly could see the patterns.*

(Interview 28A)

5.1.6.3 Tapping into External Competencies

Communication and collaboration capability not only enables a firm to develop competencies internally but also to pursue them externally. This can take place by capitalising on external networking opportunities and setting up partnerships with external companies. This enables an organisation to tap into competencies that would have been otherwise ineffective, inefficient, or resource-intensive to develop internally. Energy companies develop a communication and collaboration capability in order to tap into external competencies that will enable them to actualise certain smart meter affordances. The following quote highlights how GreenWorks is looking to develop a partnership with a technology company to provide them with a data insight platform that will help them actualise several service innovation affordances:

We've been looking at some partnerships with companies like [technology giant] and other people to start utilising some of their data platforms to do some appliance inputting work (...) we are trying to work very hard to understand what are the future propositions that our customers are going to want from us (...) We could look into the electricity usage at the appliance level, but you would have to have smart appliances and we would have to put some form of means by which to collect that information from those appliances, so we would have to be doing some very granular level consumption from those meters. So that might mean that we would need a different data insight platform, or we might choose to go with a third party. Because one of the benefits of going with a third party who will already have that data insight and that kind of capability to provide you with that service.

(Interview 15A)

Following on from the ideology of *"if you can't beat them, join them",* BlueHouse is considering collaborating with data giants, or technology start-ups in such a way that will enable them to fulfil their vision for the future. For example, if they were to view themselves as experts in 10-second data, an upskill in their data management and data analytics capabilities would be much needed. They could either look into developing a collaboration with a technology and data start-up or a technology and data giant. The following quote highlights how the choice of partnership will depend on the firm's strategy and vision as to what they want to become experts in, in the future:

> *Further down the line, we might consider partnering up with Amazon or Google. It depends on where we want to be and that's what we need to decide. If we're going to be experts in 10-second data and insights. How you derive value from 10-second data? Then why go to companies and ask them to do this for us.*
>
> (Interview 6B)

Interview data highlighted the idea that developing a new competency internal to an incumbent energy utility often involves a lot of bureaucracy, red tape, and organisational politics to navigate. As such, tapping into an external competency that is readily available can help avoid internal bureaucracy, politics, and the inefficiencies associated with a legacy business. As such, having a strong communication and collaboration capability is important to be able to capitalise on such opportunities by tapping into external competencies.

5.1.6.4 Promoting Business Alignment

Communication and collaboration capability helps promote business alignment between business functions. Interview data highlighted the active role that senior management play in promoting business alignment. When asked about the biggest challenge in finding and creating value from the smart meter data, one respondent highlighted that the lack of communication from a senior level about the key strategic priorities will result in a lack of collaboration between business functions due to a lack of business alignment, both of which are key in perceiving and actualising smart meter affordances:

> *It probably boils down to strategy. So, does everyone know what keeps the CEO awake at night? Does that cascade down to someone working on an I.T. system? If they know what the four or five things that are really key then I think it's a lot easier whether you work in the field and you're digging trenches or you work in facilities management, if*

> *that's at the forefront then you can articulate things more clearly and I as an architect can do my job better, so if someone comes to me with an idea and has framed it within those strategic dimensions, then I can jump on that and I know how that fits into the functional model of my applications and I can serve you better. I see a lot of scattergun approaches and people are not kind of joined up. The sales director or marketing director should have complementary goals but sometimes doesn't feel that way. So, I think there's a lot of silos, but I think if everyone joined up on where the value sits. Then it would much much better at delivering that value.*
>
> (Interview 26A)

Traditionally, an energy company's business functions would operate in siloes. Whilst that may have created functional excellence in the past, the adoption of smart meters has challenged the status quo of the efficiency and effectiveness of operating in siloes. The adoption of smart meters has required communication and collaboration between business functions to create alignment in the adoption process. Otherwise, the lack of such a capability will result in *"complete and utter chaos"* in the technology adoption process. The following quote highlights how one of how GreenWorks fostered business alignment through creating a new role in the business that manages the collaboration and communication between business functions, and manages the end-to-end technology adoption process:

> *GreenWorks does have a strong functional hierarchy which people tend to describe as silos. That stems from prior leadership behaviour. It also stems from the operating model and the way things are set up. We are now changing the way that the business operates because what you tend to find is that you end up with what I call, you develop functional excellence, but you have complete and utter chaos in any outcome that requires a series of functions to work together to deliver an output. So, we're beginning to modify the Operating Model and beginning to change the governance structure, introduce new roles, beginning to change the language and the behaviours in the business to be able to understand how functions operate alongside an end to end processes and end to end customer journeys to deliver outcomes. We've just made a very very significant change in smart. So, we've made one person, my level accountable for smart end to end. So, it doesn't matter where you are marketing, customer services, in the field (...) And so that's our first step towards the* end-to-end management of the *business.*

(Interview 17B)

Additionally, interview data highlighted that the lack of alignment between business functions can result in an ineffective development of new business opportunities. For example, BlueHouse highlighted how they tend to develop new business opportunities in isolation within their innovation function. Following which business functions such as finance, legal, brand, information security, and brand are activated on an ad-hoc basis. This can create an ineffective process for the development of new business opportunities because different functions are not aligned on the same outcomes and tend to have different KPIs. The following quote highlights how the more business functions work together, the more trust they develop, and the faster and more efficient the collaboration process becomes:

> *As soon as you come out of props or as soon as you come outside of innovation, everything just becomes slower. As soon as you have to go to legal, to finance, to information security, privacy, brand. It just gets harder and harder and harder. We are breaking down some of the barriers. So, once you gain trust it gets easier. So, brand, for example, we are now super on board, and they will say: not everything you're going to do is going to fit under BlueHouse. But we will find a way in which you can brand. Legal are again trying to get quicker. So, they have found that building contracts is really difficult. But actually, once they've done it for one venture, we can use that as a blueprint. And we can get all your other ventures up and running…They are seeing the benefits of working together, so it is getting better.*

(Interview 9B)

The more and more business functions can work together seamlessly, the more opportunities it provides to develop new propositions that would have not been possible otherwise. The following quotes highlight how bringing together different data sources, technology, resources, experiences, and perspectives enables new opportunities for proposition development in such a way that would not have been possible otherwise:

> *It is about partnering with others to create new opportunities, new propositions that aren't possible when you work in isolation. It's not just about the opportunities that we can develop on our own, with our own data, our own technology, our own resources,*

whether it's smart meters and all those kinds of things. It's also about how we bring that together with others as well to create something different and new for our customers.

(Interview 3B)

When we do a sprint, we consciously bring other people in whether they are connected or not. So, they get a flavour of how we work. We hold tech talk events, where anyone in the business can come and talk about what they do.

(Interview 9B)

This concludes the discussion on the communication and collaboration capability. In the following section, I will discuss the seventh and final key capability that enables the actualisation of smart meters affordances: strategic management capability.

5.1.7 STRATEGIC MANAGEMENT CAPABILITY

Strategic management capability is about an organisation's ability to successfully undertake action that is intended to affect its long-term growth and development (Child 1972; Lenz 1980). It is an organisation's ability to gain, sustain, and establish a competitive advantage over its rivals (Lee 2001). The following quote highlights how the energy sector is changing due to rapid technological changes and unstable regulatory frameworks. As such sustainable competitive advantage has been a challenge, which has had profound implications for the survival of existing utility firms. However, capitalising on the opportunities that come from the technological changes (e.g., smart meters) is of key importance in gaining and sustaining competitive advantage:

The energy industry is already changing. Because of the price cap, it is not competitive enough. We've seen so many small energy companies fall out. It's shifting to services. Within the wider strategy that shift was recognised last year…And I think the smart meter data will give us that foundation to create more services for customers. So, it's not just about energy it's about what we can tell, and what we can give the customer, and how can we help our customers be more in control of their energy, which is going to be key in developing services.

(Interview 6B)

While a strategic management capability can include a broad range of competencies from the knowledge base for value creation, to the capacity to generate and acquire resources, to the general management of technology (Lenz 1980; Xu et al. 2003), the focus here is on the aspects of the strategic management capability that are of relevance to the actualisation of smart meter affordances, in particular those highlighted in (Figure 25 below).

Strategic management capability is an important and key capability for smart meter affordance actualisation because it provides firms with five key actualisation enablers (see Figure 25 below). The five key actualisation enablers of strategic management capability are strategic awareness, strategic intent, strategic commitment, strategic flexibility, and strategic choice. All five aspects of a strategic management capability will be defined and described in the following four sections.

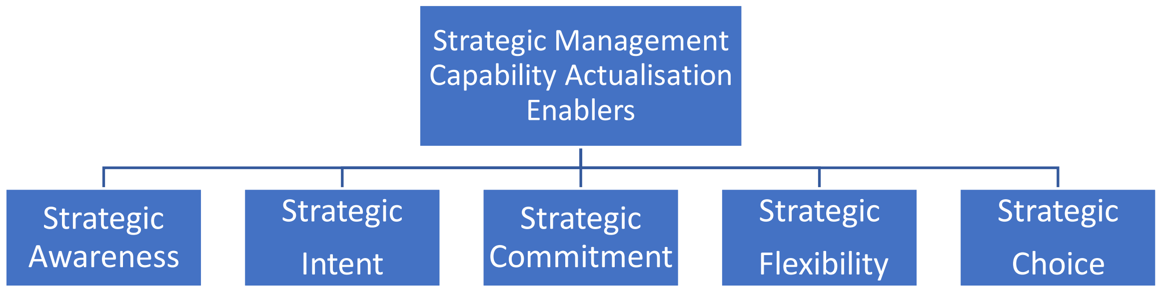

Figure 26. Strategic Management Capability Actualisation Enablers

5.1.7.1 Strategic Awareness

Strategic awareness is about the senior management's attention to - and mindfulness of - the strategic value of a new technology (Swanson and Ramiller 2004). The lack of strategic awareness can often increase business risk and can lead to the under-exploitation of a new technology (Baptista et al. 2010). Interview data highlighted that the value of smart meters can only be fully realised when energy firms move beyond viewing the smart meter adoption as a government-mandated project, towards viewing it as a business transformation that will revolutionise that way in which they operate as a business. One that will change the way in which they serve their customers, the types of product and services they offer, and make one that will make them more competitive in the landscape. The following two quotes emphasise how more attention was drawn towards the strategic awareness of smart meter value, where a mindset shift took place within the business:

> *We had a strategic meeting about November last year and started to move the thinking forward. The business very much saw this as a meter replacement program, and that was all it was about. The business was not really looking to, therefore it was just an imposed cost. So, it was just seen as: do it as quickly and as cheaply as you can because you have to. And there has been quite a mindset change now to say no, this drives future business, and actually drives the profitability of the business. Hence getting the senior management and marketing people involved, and now they have started to see it as selling smart meters actually makes money for the business. And that's a big change.*
>
> (Interview 21A)

> *It's not just about putting a meter on the wall; it rewrites the rules on how you do business and then gives you a completely different insight on your customer base which you then might be able to leverage value from.*
>
> (Interview 17A)

Strategic awareness is also about becoming aware that not fully realising the value of smart meters can increase business risk and threaten competitiveness within the marketplace, as highlighted in the following quote:

> *You get some innovative businesses out there who will start to bill their customers very differently. That's a threat to us, that's a risk to us, but also an opportunity if we can join in with that. To give our customers lower bills by providing the energy they need at different times.*
>
> (Interview 6A)

5.1.7.2 Strategic Intent

Strategic intent is *"the provision of a powerful long-term direction with particular emphasis on moving beyond the constraints imposed by current resources and capabilities"* (McGee 2015). Simply put, strategic intent is about an organisation's long-term vision for the future, which provides a focus for all members of the organisation to work towards. Informants articulated the idea that their companies are still deciding on what they want to do, and where they want to be. In other words, they are still deciding as to where they would like to position themselves strategically in the value chain; as well as their positioning in relation to data and technology firms, as articulated in the following two quotes:

> *From a strategic perspective and business perspective, we need to decide where we want to be in two years time in this space. Do we want to be upfront and doing things now? Or are we happy to just step change it up with what we are doing?*
>
> (Interview 6B)

> *The idea of where the business is going. What is the strategic outcome that the business is trying to get to? Is our primary focus cutting expenditure? Is it more operational mobile workforce? Is it more operational outcomes i.e., achieving a lot more out in the field or in achieving efficiencies of our assets? Or is it something else? Are we trying to acquire or divest in things, products, and other business? and so on.*
>
> (Interview 26A)

The adoption of smart meters and the increased digitalisation of the energy infrastructure has resulted in a shift in the competitive landscape whereby technology start-ups and data giants pose a competitive threat to energy companies:

> *The development of smart devices in the home has meant that there is a massive battle for the home going on at the moment. I don't think anybody is quite sure why they're battling for home yet and how they make money out of it. But there's something in it and everybody is going for it and you've got Amazon, Google and Energy Companies and a few others playing in that space. You've got white goods manufacturers that are beginning to produce smart fridges and all the rest. (...) you've got all sorts playing in this space you've got the big tech giants, watching waiting evolving as appropriate. You've got traditional energy suppliers like us thinking, what do we do? We've got to figure out what it is.*
>
> (Interview 17A)

> *The energy industry is already changing. I think because of the price cap it is not competitive enough. We've seen so many small energy companies fall out. I think it's shifting to services. Within the wider strategy that shift was recognised last year.*
>
> (Interview 6B)

Whilst the need to shift strategy has been recognised, the decision as to where to position themselves amongst other players in the energy, data, and technology industries remains a challenge. It seems that energy companies will not be able to pick up the speed and develop the data analytics competency internally in the same way a company like Google or Amazon would be able to. As such, they will settle for delivering services that rely on 30 minute or 10-second data frequencies. Or they may develop strategic partnerships with data and technology companies in such a way that they can deliver services that require more advanced data analytics competencies. Alternatively, they may decide to set up such a capability in an organisational subsidiary, as it is too complex to develop it within a traditional structure.

This reinforces the idea that change is difficult within a large base of legacy assets and distributed workforce steeped in the status quo. Both GreenWorks and BlueHouse seem to be taking an incremental approach towards the digitalisation of their business. However, it has been argued that those incremental approaches tend to grind out small, steady cost reductions but rarely tend to deliver breakthroughs (D'Emidio et al. 2014). In order to free themselves from legacy and status quo, BlueHouse decided to set up a technology start-up within BlueHouse Group with the autonomy to develop big data management and big data analytics as its core capabilities. This start-up was able to deliver connected home propositions, that would have otherwise impossible to deliver, had it been set up within the legacy of BlueHouse that is steeped in the status quo.

5.1.7.3 Strategic Commitment

Strategic commitment is about the long-term commitment to the adoption of a new technology by allocating enough resources, committing the best resources, and actively developing the processes necessary for the adoption of a new technology (Woiceshyn and Daellenbach 2005). The lack of strategic commitment and allocation of appropriate resources may result in a lack of business momentum to capitalise on business opportunities. As underlined in the following quote:

Our biggest issue is that we never have enough resource. We never have enough funding. You go to any innovation seminar and they always say that they have ring-fenced money to go out and do what they want. And we are here fighting against every other department in the business. And we [innovation accelerator] inevitably have a less worthwhile business case or business. Our ROI is either five years longer than everyone else or it's higher risk or it's going to pay backless. So, we have to stand up and fight against things like energy tariffs which are a given 5% margin, which will have an ROI within a year.

(Interview 9B)

Strategic commitment is not only about the commitment towards resources but also a commitment towards developing the processes, culture, and capabilities that enable the organisation to capitalise on the opportunities available to them from smart meters whether that be in the short, medium, or long term. The following quote highlights how the lack of strategic commitment at GreenWorks towards developing a smart customer application beyond the trial phase has resulted in them falling behind the competition in the space of customer experience:

It's fair to say the business has dabbled in this stuff and we've not for whatever reason made a commitment to it and now we're behind all of our competitors in that space. It's the biggest experience gap that we've got. So, if we're pushing subtly the digital team to look at that (…) we ran up a pilot with an app for a year, and customers loved it. We did develop an app but only for a pilot route (…) Did it make a difference to the way that they use their energy? Yes. Because it was just much more engaging was the consensus.

(Interview 23)

Strategic commitment is important in underpinning the actualisation of smart meter affordances because it emphasises the focus on the long-term orientation of a business. The following quote highlights how despite having the necessary know-how, BlueHouse were reluctant to branch out into the electric vehicle market because of the many unknowns. This presented them with a missed opportunity to enter the market at an early stage:

It's a risk. Because right now we are looking to invest in EVs space, we can see big companies are doing it, but we still don't know how profitable it is. So, the biggest *challenge for us is to know: Is it profitable? How much money are we going to make out of it? and is it worth the effort? Because installing all those charging points. It's a lot. We have the capability to do it because we used to do it a few years ago. So, we know how to do it. We have the capabilities we have the engineering fleet we have everything. So, we could do it, but it needs more studying. And currently, we are looking into our options, but nothing determined for sure yet.*

(Interview 5B)

5.1.7.4 Strategic Flexibility

Strategic flexibility is a firm's ability to be proactive or respond quickly to changing conditions, with a wide variety of different internal and external options (Herhausen et al. 2020). Contrary to the term "strategic flexibility" is the term "strategic rigidity", whereby an organisation is resistant to change because it is operating in a habitual mode of functioning (Langley and Truax 1994), and as a result, will be reluctant and slow in adopting new technologies (Nisar et al 2013). Interview data highlights how strategic rigidity and a subsequentlack of strategic flexibility can result in missed opportunities that would have been otherwise profitable had they been pursued and actualised. The following quote highlights how a business proposition that was potentially profitable was turned down by the business due to lack of fit and alignment and hence created an adverse reaction:

We have a couple of... I'm going to call them corporate failures so products that have been brilliant products, and the whole point of how we work is desirability, feasibility, viability. We had a product which was a massive win in desirability. So, we believe that a 6% conversion rate is good. This product got 20%. And then once we took the website down had a viral effect of 7% so it got shared on social media. We've never seen that before. And unfortunately, though it was in short term loans and the business had quite an adverse reaction to going into short term loans. So, we pushed it forward. Through feasibility to see if we could actually do it. We said to the business: we get your concerns but it's unbranded. It's just a trial to 900 customers, we're going to do anyway and just see if we can do it. And then it turned into a massive slug, and it turned an MVP [Minimum Viable Product] which we were hoping to get out in six months into a year-long over budget project which we decided last week to call it a day on this one. Because it's no longer lean, it's no longer agile.

(Interview 9B)

5.1.7.5 Strategic Choice

Strategic choice is about the adoption of courses of action and allocation of resources to achieve a specific organisational goal (Child 1972). In order to capitalise on the adoption of smart meters, an organisation may need to redefine their basic goals, whereby senior management must facilitate perusing the opportunities afforded to them by new technologies (Cottam et al 2001). Strategic choice is very much driven by a strategic awareness regarding the value of a new technology. Strategic choice is often carried out by the power-holding group in an organisation (i.e., senior leadership); whereas the implementation of the strategic choice will require collective action from various individuals and business functions and relies quite heavily on securing the cooperation of different parties involved (Child 1972). Hence, it requires a combination of communication and collaboration capability and strategic management capability to deliver on the strategic choices within an organisation.

Interview data pointed to the importance of strategic choice on both the long-term and short-term orientation of the business. The following three quotes highlight two key strategic choices that BlueHouse undertook. The first is in relation to integrating smart meter data within an already existing billing platform. The second is in relation to setting up their innovation and technology capabilities in the form of a spin-off start-up called “Connected Home” within BlueHouse Group:

> *The biggest challenge is to connect an old system with something new that is built in a very different way and then connect them. There are other ways you can do this. So, one thing you could do is you could build a smart billing platform. You just separate it from your current billing system. You can put a billing system in place that's just secure on smart. Then you can say right if you are a smart customer, you are in this billing system. If you are an old meter customer, you are in this billing system. And then eventually they'll all sort of move over.*

(Interview 15B)

> *You have got to make the call. Because you've spent so much money on the rollout. You've paid all these fines because Ofgem are still fining you for not installing enough*

meters in customers' homes… so you spend all this money and after all this customer engagement. And then you now have to spend money on the whole billing platform. So what do you do? Do you put it into an existing billing system which is cheap, or do you spend the money and build a bigger architecture? Which is more expensive. We have chosen to use our existing systems. All our customers are in one place.

(Interview 15B)

This was an active choice where BlueHouse Group chose to build a separate connected home infrastructure through Connected Home but not have that talk to the smart metering infrastructure. So today we've got the smart meters and you've got Connected Home. You are running on two different ecosystems. You are dealing with two different groups of people and the systems can't talk to each other. So really that sort of connected home vision that Smart had was never fully realised. By not being able to fully leverage the smart data and use that to create sort of products based on that.

(Interview 14B)

The first strategic choice creates challenges and has implications in terms of the effectiveness of systems integration in the long term. However, this decision was made because it was the more cost-effective option over investing in a new smart billing system. Despite the value that the new smart system might bring, cost-effectiveness was viewed as more important.

The second strategic choice creates challenges and has implications in terms of accessing a technology and innovation capability by BlueHouse, because Connected Home and BlueHouse are running in two different ecosystems. However, this decision was driven by the desire to capitalise on the efficiencies of a start-up business in setting up a new technology solution away from legacy platforms and a traditionally siloed business.

Similarly, to BlueHouse, GreenWorks, also made the strategic choice to maintain their current customer service system, as opposed to investing in a new smart customer service system. Despite the old system creating constraints around system and process integration, GreenWorks, decided to maintain their legacy system because it was the most cost-effective for the business at the time:

> *So we got a customer service system I mentioned earlier is a homebrew, took years and years to build (…) But now we're in a landscape where actually that's part of our legacy and not many people understand the true in-depth logic of how that runs (…) do you conform to the system and it gives you the constraints and you kind of change your business process with it or do you try and come up with something new, a different way of working.*
>
> (Interview 26A)

Another example of a strategic choice at GreenWorks is the decision to set up an enterprise architecture function. The aim of this function was to enable the use technology solutions to achieve business goals and create better alignment between IT and business functions. Prior to the enterprise architecture function being set-up, the IT function would create business solutions in isolation without fully understanding its use or impact in the wider business. Whereas, with the enterprise architecture function it promoted lateral thinking between IT and business to help drive IT-enabled organisational change. As highlighted in the following quote:

> *The days I spent working in IT, we were cribbed in a little bubble where we were doing IT stuff, but we didn't really know how it's used in the wider business (...) later on, the business had created an enterprise architecture function which is all about IT-enabled change. What's the optimal portfolio of applications and technologies that you can have to achieve your business goals (…) it's about lateral thinking so we need to think about what's the outcome the business is trying to get to and what's the best way to get there.*
>
> (Interview 26A)

This concludes the section on strategic management capability. In the following sections, I will discuss the idea of capability path dependency.

5.1.8 CAPABILITY PATH DEPENDENCY

A key aspect emerging from these findings is the idea of capability path dependency. This research argues that organisational capabilities are path dependant and relational to one another, in the same way that organisational affordances are. In other words, the development and embedding of one organisational capability is dependent on the development of a different/complementary organisational capability. Whilst in the previous seven sections

(Section 5.1.1 – 5.1.7), I have presented the organisational capabilities as conceptually and empirically distinct, it is worth noting that they are in fact interconnected, relational, and path dependant. To demonstrate this idea, the findings have highlighted the idea that to have an effective big data analytics capability (techniques used to analyse and acquire intelligence from big data), an organisation must rely on their big data management capability (the processes and supporting technologies to acquire, store, prepare and retrieve data for analysis). For a big data analytics capability to start to take shape, a big data management capability needs to be established beforehand. If the data collection and storage is not sorted out, an energy company will not be able to run sophisticated analysis on their data.

To give another example, the findings have highlighted the path dependency of the innovation capability on complementary organisational capabilities such as big data management, big data analytics, and technology adoption. An innovation capability can only materialise when the processes for data collection and analysis are set up. In other words, it is essential that customers agree to have a smart meter installed (technology adoption), for the smart meter data to flow seamlessly to the energy firm (big data management), and for the energy firm to be able to collect, store, and analyse smart meter data in an effective way (big data analytics). All of which enables them to build new business propositions (innovation capability) that are derived from smart data insights (e.g., energy alerts). Not having the appropriate investment in technology adoption, big data management, and big data analytics capabilities will result in innovation opportunities not fully materialising. The findings highlighted the example of BlueHouse having the aspiration to launch a 'free energy on weekends' tariff to change energy consumption behaviour from peak hours on weekdays to non-peak hours on weekends. Because they did not have the appropriate and suitable big data management and analytics capabilities to store, process, and analyse the granular data they needed, they were only able to give customers a percentage off their bill, as opposed to deducting the actual energy consumption on the weekend from the total bill. Whereas Purple Energy were able to actualise customer behaviour change affordance because they had made the appropriate investments to develop the complementary capabilities.

One final example that the findings highlighted on capability path dependency is that having a strong communication and collaboration capability will be dependent on building a strong customer engagement and communication capability. Through communication and collaboration, an organisation can become better at overcoming siloes by reaching a better understanding of the end-to-end customer experience process, which in turn can build a stronger customer engagement and communication capability.

Another pertinent findings is the idea that in order to actualise a smart meter affordance, an organisation requires a combination of organisational capabilities. Often, developing or investing in a single organisational capability will result in an ineffective or partial actualisation of a smart meter affordance. Or worse, a failure to actualise a smart meter affordance altogether. Therefore, organisations require several organisational capabilities at once in order to actualise smart meter affordances. An example is represented by one service innovation affordance (automated appliance use), whereby electrical appliances in the home (e.g., washing machine, dishwasher, electric vehicle charging) are automatically managed by what is called the "home brain". This enables a customer to turn their appliances on, and for them to automatically run when it is most efficient to run (cheapest energy; grid has capacity). To actualise this service innovation affordances, an energy firm would first need to invest in the technology adoption capability to install a smart meter in a customer's home. Then, it would need to invest in the big data management capability to store the granular energy consumption data from the smart meter. Then, it would need to invest in the big data analytics capability to disaggregate appliance usage signals from the total energy consumption data. Finally, they would need to invest in an innovation capability to conceptualise, experiment, and commercialise the 'home brain' business proposition, before this can become a new service offering for their customers. This example showcases the need for a combination of technical capabilities (technology adoption, big data management, big data analytics) as well as non-technical capabilities (innovation capability) to be able to actualise on a single organisation-level smart meter affordance.

To give another example, to actualise half-hourly settlement, energy companies would need to invest in a technology adoption capability to install a smart meter in a customer's home. Then, they would need to invest in big data management and big data analytics to store and analyse energy consumption data and energy pricing data. Following this, they would need to invest in customer engagement and communication capability to educate and inform customers about this new way of billing. And, above all, they would need to invest in their strategic management capability that makes this affordance a strategic priority and mobilises the resources needed to actualise such affordance.

This concludes the second of three chapters on research findings, aimed at answering the second key research question of: *What are the key organisational capabilities that enable smart meter affordances actualisation? And how do they enable the actualisation process?* Figure 26 below provides a summary of these findings on organisational capabilities. In the following chapter, I will discuss the third and final set of research findings: the generative mechanisms that enable or constrain the actualisation of smart meter affordances.

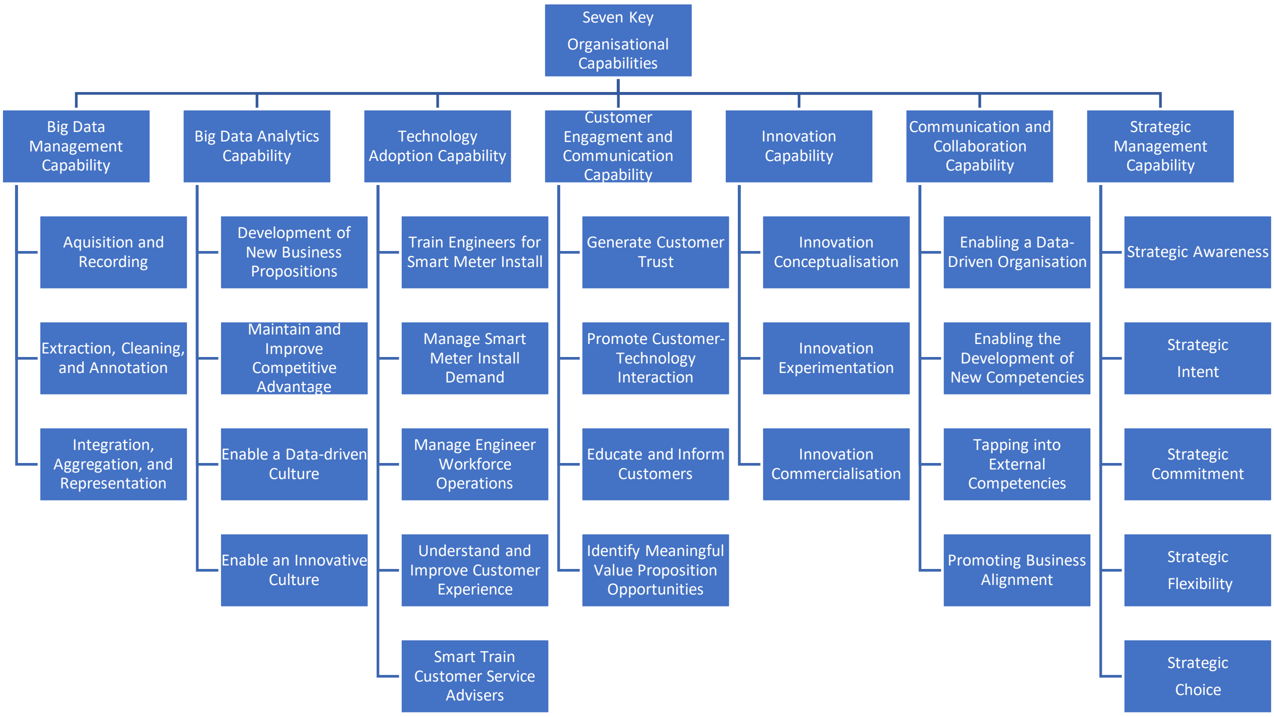

Figure 27. Organisational Capabilities and Actualisation Enablers of Smart Meter Affordance Actualisation

CHAPTER SIX

6 FINDINGS III: The Generative Mechanisms that Enable or Constrain the Smart Meter Affordance Actualisation Process

6.1 What are Generative Mechanisms?

"Good theory should help us explicate the ***generative mechanisms*** *that underlie the phenomena we observe."*

(Tsoukas 1989)

Generative mechanisms are the causal structures that explain the empirical outcomes (Bygstad et al. 2016). Generative mechanisms are hidden from our direct experience of the world but are essential to our explanation of how and why social phenomena emerge (or does not emerge) in a complex and interrelated world (Sayer 2000). Whilst researchers cannot directly view the generative mechanisms that cause the events they observe, they can retroduce what those mechanisms might be based on the researcher's observations of events and relationships among them (Volkoff and Strong 2017). This chapter aims at explaining why smart meter affordances are not actualised despite organisations having the necessary capabilities for affordance actualisation. I do so by abstracting the generative mechanisms that enable and/or constrain the affordance actualisation process. Following a process of retroduction, corroboration, iteration, and the linking of affordances and capabilities into strands, I identify four key generative mechanisms that – for the most part – constrain the affordance actualisation process, and they include: organisational immune system, siloed organisational structure, organisational legacy, and prevention driven regulatory focus. In the following four sections, I will conceptualise, describe, and discuss each of these generative mechanisms by highlighting the empirical outcomes for each generative mechanism.

6.1.1 ORGANISATIONAL IMMUNE SYSTEM

The first generative mechanism is labelled as the "organisational immune system". The organisational immune system is comprised of *"the people, policies, procedures, processes, and culture it creates to prevent change, regardless of the consequences"*(Gilley et al. 2011).

It indicates an organisation's automatic response to resist change in order to preserve and protect the status quo (Seel 2000). In the same way a human immune system rejects every foreign pathogen that threatens its existence by fighting off these pathogens, the organisational immune system rejects every new element or idea that threatens its existence or status quo by fighting off the external force that threatens its current state of operation. In the same way a human immune system exists to protect it from external viruses and bacteria, an organisational immune system exists to protect it from external forces for change. Because each organisational immune system is unique - by being internally developed over years of existence - it can protect it from being imitated by others. However, it does act as a barrier towards business change and innovation (Johannessen 1998). The following two quotes highlight how the organisational immune system can constrain an organisation's ability to actualise on smart meter affordances:

> *People need to change, and they aren't. So, we're trying to manage this technology with the old stuff in place, and it's not quite coming together.*
>
> (Interview 24A)

> *When you're working in an old incumbent, (...) people have worked here for a very long time. They know how it's done and they don't want to change.*
>
> (Interview 15B)

In the empirical data, the organisational immune system manifests itself as three key empirical outcomes. First, by protecting existing business functions. Second, by protecting the core business. Third, by compartmentalising business change. All three will be described and discussed in the following three sections.

6.1.1.1 Protect Existing Business Functions

Organisational immune system manifests itself is in the form of protecting existing business functions in their current operating state. The following two quotes highlight how if an organisation were to fully realise the value creation potential of smart meters, many of its current business functions would cease to exist (e.g., billing, customer service, credit collection). As such, and because there is a fear of losing business functions that have been built and have existed for years, the potential business value creation afforded to them from the adoption of smart meters is not fully embraced and realised, despite them being perceived as potentially "value-adding" to the business. The following two quotes highlight how by fully utilising the value of smart, the billing function in an energy company can be – but is not - fully automated:

> *You could say that we won't need anyone in this building if you implement the process of remote switching between modes, where customers who don't pay their bills are automatically switched to pay as you go mode. (...) but we haven't really maximised the potential of smart.*
>
> (Interview 13A)

> *If we are entering a more digital world where information is more real-time and live, we can start to bill customers monthly, or weekly, or even instantly, in real-time (...) If we fully digitise our business and we have the apps, systems, and present data in real-time and there's no delay in transmission of it. Then billing almost becomes irrelevant because we have the money coming out of the customer's account every 10 minutes as they use it. Automatically. At one extreme, so it opens up those possibilities.*
>
> (Interview 17A)

6.1.1.2 Protect Core Business

Organisational immune system emerges in the form of protecting the core business. In other words, protecting what the business is good at and best known for at this current time. The following quote underlines how utilising smart meter data, in particular, 30-minute data provides a threat to the core business. As such, it activates an automatic organisational immune system response to resist this business opportunity because it changes the core business. However, the additional technology investment to gain access to energy consumption data at 10-second does not change the core business but helps diversity it. As a result, it tends to be faced with less resistance, as highlighted in the following quote:

> *Where your I.T. changes the business. I think perhaps one of the most interesting things is the difference between how we can handle and work with 10-second data and how we can handle and work with half-hourly data. Because of the regulating side and the pricing side and the business strategy side, the half-hourly data actually impacts the*

core of the business therefore there's a lot of resistance. Whereas with the 10-second data, it is the way we can diversify our business and therefore there's less resistance there! You can basically come up with products because everything is an opportunity.

(Interview 15B)

In order to protect their core business, BlueHouse decided to keep the costly operational process of smart meter installation in-house. The decision to keep the process in-house was in line with BlueHouse's core business. After all, they view their engineer workforce as their core competency, their shop front, and their biggest trust generator, as clearly articulated by one respondent: *"They are like our shopfront. We know we've got these reliable and trained engineers"* (Interview 6B). As such, the decision to keep a costly operational process in-house was to protect their core business.

6.1.1.3 Compartmentalise Technology Adoption

The organisational immune system manifests itself in the form of compartmentalising technology adoption. This meant that the adoption of smart meters took place in a compartmentalised fashion (in the form of projects), as opposed to being integrated into the business as a whole (in the form of an organisation-wide digital transformation initiative). This resulted in employees who were part of the smart meter projects being involved in the change. Whereas, employees who were not part of the smart meter projects were not involved in the change and knew very little about it. The following three quotes emphasise this idea, and showcase how the compartmentalisation of technology adoption creates challenges towards the seamless integration of smart meters and constrains an organisation's ability to perceive and actualise smart meter affordances:

I found we were making changes at the same time the heritage business was simultaneously making a different change. So, we were trying to land on their old processes smart, where they had already changed. So now we're trying to hit a moving target in terms of change. And that was really difficult, and it was really hard to organise. We found that we weren't in skew with projects, or we weren't being considered as part of their change. And that was problematic.

(Interview 1A)

We are still in project mode with smart and we are rolling out with SMETS2 at the minute. So it's still being seen very much as a program rather than business as usual. So that's probably quite an interesting observation because at some point we need to try to get our heads around the fact that smart is just going to be business as usual. We are going to have less and less heritage meters. But I think it's still being seen very much in isolation. And I don't think in all honesty that we've embraced the opportunity of smart. There are pockets of people involved but it's not being looked at as one holistic piece.

(Interview 23A)

The problem is at the moment we're living in three worlds. We live in a traditional world which is split up into different sections, you've got credit customers, you have pre-payment customers, you have gas customers, you've got electricity customers, and we've got our other products that we do as GreenWorks. So, there's a lot in that, but we do it very well. That's our bread and butter. Then we have our SMETS1, which is a huge portfolio, not hugely different from traditional but it has its own processes attached to it. And then we've got SMETS2, and SMETS3 into what's possibly coming in the future and we've got everything to do with that. As an organisation, we have to cope with all three. In the long term they will all be one, but it's that evolution of keeping the lights on and keeping customers happy in that world not letting them be forgotten or get a worse level of service or any of that, and then managing the smart meter program and install and the DCC, and it's managing those three is challenging. And the only way you can really do it is to keep them separate at the moment.

(Interview 16A)

In order to manage the organisational immune system, Seel (2000) argues that senior management have a significant role to play in acting as an immuno-suppressants by trying to damp down the resistance to change and to help nurture new behaviours. Otherwise, the organisational immune system would result in ineffective and disjointed efforts to technology adoption and organisational change.

6.1.2 SILOED ORGANISATIONAL STRUCTURE

The second generative mechanism emerging from the analysis of interview data is labelled as "siloed organisational structure". Siloed organisational structure is where an organisational unit contains its own talent and management team, and lacks the motivation and desire to work and communicate with other organisational units (Aaker 2008, p.2). With knowledge and expertise being housed within organisational siloes, organisations can have trouble serving their organisational goals that require them to harness resources that transcend beyond organisational siloes (Gulati 2007). As highlighted in the following two quotes:

> *Trying to cut across those silos is difficult. And understanding where the value is, who should you target, who should you look to work with is difficult.*
>
> (Interview 4B)

> *The challenge is what's usually against the backdrop of a landscape. So, we have a lot of legacy applications, we might have business units that don't necessarily talk to each other (…) we're kind of fractured and splintered and all that kind of stuff.*
>
> (Interview 26A)

In the empirical data, siloed organisational structure manifests itself as two key empirical outcomes. First, by constraining communication and collaboration across functions. Second, by constraining data sharing and integration. Both of which will be described and discussed in the following two sections.

6.1.2.1 Constrain Communication and Collaboration Across Functions

A siloed organisational structure can constrain an organisation's ability to communicate and collaborate across business functions. But, communication and collaboration is a necessary and important capability for the actualisation of many smart meter affordances. The following two quotes highlight how siloed business functions result in a misalignment across business functions, and an ineffective organisational adoption of smart meters:

> *GreenWorks does have a strong functional hierarchy which people tend to describe as silos. That stems from prior leadership behaviour. It also stems from the operating model and the way things are set up. We are now changing the way that the business operates because what you tend to find is that you end up with what I call, functional*

excellence, but you have complete and utter chaos in any outcome that requires a series of functions to work together to deliver an output. So, we're beginning to modify the Operating Model and beginning to change the governance structure, introduce new roles, beginning to change the language and the behaviours in the business to be able to understand how functions operate alongside an end to end processes and end to end customer journeys to deliver outcomes.

(Interview 17B)

I think the challenge right now is that we as a business we have a metering business that is trying to install the meters, but it's not aligned necessarily with our products, and our tariffs, propositions, people. I think there's lots of reasons why to some extent we think we can muddle along without solving the smart issue I would say. I don't think we fully understand as a business about what value it's bringing it or potentially what cost it's bringing as well.

(Interview 14B)

6.1.2.2 Constrain Data Sharing and Integration

A siloed organisational structure can constrain an organisations ability to share and integrate data across business functions. Data sharing and integration are both necessary and important for the actualisation of many smart meter affordances. The following two quotes highlight how a siloed organisational structure means that business functions can only have access to a small percentage of data about the customers that they manage, which can create challenges for understanding the end-to-end customer journey:

There are different areas of the business that look after different types of customers, and primarily the customer level information is within our customer service system. But when we take smart meter data, it is stored within another system. So we're not necessarily able to put the two together at this point in time which is the work which we are trying to do.

(Interview 23A)

I think the challenge we've got in GreenWorks in relation to data is that we've got a corporate culture of "you can only see your slice of the pie". For example, my team *can only see 15% of the customer base (…) So if you are a customer and you build up a credit in the winter you disappear from what I can see, even though you're still 3,000 pounds in debt. We have been waiting four months for somebody to come back and do the analytics on the full data that we've done on that (…) so I used that as an example to show you the approach to data.*

(Interview 13A)

6.1.3 ORGANISATIONAL LEGACY

"*Unless a company is led by people who embrace innovation and change, it will remain in a* ***legacy state****.*"

(Philip Hillenbrand)

The third generative mechanism is labelled as "organisational legacy". Organisational legacy is about an organisation's inherited and existing technology, processes, culture, and mindsets (Hillenbrand 2019). Organisational legacy carries with it institutionalised practices that organisational members accept and approve of (Feldman et al. 2019). Efforts to adopt a new technology (e.g., smart meters) and foster innovation at established companies often run into challenges from the inherited organisational legacy that can represent often outdated technology, processes, culture, and mindsets (Hillenbrand 2019). The following quote highlights how organisational legacy as a generative mechanism can create challenges for organisational change:

Evolution is a challenge. We've done things the same way for a long time, it gets embedded and ingrained within our ways of working. And this is a massive change and an evolution.

(Interview 16A)

In the empirical data, organisational legacy manifests itself as four key empirical outcomes. First, by constraining capability development. Second, by constraining new systems adoption. Third, by constraining business diversification. Fourth, by enabling a risk-averse culture. All four will be described and discussed in the following four sections.

6.1.3.1 Constrain Capability Development

Organisational legacy can constrain the development of new organisational capabilities. However, the development of new organisational capabilities is necessary for the actualisation of many smart meter affordances. The following two quotes highlight how as a business, GreenWorks is being described as being “old fashioned”, “poor at selling”, and “not a learning organisation”. These institutionalised and inherited practices can stand in the way of developing new and meaningful capabilities such as big data management capability, big data analytics capability, innovation capability, or customer engagement and communication capability that enable an organisation to become “a learning organisation”, or to become “good at selling”. The following two quotes highlight this idea:

> *… if we were Amazon or one of those types of organisations, I think it would be incredibly useful to understand a bit more about our customers and to be able to communicate with them. But we are not. We are a very, very old fashioned, antiquated organisation that is very, very poor at selling. We've always been poor selling. We were almost frightened of it. So, our ability to look at customers usage and think, I wonder if that customer could do with a new boiler because they are spending so much money on their gas or something like that. We are very poor at that.*
>
> (Interview 6A)

> *It was a pilot. We run it for a year and the point was to see whether or not the use of an app would help customers to reduce the amount of energy that they used. There were loads of learnings from it and we are starting to look at them again now, because my fear is that they've just been lost within the business. And that's part of one of the challenges that we've got is that we're not a learning organisation, and I am sure I am not the only one to say this. We've got some good stuff there and we've not embraced it.*
>
> (Interview 23A)

6.1.3.2 Constrain New Systems Adoption

Organisational legacy can manifest itself is in the form of having legacy systems that constrain the adoption of new systems. Legacy systems are “*old processes, technology, computer systems, or application programs that continue to be used, typically because they still function for the users’ needs, even though newer technology or more efficient processes of performing a task are now available”* (Jha et al. 2020, p.2). Interview data highlighted that legacy systems that have been part of the business for a very long time have become difficult to change, move, or replace. This can create challenges for adopting new systems that are necessary for the actualisation of smart meter affordances:

> *We have got a customer service system I mentioned earlier is a homebrew. It took years and years to build (...) but now we're in a landscape where actually that's part of our legacy and not many people understand the true in-depth logic of how that runs. It's a complex beast written in an ancient language. So that's kind of a millstone. It features in the landscape as something that is an immovable object. People have tried to move and it's very, very difficult (...) it is now cumbersome and slow to change.*
>
> (Interview 26A)

6.1.3.3 Constrain Business Diversification

Organisational legacy can manifest itself in the form of resisting business diversification opportunities that are not well aligned with the core business. The following quote highlights how a business diversification opportunity that proved to be profitable was rejected by the business because of its misalignment with the core business. Specifically, the business diversification opportunity in financial services was not deemed in line with the core business of - energy trading:

> *We have a couple of... I'm going to call them corporate failures so products that have been brilliant products, and the whole point of how we work is desirability, feasibility, viability. We had a product which was a massive win in desirability. So we believe that a 6% conversion rate is good. This product got 20%. And then once we took the website down. It had a viral effect of 7% so it got shared on social media. We've never seen that before. And unfortunately, though it was in short term loans, the business had quite an adverse reaction to going into short term loans. So, we pushed it forward. Through feasibility to see if we could actually do it. We said to the business: we get your concerns but it's unbranded. It's just a trial to 900 customers, we're going to do anyway and just see if we can do it. And then it turned into a massive slug and it turned an MVP [Minimum Viable Product] which we were hoping to get out in six months into a yearlong over-budget project which we decided last week to call it a day on this one. Because it's no longer lean, it's no longer agile.*

(Interview 9B)

6.1.3.4 Enable Risk Aversion Culture

Organisational legacy can manifest itself in the form of promoting a culture of risk aversion. Interview data highlighted that organisational legacy carries with it institutionalised practices whereby organisational members accept and approve such as the "fear of failure". The following two quotes highlight how the culture of risk aversion overrides the desire to experiment, innovate, and learn from failures, and can result in missed opportunities for organisational growth and business diversification:

> *Personally, I don't think as a business we're always great at failing. If there's any sniff of something not working, we are like "no, we are not doing that anymore". Whereas actually, we are a big company, and in some instances, we've got the money to be able to do it. Because all sorts of projects come in, and as soon as there is a slight sniff of them going into the negative, they get shut down.*

(Interview 11B)

> *Only now are we looking at how we can extract business value from the data. But one of the things with this is that the biggest difference in my view between a large company and a small company is that within the small tech company you write the product first and then you write the business case afterwards. You can play with the data. You see what you can get out of it and then you market. In a large company, the egg has to come before the chicken. You have to have the business case. How much money you're going to save? How much money you're going to make? How is this product is going to test with customers? before you've actually built it.*

(Interview 15B)

6.1.4 PREVENTION DRIVEN REGULATORY FOCUS

The fourth generative mechanism is labelled as "prevention driven regulatory focus". Regulatory focus theory indicates that there are two key ways in which people regulate their cognition and behaviour in order to pursue their goals: promotion focus, and prevention focus (Brockner and Higgins 2001). Promotion focus regulation strives for *reaching a desirable end* *state* through advancement and accomplishment, whereas prevention focus strives for *avoiding an undesirable state* through being vigilant and responsible (Brockner et al. 2004). Research suggests that promotion and prevention focus are uniquely related to work behaviours such as productivity, innovation, and safety adherence (Lanaj et al. 2012). For example, prevention focus has a strong positive relationship with safety behaviour, whereas promotion focus has a weak negative relationship with safety behaviour (Wallace and Chen 2006).

Interview data suggests that the regulatory focus of both BlueHouse and GreenWorks is a prevention driven one, whereby the adoption of smart meters in the energy sector is driven by a desire to *"avoid an undesirable state"*, namely the fines associated with non-compliance. This idea is highlighted in the following four quotes, whereby the emphasis is on compliance with regulation and getting the numbers of smart meters installed:

> *This is, we are mandated to do this. And that was really the starting point rather than actually what can we do, what is the value that we can get from this data.*
>
> (Interview 14B)

> *We've got zero tolerance with anything which is putting us in non-compliance (…) We will do whatever we need to do to make sure that we remain compliant.*
>
> (Interview 5A)

> *… right now we are single-mindedly focused on getting the numbers of meters on the wall because that's what we're mandated to do by the government and the penalties are huge.*
>
> (Interview 12B)

> *The smart meter journey rollout has really been a technology led rollout. So, it's been driven by a requirement to have a certain number of meters in at a point in time. It's been very much driven by developing the technology and deploying the technology (…) the intention always was to make sure that the most number of meters went out as quickly as possible.*
>
> (Interview 14A)

In the empirical data, prevention driven regulatory focus manifests itself as two key empirical outcomes. First, by reinforcing an operational focus. Second, by constraining the development of new organisational capabilities. Both of which will be described and discussed in the following two sections.

6.1.4.1 Enable Operational Focus

Prevention driven regulatory focus manifests itself is in the form of an operational focus of the smart meter adoption. One informant described the operational focus as "*All the time there's a regulatory absolute must-do stuff, the nice to haves tend to fall away"* (Interview 1A). Energy companies will be fined for not installing enough smart meters but will not be fined for not developing capabilities that will improve their efficiency and assist in innovative activities. As such, their focus is on the operational side of installing smart meters as opposed to the strategic side in terms of the value creation potential of what smart meters can provide. As highlighted in the following quote:

> *I've been working in smart for 10 years. It's been more about looking at and monitoring our progress against the set objectives and the observations that we've got. And then looking at which customers we want to engage with at any particular time. Our entire target to deliver smart to as many customers as we can. It's less about looking at once we've got the meter on the wall what do we do with it.*
>
> (Interview 13B)

Having an operational focus means that energy companies will focus on developing a technology adoption capability over all other complementary and necessary organisational capabilities for affordance actualisation. The following two quotes highlight how the priority is given to developing a technology adoption capability as opposed to a big data management capability:

> *The biggest issue with smart meters… and I think it's actually quite similar in other companies… is that the energy companies have rolled these things out. We manage our own installation, our own services. Because we have that expertise within the business. We were one of the earliest adopters but what didn't happen until much, much later is that nobody built the IT platform to handle the data.*

(Interview 15B)

There are not very many large energy companies that leverage the power of this data. And so, I could immediately see what the power was. The harder thing is because it has to come from a regulatory position is that nobody wants to spend the money on the IT infrastructure because they've already spent the money for the regulator. They've already put the smart meters on the wall. They've already paid the fines because they're not putting enough smart meters on the wall.

(Interview 15B)

Whilst business motivations of improving efficiency, protecting market share, assisting in innovative activities, and increasing productivity and profitability are important (DeLone and McLean 1992), they are viewed as secondary or less important to comply with the regulatory requirements. As highlighted in the following quote:

If a project is smart enduring, a lot the value is we won't get fined, and it's about meeting the regulation needs. But I do encourage my team to say that's fine but while we're building, what value can we drive into the business anyway? Are there any savings? Is there any benefit at all?

(Interview 24A)

6.1.4.2 Constrain Capability Development

A prevention driven regulatory manifests itself in the form of constraining an organisation from developing new organisational capabilities. This is important because organisations need to build new organisational capabilities to actualise smart meter affordances. The findings of this study have shed light on the prevention driven regulatory focus constraining the development of three key organisational capabilities: big data management capability, innovation capability, and communication and collaboration capability.

In the first instance, the following two quotes highlight how energy companies are having to focus on the operational investments as opposed to the strategic ones. As such they are investing in operational capabilities such as technology adoption, as opposed to strategic capabilities such as innovation, big data management, big data analytics. As a result, they are less able to actualise a range of smart meter affordances, due to the lack of organisational capabilities to do so:

> *The challenge at the moment is there is so much regulation on the industry particularly with things like price caps. Energy suppliers don't have money to invest in diversification. So for most energy companies and this is true of GreenWorks, the focus is on reducing cost because our profits have been slashed so much by the price cap. The main thing is to try and reduce costs in the business and unfortunately reducing cost in the business does not lead itself well to investing in a new business areas. So that's the challenge you've got smart being rolled out coming at a very high cost and you've got price caps and other regulated positions that and has meant that we are not in the right place to really be strategic at the moment.*
>
> (Interview 27A)

> *It's a massive, massive opportunity that we've not exploited because of the fact that it's mandated by the government, it is seen as a project. We've not quite embraced that opportunity. But the opportunity is greater transparency in customer data, sharing of customer data, using customer data to help inform the customer to create trust in the industry and accurate bills. It really is a massive opportunity. It's being seen as a problem I would suppose by some because of the complexity in how we operate. I don't think it is in itself.*
>
> (Interview 23A)

In the second instance, the following two quotes highlight how the prevention driven regulatory focus has meant that an organisation with limited resources tends to choose to use their limited resources to run their operational “must do” or “must-have” activities, whereas innovation activities are viewed as a “nice to have” activities:

> *As much as we try and drive innovation and want to do all these fun things. Us and other suppliers are in one dilemma, we only have so much money we can spend every year (…) The problem we have is: to get a benefit from smart will cost money and while we're still trying to deliver smart and meet mandates and these really hard pressures. The desire is there, the ability of us to do it is there but the budget isn't. Until we get*

the smart technology basically out there and at least accepted by the 50 per cent of customers, then we can invest in innovation. That's where I think our dilemma is, we only have so much money and so much time. ***Today is about spending our money and time on delivering the must, the mandate, and we will worry about innovation later.***

(Interview 24A)

We have our targets which get negotiated in an agreement with Ofgem (Office of Gas and Electricity Markets) as to what percentage of our customers will have a smart meter by the end of 2020. So, there is a role there to ensure our agreed target is met. I think more fundamentally, product innovation is the key challenge for us as a business. I don't think we fully are behind it because we don't have a compelling offer. So in the short to medium term as a business before we get into the advanced use of data, we should land what value do we see from a smart meter customer and we should have a product designed to make it more appealing to a customer (…) But the drive very much is to get the volume of meters in. We follow the path of least resistance to get them in. But it means that we're having to accept some challenges and some issues with the processes just because we have to resolve issues as we go along. That might be our reality, but it doesn't help build confidence to build products and offers which we might not be able to fully support currently.

(Interview 14A)

Interview data highlighted that whilst the desire to pursue innovation activities was there at the beginning of the smart meter adoption process, this desire was slowly overridden by the need to adhere to the regulatory requirement and install as many smart meters as they can in line with their installation targets. As highlighted in the following quote:

I remember back in the day 5-6 years ago we started out with the right intent for smart because I remember doing the journey maps at the time and we were looking at the whole experience and if customers hadn't engaged. How would we engage them? And I think that thinking was lost when it became a project, and it became a government-mandated rollout. I think that's really the crux of it really. And then subsequently we've just added bits and pieces and got different parts of the business area doing little bits of it but we're still not really embraced smart as "this is the way forward".

(Interview 23A)

An interesting angle to the prevention driven regulatory focus in relation to constraining the development of an innovation capability is that it resulted in innovation ideas and opportunities being stopped in their course. Because energy companies operate in a heavily regulated industry, they are limited in the innovation opportunities they can pursue. As highlighted in the following two quotes:

> *The atmosphere in the industry at the moment is just so cost-constrained, so pressurised, where there are energy price caps. I think it's killing innovation. When the government did the Retail Market Review several years ago, they* ***killed off a lot of innovation****. Certainly, within GreenWorks, they killed off a lot of tariff innovation and it pushed everyone down a certain route.*
>
> (Interview 1A)

> *People put an idea in to see how this could happen but as soon as they get the feedback. "oh! we can't, due to regulation", and then they think what's the point in trying. But it's there for a reason, the regulation can tie you down a bit, but you've always got to think outside the box. There's always ways and means of doing something. It's just making sure that we're doing it from the right guidelines.*
>
> (Interview 12A)

Along similar lines, the following quote highlights how GreenWorks wanted to introduce innovative tariffs to customers, however, this initiative was stopped because it meant that customers would not be able to easily compare their tariff to that of other suppliers, a necessary condition from the regulators, as highlighted in the following quote:

> *We can offer catered innovative tariffs which ironically was stopped very early because it got too complicated. We wanted to do all these wonderful things. But then the government turned around and said customers aren't able to compare tariffs very easily. So, if you want to change supplier you won't have an easy way of going, well I am on this structure but you are offering that, is that better for me. And it was decided very early on that is gets really complicated. So, they stopped us offering these wonderful complex tariffs simply because it got too complicated.*
>
> (Interview 16A)

Another example is related to remotely turning the energy on and off when tenants move out and into properties. However, these ideas were not taken forward because they were not supported by regulation due to safety concerns, as highlighted in the following quote:

> *We had lots of ideas, things like change of tenancy, to turn the power off remotely, so the new tenant has to contact us. That's the only way to get power. We backed away from all of that, because it is not supported government wise.*
>
> (Interview 24A)

In the third instance, interview data highlighted that the desire for an organisation to become more communicative and collaborative by investing in developing a communication and collaboration capability was lost due to the regulatory focus of the adoption of smart meters. The following quote highlights how GreenWorks had the right intention of adopting smart meters as an end-to-end business process and business transformation initiative. However, once it became clear that it is a regulatory requirement and mandate, the focus shifted towards investing mainly in a technology adoption capability. This was done in order to achieve a high number of smart meter installs, and meet the regulatory requirement. As a result, the business transformation was only done in *"bits and pieces"*:

> *I think you just need a much more collaborative approach. We've got the right people, but they are just not talking to each other. Our boss used to run the whole of the metering business and I remember back in the day 5-6 years ago we started out with the right intent for smart because I remember doing the journey maps at the time and we were looking at the whole experience and if customers hadn't engaged. How would we engage them? And I think that thinking was lost when it became a project, and it became a government-mandated rollout. I think that's really the crux of it really. And then subsequently we've just added bits and pieces and got different parts of the business area doing little bits of it but we're still not really embraced smart as "this is the way forward".*
>
> (Interview 23A)

This concludes the third and final chapter of the research findings aimed at answering the third key research question of: *What are the generative mechanisms that enable/constrain* *affordance actualisation? And how are they manifested in terms of empirical outcomes?* Figure 27 below provides a summary of these findings. In the following chapter, I will discuss the findings of this thesis in light of the broader academic literature, as well as, the management and policy practice.

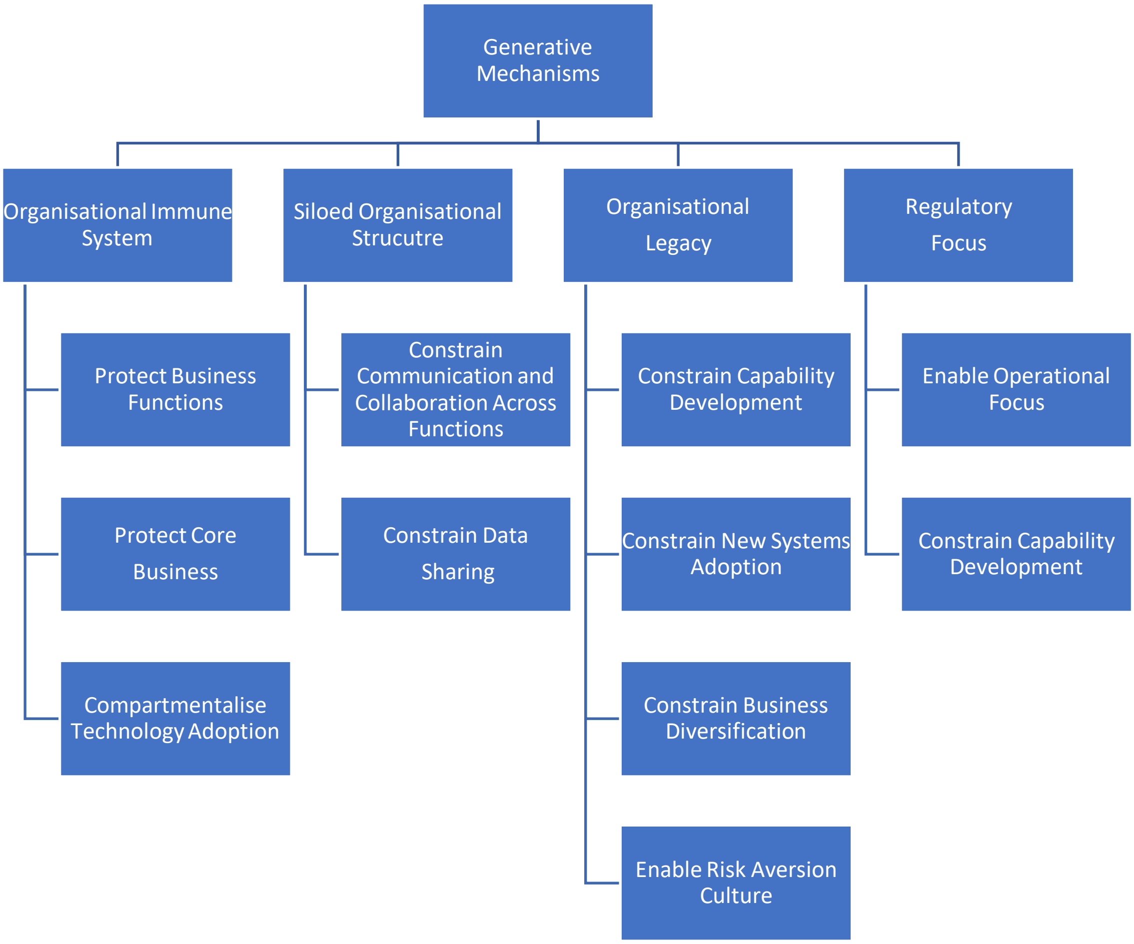

Figure 28. Overview of Generative Mechanisms and Empirical Outcomes

CHAPTER SEVEN

7 DISCUSSION AND CONCLUSION

THEORETICAL CONTRIBUTIONS & MANAGERIAL AND POLICY IMPLICATIONS

7.1 INTRODUCTION

In the previous three chapters, I have described and discussed the findings of this thesis. In chapter four, I highlight the organisational affordances that smart meters enable, and I detail subcategories for each organisational affordance. In chapter five, I cover the organisational capabilities that energy firms require to actualise smart meter affordances, and I detail the actualisation enablers for each organisational capability. Finally, in chapter six, I cover the generative mechanisms that - for the most part - constrain the affordance actualisation process by highlighting the empirical outcomes for each generative mechanism. Table 8 below provides a summary of the organisational affordances, organisational capabilities, and generative mechanisms that this research sheds light on. In this chapter I will discuss the relevance of these findings, highlighting the theoretical, policy, and managerial contribution stemming from my work. Finally, I will conclude this chapter by highlighting the limitations of this research and outlining avenues for future research.

<table>
<tr><th rowspan="6">Organisational Affordances

The possibilities for action arising from the relationship between an IT artefact and a goal-oriented actor or actors</th><th>Organisational Affordances</th><th>Organisational Affordance Subcategories</th></tr>
<tr><td>Customer Oriented Affordances</td><td>• Customer Education
• Customer Empowerment
• Customer Behaviour Change
• Customer Convenience
• Price Customisation
• Fast Switching</td></tr>
<tr><td>Energy Trading Affordances</td><td>• Calculating Energy Imbalance
• Timely Demand Side Response</td></tr>
<tr><td>Business Process Improvement Affordances</td><td>• Billing
• Debt Reduction
• Customer Relationship Management
• Field Operations
• Fraud Prevention</td></tr>
<tr><td>Energy Market Localisation Affordances</td><td>• Local Energy Storage
• Peer-to-peer Energy Trade</td></tr>
<tr><td>Service Innovation Affordances</td><td>• Automated Trigger Based Service Action
• Trigger Based Service Interaction</td></tr>
</table>

	Organisational Capabilities		Actualisation Enablers
Organisational Capabilities An organisation's capacity to deploy its assets, tangible or intangible, to perform a task or activity to improve performance	**Big Data Management Capability**	Technical Capabilities	• Data Acquisition and Recording • Data Extraction, Cleaning, Annotation • Data Integration, Aggregation, and Representation
	Big Data Analytics Capability		• Development of New Business Propositions • Maintain and Improve Competitive Advantage • Foster a Data-Driven Culture • Foster an Innovative Culture
	Technology Adoption Capability		• Train Engineers for Smart Meter Install • Manage Smart Meter Install Demand • Manage Engineer Workforce Operations • Understand and Improve Customer Experience • Smart Train Customer Service Advisers
	Customer Engagement and Communication Capability	Non-technical Capabilities	• Generate Customer Trust • Promote Customer-Technology Interaction • Educate and Inform Customers • Identify Meaningful Value Propositions
	Innovation Capability		• Innovation Conceptualisation • Innovation Experimentation • Innovation Commercialisation
	Communication and Collaboration Capability		• Enabling a Data-Driven Organisation • Enabling the Development of New Competencies • Tapping into External Competencies • Promoting Business Alignment
	Strategic Management Capability		• Strategic Awareness • Strategic Intent • Strategic Commitment • Strategic Flexibility • Strategic Choice
	Generative Mechanisms		**Empirical Outcomes**
Generative Mechanisms The causal structures that explain empirical outcomes	**Organisational Immune System**		• Protect Business Functions • Protect Core Business • Compartmentalise Technology Adoption
	Siloed Organisational Structures		• Constrain Communication and Collaboration Across Functions • Constrain Data Sharing
	Organisational Legacy		• Constrain Capability Development • Constrain New Systems Adoption • Constrain Business Diversification • Enable Risk Aversion Culture
	Prevention Driven Regulatory Focus		• Enable Operational Focus • Constrain Capability Development

Table 9. Summary of Research Findings

7.2 THEORETICAL CONTRIBUTION

This research contributes to knowledge on big data and organisational value creation, organisational affordance actualisation, and more broadly, to the literature on information systems, innovation and firm performance. Using the affordance theory lens, I provide empirically grounded insights into the opportunities for value creation (organisational affordances) that big data technologies provide, explain how these value opportunities are realised, and what constrains these value opportunities from being realised.

Whilst significant attention has been paid towards studying the relationship between big data investments, resources, and capabilities and firm performance or competitive advantage (Gupta and George 2016; Côrte-Real et al. 2017; Mehmood et al. 2017; Shamim et al. 2019; Gupta et al. 2020; Mikalef et al. 2020; Bag et al. 2021; Gu et al. 2021), limited attention has been paid towards understanding how organisations realise/achieve/actualise value from big data technologies (Günther et al. 2017). For this reason, there has been a call for more research that looks into understanding the processes and mechanisms through which organisations realise value from big data technologies (Fosso Wamba et al. 2015; Mikalef et al. 2017b). In their systematic literature review, Günther et al. (2017) highlight that the literature is still in its early stages in explaining how organisations realise value from big data technologies and called for future research to empirically examine *"how different actors within organisations work with big data in practice?"* Since then, a small number of studies emerged that have responded to this call (Lehrer et al. 2018; Dremel et al. 2020a; De Luca et al. 2020).

In the last decade, affordance theory has become the predominant way to theorise about how organisations effectively actualise technology potential to achieve desirable outcomes. While significant attention has been paid to studying the organisational affordances of big data technologies and their subsequent actualisation in a *number of industries* including automotive engineering (Leonardi 2013), healthcare (Strong et al. 2014; Anderson and Robey 2017), financial services (Leidner et al. 2018), insurance, banking, telecommunication, e-commerce (Lehrer et al. 2018), gaming (Tim et al. 2020) and automotive manufacturing (Dremel et al. 2020a), no study has so far looked into studying the organisational affordances of big data technologies in the energy sector, despite the mass adoption of smart metering technology in the UK and across the world.

Against this backdrop, this research investigates the organisation-level affordances that smart meters enable and explains how two incumbent energy firms in the UK actualise (or do not actualise) the organisational affordances offered to them from the adoption of smart meters. I do so by answering the following three research questions:

1. What are the organisational affordances that smart meters afford?

2. What are the key organisational capabilities that enable smart meter affordances actualisation? And how do they enable the actualisation process?
3. What are the generative mechanisms that enable/constrain affordance actualisation? And how are they manifested in terms of empirical outcomes?

An affordance theory lens provides the theoretical foundation to empirically examine how organisations and actors within organisations can realise value from big data. It does so by examining the capabilities, organisational goals, and actions that enable them to realise value. In contrast to strategic management theories such as dynamic capabilities, and resource-based view who seek to contextualise and confirm the positive relationship between big data investments and firm performance (Gupta and George 2016; Côrte-Real et al. 2017; Mikalef et al. 2020; Bag et al. 2021), affordance theory offers a unique and granular perspective to understand the processes and mechanisms of value realisation by focusing on the relationship between organisational actors and big data technologies (Strong et al. 2014). Many studies have utilised affordance theory to better understand the process of realising value from the adoption of new technologies (Zammuto et al. 2007; Leonardi 2011; Strong et al. 2014; Anderson and Robey 2017; Tim et al. 2020). However, no study has so far explored the organisational capabilities of affordance actualisation or why organisations fail to actualise technology affordances despite being able to perceive the potential for value creation. This research extends the use of affordance theory to the context of big data technology by studying the actualisation of smart meter affordances in the energy sector in the UK. In the following three sections, I will discuss the theoretical implications of this research centred around the three key research findings: 1) organisational affordances 2) organisational capabilities, and 3) generative mechanisms.

7.2.1 Organisational Affordances

Previous research has utilised an affordance theory lens to identify organisation-level affordances (i.e., possibilities for action) in several industries. In fact, new technologies such as electronic healthcare records (Strong et al. 2014), enterprise social media (Leidner et al. 2018), and big data analytics (Lehrer et al. 2018; Dremel et al. 2020a; De Luca et al. 2020) are studied in terms of their possibilities for action. However, no study so far has investigated the technology affordances from big data technologies in the energy sector. For this reason, this study extends the affordance theory perspective to the context of the energy sector by presenting empirically informed insights into the technology affordances that smart meters enable. This is of value because technology affordances help us understand and explain how organisations - especially complex ones - develop and implement new possibilities for action in light of the adoption of a big data technology. First, by understanding what these possibilities for action are. Second, by understanding how these possibilities for action can be realised.

The first key contribution of this research is that it provides a novel, systematic, and empirically informed collection of organisational affordances that smart meters enable. I do so by providing empirical evidence and conceptualisation for 17 organisational affordances (see Chapter 4). Identifying the smart meter affordances is of value because it sheds light on a series of specific action possibilities that were previously unknown to the literature on technology affordances. Moreover, it provides actors in energy firms with a comprehensive list of action possibilities that they can pursue to realise the value of smart meter adoption. This research highlights that these action possibilities can be industry-oriented, market-oriented, process-oriented, or innovation-oriented. To do so, I categorise the 17 organisational affordances into five key clusters: customer-oriented affordances (market-oriented), energy trading affordances (industry-oriented), business process improvement affordances (process-oriented), energy market localisation affordances (industry-oriented), and service innovation affordances (innovation-oriented).

The first organisation-level affordance cluster is **customer-oriented affordances** which are organisational affordances that are directed towards delivering value for the energy consumer and include: customer education, customer empowerment, customer behaviour change, customer convenience, price customisation, and fast switching. Customer-oriented affordances help energy consumers to become more educated and informed about their energy consumption and empower them to make decisions about how and when they use their energy. Also, they enable energy consumers to seamlessly manage their energy bills, payments and change energy suppliers (see Section 4.1.1).

The second organisation-level affordance cluster is **energy trading affordances** which are about how smart meters have enabled energy companies with new ways to manage their energy trading activities and include: calculating energy imbalance, timely demand-side response, and half-hourly settlements. Energy trading affordances enable energy companies to better estimate energy demand and better manage their wholesale energy purchase processes. It also enables energy companies with new ways of paying for energy usage from the grid, for example instead of paying for energy on a 24-hour interval, they can pay for energy at 30-minute intervals, known as "half-hourly settlements" (see Section 4.1.2).

The third organisation-level affordance cluster is **business process improvement affordances** which are about improving the effectiveness, efficiency, and productivity of business processes in billing, debt reduction, customer relationship management, field operations, and fraud prevention. Business process improvement affordances enable energy companies to improve their billing process by replacing estimated bills with accurate ones, and subsequently better manage their energy debt portfolio. They improve the customer relationship management processes by reducing call volume and complaints. They also reduce the need for engineer servicing visits, as smart meters can be managed remotely. Finally, they enable energy companies to detect energy fraud scenarios and improve their fraud detection processes (see Section 4.1.3).

The fourth organisation-level affordance cluster is **energy market localisation affordances** which are about how smart meters play a key role in transforming the energy infrastructure and energy production from a centralised to a decentralised one. Smart meters do so by enabling energy companies to provide local energy storage (e.g., battery installation), and peer-to-peer energy trading services, whereby energy is traded more locally between individual energy consumers (see Section 4.1.4).

The fifth, and final organisation-level affordance cluster is **service innovation affordances** which are about how smart meters offer energy companies with opportunities to create new service experiences or service solutions that are of value for the energy consumer and generate competitive advantage for the energy firm. These include fully automated service innovation opportunities (e.g., automating appliance usage), or semi-automated service innovation opportunities (e.g., assisted living) (see section 4.1.5).

In addition to identifying the organisational affordances clusters that smart meters enable, this research showcases how organisational affordances are path-dependent and relational to one another, which is consistent with previous research (Strong et al. 2014). Path dependency means that the actualisation of one organisational affordance may be dependent on the actualisation of another organisational affordance. Building on this notion, this research extends previous research by studying technology affordances and affordance actualisation within the context of smart meters in the energy sector by providing further insights into the dynamic relationship between organisation-level smart meter affordances and affordance actualisation.

The findings of this research on organisational affordances provide a platform for future quantitative research to operationalise the identified and conceptualised organisational affordances. Moreover, this research provides important and relevant managerial implications in two key ways. First, this research identifies an extensive list of organisation-level affordances which managers in energy companies can use as a benchmark against which to evaluate their current and/or future activities and actions. Additionally, the extensive list of organisational affordances can be used as a framework to inform business decisions relating to changing the organisational structure, setting up team training, investing in research projects, pursuing innovative activities, developing new organisational capabilities, and so on. Second, this research highlights the path-dependent and dynamic nature of organisational affordances. This has important managerial implications because it urges managers to work towards actualising as many organisational affordances as they can. Because the more affordances organisations actualise, the more doors will open for the actualisation of new smart meter affordances. Altogether, this increases an organisation's ability to maximise the value realisation potential from smart meters or from the adoption of a new technology.

7.2.2 Organisational Capabilities

The second key contribution of this research is that in addition to detailing the organisational affordances that smart meters afford, it explains how these affordances are actualised. I do so by empirically investigating the organisational capabilities that energy companies require to actualise smart meter affordances by providing conceptualisation and empirical evidence for each organisational capability. I also explain how each organisational capability provides an organisation with several "actualisation enablers" that promote the affordance actualisation process.

Despite the growing research highlighting the positive relationship between big data and firm performance (Chen et al. 2015; Raguseo and Vitari 2018; Gupta et al. 2020), many organisations still fail to reach their strategic goals despite investing substantial resources into big data technologies (Grover et al. 2018). One key reason for this is that there is a lack of understanding of the processes and mechanisms through which organisations realise value from big data technologies (Fosso Wamba et al. 2015; Mikalef et al. 2017b). In the past few years, affordance theory emerged as a key theoretical perspective that enabled researchers to hone in and theorise on the processes and mechanisms that enable organisations to realise value from big data technologies. However, despite capabilities being one of the founding principles of affordance theory - whereby it denotes that for an organisation to actualise a technology affordance, it must possess certain organisational capabilities to do so - no research has empirically examined the organisational capabilities of the affordance actualisation process. Instead, previous research has focused on the role of organisational actions (Dremel et al. 2020), technological features (Lehrer et al. 2018; Tim et al. 2020), and organisational features (Tim et al. 2020) in the affordance actualisation process. For these reasons, this research focuses its attention on the organisational capabilities of affordance actualisation by empirically investigating their role in the affordance actualisation process.

This research contributes to the literature on affordance theory by extending the affordance actualisation literature towards better understanding the role of organisational capabilities in the affordance actualisation process. More broadly, this research fills a research gap in the big data literature by shedding light on the processes and mechanisms through which organisations realise value from big data technologies (Günther et al. 2017). It does so by suggesting that there are seven key organisational capabilities needed for affordance actualisation, which include both technical and non-technical capabilities. The **technical capabilities** include big data management capability, big data analytics capability, and technology adoption capability. Whereas, the **non-technical capabilities** include customer engagement and communication capability, innovation capability, communication and collaboration capability, and strategic management capability.

The first key organisational capability is **big data management capability.** Big data management capability is about having the processes and supporting technologies to acquire, store, prepare and retrieve data that is large, fast-moving, and diverse for analysis (Gandomi and Haider 2015). This research suggests that big data management capability provides organisations with three key actualisation enablers for affordance actualisation which include:

data acquisition and recording of smart meter data; data extraction, cleaning, and annotation of smart meter data; data integration, aggregation, and representation of smart meter data with other complementary sources of organisational data (see section 5.1.1).

The second key organisational capability is **big data analytics capability**. Big data analytics capability is about having the techniques available to analyse and acquire intelligence from big data that is large, fast-moving, and diverse (Gandomi and Haider 2015) in order to support the different value-creating needs of an organisation (Grover et al. 2018). This research suggests that big data analytics capability provides organisations with four key actualisation enablers for affordance actualisation which include: enabling the development of new business propositions, maintaining and improving competitive advantage, fostering a data-oriented culture, and fostering an innovative culture (see section 5.1.2).

The third key organisational capability is **technology adoption capability**. Technology adoption capability is about the efficacy in the implementation, integration, and augmentation of a new and advanced technology within an already existing organisational routine by putting a new technology into practice within an organisational context (Meyer and Goes 1988; Woiceshyn and Daellenbach 2005; Damanpour and Schneider 2006). This research suggests that technology adoption capability provides organisations with five key actualisation enablers for affordance actualisation which include: enabling the training and recruitment of engineers for smart meter installation, enabling the management of customer demand, enabling the management of the engineer workforce operations, enabling the understanding and improvement of customer experience, and enabling the training of customer service advisors to manage smart customers (see section 5.1.3).

The fourth key organisational capability is **customer engagement and communication capability**. Customer engagement and communication capability is about the extent to which an organisation utilises different forms of communication to provide their customers with knowledge and understanding about their offerings to succeed in creating a long-term relationship with their customers (Voyles 2007; Finne and Grönroos 2017; Sashi 2021). This research suggests that customer engagement and communication capability provides organisations with four key actualisation enablers for affordance actualisation which include: enabling the generation of customer trust, promoting a customer-technology interaction, educating and informing the customer, and identifying meaningful value proposition opportunities (see section 5.1.4).

The fifth key organisational capability is **innovation capability.** Innovation capability is about the resources possessed by an organisation that are devoted to identifying and creating new value by transforming knowledge and ideas into new products, processes, and systems for the benefit of the customer, the firm, and its stakeholders (Lawson and Samson 2001). This research suggests that innovation capability provides organisations with three key actualisation enablers for affordance actualisation which include: conceptualisation, experimentation, and commercialisation of service innovation affordances (see section 5.1.5).

The sixth key organisational capability is **communication and collaboration capability**. Communication and collaboration capability is about a firm's ability to exchange information between individuals, teams, or departments in such a way that enables them to work together, have a mutual understanding, a common vision, and share resources to achieve a collective goal (Kahn and Mentzer 1998). This research suggests that communication and collaboration capability provides organisations with four key actualisation enablers for affordance actualisation which include: enabling a data-driven organisation, enabling the development of new competencies, tapping into external competencies, and promoting business alignment (see section 5.1.6).

The seventh, and final key organisational capability is **strategic management capability**. Strategic management capability is about an organisation's ability to successfully undertake action that is intended to affect its long-term growth and development (Child 1972; Lenz 1980; Lee 2001). This research suggests that strategic management capability provides organisations with five key actualisation enablers for affordance actualisation and include: strategic awareness, strategic intent, strategic commitment, strategic flexibility, and strategic choice (see section 5.1.7).

In addition to identifying the organisational capabilities and actualisation enablers for smart meter affordance actualisation, this research highlights that organisational capabilities are path-dependent and relational to one another, in the same way organisational affordances are. As such, this research extends previous research by highlighting the notion of capability path dependency. Whereby, the development and success of one organisational capability is dependent on the success and development of a different/complementary organisational capability (see section 5.1.8).

Much of the previous research has focused on the technical capabilities in realising the value of big data technologies (e.g., big data analytics capability; big data analytics capability) (Fosso Wamba et al. 2015), whereas one of the major contributions of this research is that it sheds light on a more complex set of capabilities that support affordance actualisation process, which goes beyond the realm of technical capabilities. This research extends previous research by highlighting that *for an organisation to realise the value potential from big data technologies, both technical and non-technical capabilities must be deployed.* The non-technical capabilities are viewed as both equally important and complementary to the technical capabilities in actualising (i.e., realising value from) big data technology affordances (see Chapter 5).

The findings of this research on organisational capabilities provide a platform for future quantitative research to operationalise the conceptualised organisational capabilities. Moreover, the findings of this research have important and relevant managerial implications. First, by highlighting the capability path dependency, it urges managers in organisations to invest in the broad range of organisational capabilities for them to be able to effectively realise and maximise the value potential they can achieve from the adoption of a new technology. Second, this research highlights that to actualise smart meter affordances, organisations must invest in both technical and non-technical capabilities. Finally, by providing an extensive list of organisational capabilities that organisations require to realise value from big data technologies, managers in organisations can use this list of capabilities as a benchmark to identify the organisational capabilities that they have or do not have and use these insights to inform their decisions on what organisational capabilities they would need to pursue.

7.2.3 Generative Mechanisms

The third key contribution of this research is that in addition to detailing the organisational affordances that smart meters afford, explaining how organisational affordances are actualised, it explains why affordances are perceived but not actualised despite organisations having the necessary capabilities to do so. I do so by empirically examining the generative mechanisms that operate within the two energy firms under study. In this research, I provide a conceptualisation for each generative mechanism and highlight the empirical outcomes for each generative mechanism by explaining how each generative mechanism constrains the affordance actualisation process.

Previous research has sought to study organisational affordances and affordance actualisation processes (Zammuto et al. 2007; Strong et al. 2014; Lehrer et al. 2018; Dremel et al. 2020a; De Luca et al. 2020; Tim et al. 2020). However, no research so far has explained why organisational affordances are perceived but not actualised. This research not only extends research on affordance theory but also fills a broader research gap by explaining why organisations fail to reach their strategic goals despite investing substantial resources into big data technologies (Grover et al. 2018).

This research suggests that *organisational capabilities are a necessary but not sufficient condition for affordance actualisation*. This is due to the generative mechanisms that constrain the affordance actualisation process. Generative mechanisms are causal structures that explain empirical outcomes (Bygstad et al. 2016). They are hidden from our direct experience but are essential to our explanation of how and why social phenomena emerge in a complex and interrelated world (Sayer 2000). When investigating the affordance actualisation process in incumbent firms, the journey to actualisation becomes a lot more complex because it is often influenced by history, legacy, structures, and power forces that are at work that organisational actors are often not aware of when pursuing the affordance actualisation process. The reason for this is that organisational actors are not aware of these generative mechanisms because they cannot observe them (Volkoff and Strong 2013). Whilst generative mechanisms cannot be observed, we can observe the empirical outcomes that they produce (Volkoff and Strong 2017). As such, this research examines and analyses the empirical outcomes, and following a process of retroduction unearths four relevant generative mechanisms that "*underlie the phenomena we observe"* (Tsoukas 1989). This research identifies four key generative that - for the most part - constrain the affordance actualisation process and they are: organisational immune system, siloed organisational structure, organisational legacy, prevention driven regulatory focus.

First, **organisational immune system**. The organisational immune system is comprised of *"the people, policies, procedures, processes, and culture it creates to prevent change, regardless of the consequences"*(Gilley et al. 2011). This research has found that the organisational immune system is a powerful generative mechanism that constrains the affordance actualisation process by protecting existing business functions, protecting core business focus and compartmentalising technology adoption.

Second, **siloed organisational structure.** Siloed organisational structure is where organisational units lack the motivation and desire to work and communicate with other organisational units (Aaker 2008), which results in organisations having trouble harnessing resources that transcend the organisational siloes that can serve their organisational goals (Gulati 2007). This research suggests that siloed organisational structure constrains the affordance actualisation of smart meter affordances by limiting the communication and collaboration between business functions and limiting the data sharing and integration across business functions. Both of which are essential for the actualisation of smart meter affordances.

Third, **organisational legacy.** Organisational legacy is an organisation’s inherited and often outdated technology, processes, culture, and mindsets (Hillenbrand 2019) that can hinder efforts of adopting a new technology in an incumbent firm. This research finds that organisational legacy hinders smart meter affordance actualisation by constraining the development of new organisational capabilities, the adoption of new organisational systems, attempts of business diversification, and by promoting a risk-averse culture. All of which hinder the affordance actualisation process.

Fourth, **prevention driven regulatory focus**. Prevention driven regulatory focus is when an organisation regulates its cognition and behaviour in order to pursue the organisational goal of avoiding an undesirable state as opposed to seeking a desirable end state (Brockner et al. 2004). The findings have suggested that organisational efforts and motivation for adopting smart meters are to avoid paying fines for non-compliance (i.e., avoid undesirable end state), as opposed to improving efficiency, protecting market share, assisting in innovative activities, and increasing productivity and profitability (i.e., seek desirable end state) (DeLone and McLean 1992). In fact, energy companies will be fined for not installing enough smart meters but will not be fined for not developing capabilities that will improve their efficiency and assist in innovative activities. As such, this research suggests that prevention-driven regulatory focus hinders an organisation’s ability to actualise smart meter affordances by enabling an operational focus and constraining the development of new organisational capabilities. The prevention driven regulatory focus means that energy firms prioritise the operational side and installation of smart meters (i.e., technology adoption capability) to be protected from fines, and a de-prioritise the investments in complementary organisational capabilities (e.g., big data management capability, innovation capability). Prevention-driven regulatory focus means that organisations actively work towards avoiding fines associated with non-compliance, at the same time hindering their ability at business advancement and growth.

The generative mechanisms identified in this research can vary in strength and therefore manifest in different degrees. For example, the higher the organisational immune system is, the less likely an organisation can be flexible and adaptive to business change. Whereas the lower the organisational immune system is, the more likely an organisation can be flexible and adaptive to business change. To give another example, the higher the siloed organisational structure the less likely an organisation can communicate and collaborate. Whereas, the lower the siloed organisational structure is the more likely an organisation can communicate and collaborate.

It is important to note that the powers of generative mechanisms are of *deterministic causality* and not of *material causality* (Archer et al. 1998; Carter and New 2004). In other words, the powers of generative mechanisms do not determine or predict action, but instead, create the conditions that enable or constrain action. In the context of this study, generative mechanisms are viewed as those that create the conditions that constrain the actualisation of organisational affordances. However, agents or actors have the power to modify the generative mechanisms around them and the powers they hold. Being aware of these generative mechanisms means that actors can proactively modify the generative mechanism in line with their affordance actualisation goals and outcomes. As most of the generative mechanisms identified in this research tend to create conditions that constrain affordance actualisation, organisational actors that are aware of these generative mechanisms can proactively modify the generative mechanisms to become more enabling and less constraining. As such, these findings have important managerial implications as they bring to the fore factors that cannot be observed, but of which we can observe the empirical outcome of (e.g., a failed attempt at actualising a smart meter affordance). By taking the steps to change the powers of these generative mechanisms, organisations will be better able to actualise smart meter affordances and realise the value creation potential from big data technologies.

Table 10 below provides a summary of this thesis's theoretical contribution structured around the three key research findings.

Research Findings	Research Contribution
Organisational Affordances	• Fills a research gap by focusing on the action possibilities that the adoption of a big data technology affords within organisations that it is adopted within. • Extends the use of affordance theory to the timely and relevant context of the energy sector and smart meters. • Identifies five distinct clusters of organisational affordances.
Organisational Capabilities	• Fills a research gap by explaining how organisations can realise value from big data technologies using a combination of technical and non-technical capabilities. • Extends affordance theory by examining the role of organisational capabilities in the affordance actualisation process. • Extends affordance theory by shedding light on the actualisation enablers that act as an intermediate link between affordances and capabilities for affordance actualisation. • Provides the literature with a comprehensive list of organisational capabilities that enable them to realise the value potential from the adoption of a new technology that extends beyond the technical capabilities.
Generative Mechanisms	• Fills a research gap by explaining why organisations are unable to realise the value of their big data investments. • Extends affordance theory by explaining why affordances are perceived but not actualised despite having the capabilities to do so. • Extends affordance theory by arguing that organisational capabilities are a necessary but not sufficient condition for affordance actualisation.

Table 10. Summary of theoretical contribution

7.3 POLICY IMPLICATIONS

This research is geared towards understanding how energy firms realise the value potential from the adoption of smart meters. Therefore, the focus of this study is geared towards an organisational level of analysis. However, the adoption of smart meters takes place in a heavily regulated industry and involves multiple stakeholders including policymakers and regulators. As a result, this research does provide important and relevant industry-level policy implications. In particular by shedding light on the role of the regulator in fostering a prevention driven regulatory focus within energy firms, as highlighted in (Section 6.1.4) of the findings.

The idea and conviction that regulation is associated with being a barrier to innovation holds to be true within the wider academic literature (e.g., Nisar et al. 2013). However, this research explores this idea further by providing an understanding of how and why the regulator and policy-makers have created more difficult conditions for innovation to take place, in particular regarding the regulatory focus.

A key implication for policymakers is that when pursuing future digital transformation mandates within industries, is to maintain awareness of their role and influence in fostering a prevention focus within organisations. Awareness of their role is important because quite often this happens without an explicit intention in doing so from the regulators' side. Following this, and through conversations and consultations with the relevant organisations, policymakers can seek ways to foster a more promotion-driven regulatory focus within organisations; one that will encourage them to pursue innovation opportunities, and develop new organisational capabilities for affordance actualisation. For example, one way to achieve a promotion focus is to replace the fines with incentives. Whereby, instead of energy companies being fined for non-compliance, they could receive an incentive for doing so. This way energy companies can focus on their advancement and growth to be better able to actualise affordances and realise organisational value, instead of being fixated on avoiding fines for non-compliance which compromises on their ability to actualise value-adding affordances.

7.4 MANAGERIAL IMPLICATIONS

More broadly, the findings of this study provide important managerial implications for the realisation of value potential from big data technologies in organisations in three key ways. First, providing managers with insights into the action possibilities that smart meters enable. Second, by providing managers with insights into the organisational capabilities needed to realise the value from the adoption of smart meters or a big data technology. Third, by providing managers with insights into why they are unable to realise the value of their big data investments. However, and more specifically, this research provides several action-based recommendations as follows:

7.4.1 Have a shared positive organisation-wide perception towards technology adoption and its benefits

This research highlights that for an organisation to communicate the benefits or value of a new technology, an organisation must have a shared positive organisational perception towards the adoption of smart meters and the value it brings to the organisation. Otherwise, an organisation will fail to communicate the benefits of smart meters to their customers, because they do not fully believe in the benefits themselves. Interview data highlighted the impact that the negative press has had on both BlueHouse and GreenWorks, and if organisations are not careful, they might find themselves in a position where they use these same narratives to justify customer reluctance and lack of customer demand and uptake. Therefore, having a shared positive approach and attitude towards the adoption of smart meters will enable energy firms to articulate more clearly the value of smart meters to their customers, and as a result, their customers will engage more positively with the technology. Failing to have a shared positive organisational perception towards smart meters means that energy firms will be trying to encourage their customers to adopt a smart meter without being fully convinced of the technology themselves. As a result, they may use the negative examples shared by the media or the reluctance of the customers to self-justify why the market of smart meters is not taking off in the way that it is expected to. Additionally, they might end up overcompensating the customer to adopt a smart meter through various incentives (monetary incentive, percentage off a bill, free products), when one could argue that the benefits of having a smart meter should be sufficient on their own for a customer to want to have a smart meter installed.

7.4.2 Have a strong and clear communication strategy

Interview data have highlighted the negative impact that negative media coverage has had on the adoption of smart meters and on customer demand and uptake. As such, firms need to have a clear and strong communication strategy in place to tackle misinformation, educate their customers, and address negative press coverage. Failing to have a strong and clear communication strategy means that an organisation's ability to effectively and successfully adopt smart meters or a new technology will be significantly compromised. Therefore, organisations must have a clear strategy in place to tackle such issues. A strategy that clearly outlines how their organisation plans to engage and communicate with its customers around misinformation and misunderstanding. This can be achieved through marketing campaigns or using customer service advisors and engineers to proactively engage in educating customers on the misconceptions surrounding smart meters.

7.4.3 Embrace business change and transformation

Although big data technologies have the potential to transform entire business processes and business models, the findings of this study have highlighted that both BlueHouse and GreenWorks have adopted smart meters but are reluctant to transform their business in a way that would capitalise on the opportunities that smart meters provide. Moreover, business decisions taken are usually in line with preserving - as opposed to transforming - the core business in its current state. For example, interview data highlighted that BlueHouse views its engineer workforce as their core competency, their shop front, and their biggest trust generator.

As a result, their decision to keep the costly operational process of smart meter installs in-house was in order to preserve their core business. When one could argue that outsourcing such a costly operation (which is non-value-adding) would free up organisational resources to focus on the value-adding activities such as delivering on new propositions or new services. As such, this research highlights the importance of embracing business change and transformation and for organisations to not be afraid of rethinking "*what are we good at?*" or "*what are we best known for*" because business change and transformation will be a key driver for business survival, business differentiation, and competitive advantage.

7.4.4 Utilise senior management team as 'immunosuppressants'

This research sheds light on the organisational immune system *"the people, policies, procedures, processes, and culture it creates to prevent change, regardless of the consequences"* (Gilley et al. 2011) as a generative mechanism that constrains an organisation's ability to actualise organisational affordances. Equally so, the findings of this research have shed light on the power of senior management teams in leading and acting on change (strategic management capability). As such, this research sheds light on the importance of organisations effectively utilising their senior management teams and the power they hold by acting as immuno-suppressants for the organisational immune system (Seel 2000). The senior management team can act as immuno-suppressants by dampening down the resistance to change and nurturing new behaviours that embrace change. The failure of the senior management team in tackling the organisational immune system will result in an ineffective adoption of a new technology and an organisation's inability to realise the value of new technology adoption.

In the following section, I will conclude this chapter by discussing the research limitations and outlining avenues for future research.

7.5 RESEARCH LIMITATIONS AND FUTURE RESEARCH

This research offers important and relevant theoretical, empirical, and managerial contributions as highlighted in the previous two sections. However, this research is also subject to a few limitations. First, this research takes place in the context of two incumbent and traditional energy firms in the UK: BlueHouse and GreenWorks, and therefore does not cover the perspective of newer and more digitally-enabled energy firms such as PurpleEnergy. Although efforts were made to include publicly available information about PurpleEnergy that offer an interesting contrast to the findings emerging from BlueHouse and GreenWorks (see section 5.1.4.2), no empirical research was carried out in PurpleEnergy. As such, future research would benefit from empirical research carried out in digital native energy firms, as it would offer an interesting contrast to the generative mechanisms that this research outlines. Whilst the generative mechanisms highlighted in this research mostly look at those “constraining” an organisation’s ability to actualise smart meter affordances, future research could shed more light on the generative mechanisms that work on “enabling” the affordance actualisation process. The emphasis on the constraining generative mechanisms here is due to the context in which this research took place (incumbent firms influenced by its history, legacy, structures), whereas future research carried out digital native competitors will offer a new context in which elements such as history, legacy, and structure are less prevalent.

Second, the data collection period for this research took place over 10 months. Whilst 10 months is a significant time to spend in the field, it was not long enough for the research project to be classified as a longitudinal case study, and therefore it did not enable me to track and observe the affordance actualisation process as it unfolded. Instead, I relied on respondents’ accounts of past and present events to better understand the affordance actualisation process, as well as past and present company documents and news articles. Future research would benefit from carrying out a longitudinal case study in an energy firm that is actualising smart meter affordances to observe the affordance actualisation process as it unfolds. Longitudinal case studies have been identified as a suitable mode of enquiry for critical realist case studies and for identifying the generative mechanisms that are at work within the context of study (Easton 2010).

Third, this research is subject to the limitations that any qualitative research would be subject to. Whilst, the findings of this research cannot predict outcomes in other or similar contexts, they can help explain outcomes. Whereby, insights can be drawn from this research to better inform our understanding/future research on how incumbent firms realise value from big data technologies. Future research could benefit from carrying out quantitative research on the findings of this thesis to empirically examine the relationship between organisational investments in different organisational capabilities and their impact on a firm’s ability to realise big data and firm performance. Future research could also test the relationship between a firm’s actions that are targeted towards changing the powers of generative mechanisms from "constraining" to "enabling" and their impact on an organisation's ability to realise value from big data technologies and firm performance.

Fourth, the adoption of smart meters is a multi-stakeholder project. However, the interviews in this study are limited to those conducted in the context of the energy firm. Future research could benefit from conducting interviews with the different stakeholders involved in the adoption of smart meters in the energy industry. Such stakeholders include OFGEM (the Office of Gas and Electricity Markets); the regulator, BEIS (the department for business, energy, and industrial strategy); the government department responsible for commissioning the smart meter industry-wide adoption BEIS, the national grid; responsible for the distribution of energy, the firms responsible for energy generation, the DCC (Data Communications Company); responsible for connecting smart meters with energy suppliers systems, network operators, and other authorised users. Interviews with different stakeholders would provide interesting insights into the adoption of smart meters in the energy industry and the ways in which the different stakeholders create and realise value from them.

Fifth, the best possible efforts were made to ensure the list of organisational affordances identified in this research is comprehensive. This was done by interviewing respondents from different business functions, from different levels in the hierarchy, interviews in two different organisations, and following a systematic process for data collection and analysis. Still, one of the limitations of this study is the while the list is comprehensive, it may not be exhaustive, because new organisational affordances can emerge all the time.

Finally, this research takes place in a heavily regulated industry (the energy industry). Operating in a heavily regulated industry means that the amount of organisation-level technology affordances that an energy firm can actualise can be limited. Additionally, it can slow down the affordance actualisation process, as energy firms would require approval from the regulatory body whenever there is a change to any of their businesses processes, and they would need to ensure that they are in line with government regulation. Failing to do so would result in energy firms incurring heavy fines for non-compliance with regulation. As such, future research would benefit from carrying out research on the actualisation process of organisation-level technology affordances in non-regulated or less regulated industries (e.g., retailing, consumer goods) as this would offer interesting novel insights.

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9 APPENDICES

9.1 APPENDIX A – ETHICAL APPROVAL

Cardiff Business School
Ysgol Busnes Caerdydd

Oufan, Sarah
Cardiff University Business School

01 March 2017

Dear Sarah:

Ethics Approval Reference: E12017005
Project Title: Big Data and Decision Making

I would like to confirm that your project has been granted ethics approval as it has met the review conditions.

Should there be a material change in the methods or circumstances of your project, you would in the first instance need to get in touch with us for re-consideration and further advice on the validity of the approval.

I wish you both the best of luck on the completion of your research project.

Yours sincerely,

Electronic signature via email

Debbie Foster
Chair of the ethics sub-committee
Email: CARBSResearchOffice@cardiff.ac.uk

9.2 APPENDIX B – INTERVIEW QUESTIONS

INTERVIEW QUESTIONS

Respondent background

- Current/previous roles in the organisation?
- Could you tell me about smart meters within [insert company name]?
- Could you tell me briefly about the smart meter journey within [insert company name]?
- Tell me about your current thinking about smart meters within this organisation
- Could you tell me about the key projects that you are currently working on that are related to smart meters?

Affordances

- What do you use smart meter data for?
- What happened once you started using smart meters?
- What do smart meters data enable you to do?
- What do smart meters make it more difficult to do?
- Were there things that you were expected to do with smart meters that were not in fact possible?
- What are the risks involved in using smart meters?

Note: Explore the affordances on the individual, team, and organisational level

Smart Meters and Organisational Capabilities

- What organisational changes have been/are undertaken to be able to work with smart meters?
- What have been the main challenges with the smart meter journey?
- What have been the success factors for the implementation of big data?
- What **infrastructure** is there in place at the moment for storing data from smart meters?
- What future changes to the infrastructure need to be done to cope with smart meter integration?
- What new **teams** have been formed to handle smart meters?
- What teams do you anticipate being formed to cope with the growing number of smart meters?
- What new **capabilities/skills** were needed to handle smart meters?
- Are these capabilities built up or brought into the company? And how?
-
- What new **capabilities/skills** do you anticipate are needed in the future?
- What **new tools/ technologies** were used to handle smart meters?
- What **new tools/ technologies** do you anticipate are needed in the future?
- What is your current thinking on the state of smart meters at this company?
- As the number of smart meters being installed grows, what measures are in place to deal with a larger scale of data?

Big Data

- Are you familiar with the buzzword "big data"?
- If someone were to say the word big data, what immediately comes to your mind? And how would you define it?
- How do you see big data within the context of this organisation?
- How are data-driving decisions and business models changing the industry?

Closing questions

- Is there anything else you would like to add?
- Is there anyone else you think I should contact?
    - Share the reporting structure and get their opinion on it.
- Do you have any questions?
- Would it be possible to keep in touch should I have any questions in the future?

9.3 APPENDIX C – DATA CODING SAMPLE

9.3.1 Sample of Open Coding

Quote	Interview Reference	Perceived Affordance	Actualized Affordance	All affordances (percieved & actualized)	higher level affordance (7 thus far)	Organizational Goal	Capability?	Notes (my thoughts/ questions)
[00:08:54] Previously collecting data once a quarter and that moved to once every half hour. So there's a massive increase in the volume of data so that was the first big one. The second thing is actually what do you do with that data. And there again are a couple of different levels of thinking there. So with smart meter data as we got today the kind of half hourly data you can do some interesting stuff so you can look at demand what what is the demand on the grid in a particular area a particular time of day and you can you can start looking at flexibility offering interesting tariffs to customers around free use tariffs and helping to balance demand and that's that's really valuable. So you can do that with the half hourly level that gives you something new that you've never had before and that's something pretty fundamental. [00:09:45][51.9]	Interview 4 - Company B		- Flexible tarriff - Balance energy demand	- Near real-time understanding of energy demand - Offer flexible tarriffs to customers (e.g. free use tarriffs) - Balance demand on the grid	- Better understand energy usage - Better understand energy demand - Balance energy imbalance on the grid			better understanding energy usage leads and better understand demand can enable energy companies to nudge customers to change their behaviour from using energy on peak times to off peak times - changing consumer behaviour in order to balance the energy imbalance on the grid - thinking out loud I think SSE have specific meters (non-smart) that give different tarriffs however these meters do not have a smart meter replacement for it yet!!!
[00:09:45] The more interesting thing is that actually smart meters are probably just the beginning of connected connected energy devices where you can understand at a really granular level how much energy is being used. So we have some trials to look at 10 second data coming from fridges and that have second data so as you start to get more and more granular you can tell really interesting things like... is this fridge likely to break down? [00:10:09][23.9]	Interview 4 - Company B	Connected energy devices		- The start of connected energy devices - understand energy usage at a much granular level (every 10 secs) - predict breakdown (e.g. when a fridge is likey to break down)	- Better understand energy usage - offer new products and services			
[00:10:28] The 10 second meter won't give you the fridge. It will give you the whole energy reading from the house but you can disaggregate the different devices in the house. If you have a long enough time period. [00:10:39][10.8]	Interview 4 - Company B		Disaggregate a fridge in an enegry signal	- disaggregate the different devices in the house (e.g. fridge)	- Better understand energy usage		Data Science: disaggregate the data	Can we think of 10 second data as a capability. Since not both case studies have it. It also requires an investment in terms of getting customers to accept the chip, collecting the data, and analyzing it. In addition to the resources and skills needed to carry out each!
[00:10:44] There's like a background kind of energy reading in the house with all the devices that are always on pretty much the fridge being the obvious one. Yeah you can tell when lights turn on more or less can tell when a kettle turns on you know. No not perfectly but enough that you can get a regular kind of pulse out from some of these devices. So when you get down to 10 second level for such a predictive predictive maintenance which it becomes really interesting as a whole new set of products and services for customers it means that hopefully your fridge doesn't break down and ruin all your food anymore. You could kind of preempt it. So we're looking at that today. That's that's where I'm interested in what we can do with smart meters because it offers an awful lot more to consumers...to customers. [00:11:28][43.8]	Interview 4 - Company B	Predictive Maintenance		- offer predictive maintenance - offer a new products and services to customers	- offer new products and services			predictive maintenance is still under trial... does that make it a perceived affordance or an actualized affordance? It almost seems like an affordance goes from perception to ideation to testing until it is finally actualized.
[00:11:38] We're starting to look up energy imbalance. Grid imbalance where we are. Where we... like historically we've had these kind of four meter readings a year and you've got to make a lot of guesses and assumptions about how much energy someone is using. So now you can stop doing that. You can get that right straight away pretty much. There are tariffs and propositions that are based on smart meter data as well but that's probably the other interesting bit right now. So I mentioned a time of use tariffs. That we've started we've trialled a few we've done things like free saturdays. We are likely to do a lot more of that kind of thing with smart meter data so changing consumer behavior and to benefit them but really to balance the grid that's the kind of benefit. [00:12:28][50.4]	Interview 4 - Company B		Free energy Saturdays Balance the energy on the grid	- Grid/ energy imbalance - Make more informed decisions on energy usage - Offer new tarriffs & propositions - Time of use tarriff (e.g. free energy saturdays) - Change consumer behaviour/ energy usage patterns - Balance the grid	- Balance energy imbalance on the grid			The motivation of getting customers to change their habits is so they can save money on their bills by using the cheaper energy tarriffs BUT the real incentive for the company is to balamce the enrgry on the grid.
[00:12:36] You try to incentivize people to use energy at times when the grid has got capacity. [00:12:44][8.6]	Interview 4 - Company B		- balance the grid	- balance the grid	- Balance energy imbalance on the grid			- offering customers free energy on weekends. The assumption might be that residential customers use more energy on weekends. However, the big industrial units are shut on weekends so incentivizing

9.3.2 Sample of Axial Coding - Affordances

Quote	Interview Reference	Data Type	Perceived Affordance	Actualized Affordance	All affordances (percieved & actualized)	higher level affordance	Organizational Goal	Capability	Notes, thoughts, questions
00:08:54] Previously collecting data once a quarter and that moved o once every half hour. So there's a massive increase in the volume of data so that was the first big one. The second thing is actually what do you do with that data. And there again are a couple of different levels of thinking there. So with smart meter data as we got oday the kind of half hourly data you can do some interesting stuff so you can look at demand what what is the demand on the grid in a particular area a particular time of day and you can you can start ooking at flexibility offering interesting tariffs to customers around ree use tariffs and helping to balance demand and that's that's really valuable. So you can do that with the half hourly level that gives you something new that you've never had before and that's something pretty fundamental. [00:09:45][51.9]	Interview 4 - Company B	30 minute data		- Flexible tarriff - Balance energy demand	- Near real-time understanding of **energy demand** - Offer **flexible tarriffs** to customers (e.g. free use tarriffs) - **Balance demand** on the grid	- Balance the grid - Change customer behaviour			better understanding energy usage leads and better understanding demand can enable energy companies to nudge customers to change their behaviour from using energy on peak times to off peak times - changing consumer behaviour in order to balance the energy imbalance on the grid - thinking out loud I think GreenWorks have specific meters (non-smart) that give different tarriffs however these meters do not have a smart meter replacement for it yet!!! I think they are called economy 7 & economy 9.
00:09:45] The more interesting thing is that actually smart meters are probably just the beginning of connected connected energy devices where you can understand at a really granular level how much energy is being used. So we have some trials to look at 10 second data coming from fridges and that have second data so as you start to get more and more granular you can tell really interesting things like... s this fridge likely to break down? [00:10:09][23.9]	Interview 4 - Company B	10 second data	Connected energy devices		- The start of **connected energy devices** - understand **energy usage** at a much granular level (every 10 secs) - **predict breakdown** (e.g. when a fridge is likey to break down)	- understand customer behaviour - offer new products and services			
00:10:28] The 10 second meter won't give you the fridge. It will give you the whole energy reading from the house but you can disaggregate the different devices in the house. If you have a long enough time period. [00:10:39][10.8]	Interview 4 - Company B	10 second data		Disaggregate a fridge in an enegry signal	- **disaggregate** the different devices in the house (e.g. fridge)	- offer new products and services		Data Science: disaggregate the data	Can we think of 10 second data as a capability. Since not both case studies have it. It also requires an investment in terms of getting customers to accept the chip, collecting the data, and analyzing it. In addition to the resources and skills needed to carry out each!
00:10:44] There's like a background kind of energy reading in the house with all the devices that are always on pretty much the fridge being the obvious one. Yeah you can tell when ights turn on more or less can tell when a kettle turns on you know. No not perfectly but enough that you can get a regular kind of pulse out from some of these devices. So when you get down to 10 second level for such a predictive predictive maintenance which it becomes really interesting as a whole new set of products and services for customers it means that hopefully your fridge doesn't break down and ruin all your food anymore. You could kind of preempt it. So we're looking at that today. That's that's where I'm interested in what we can do with smart meters because it offers an awful lot more to	Interview 4 - Company B	10 second data	Predictive Maintenance		- offer **predictive maintenance** - offer a **new products and services** to customers	- offer new products and services			predictive maintenance is still under trial... does that make it a perceived affordance or an actualized affordance? It almost seems like an affordance goes from perception to ideation to testing until it is finally fully actualized.

9.3.3 Sample of Axial Coding – Capabilities

Interview Quote	Interview Reference	Summary	High level capability Aug/Sept 2020	Notes A few generative mechanismare noted Aug/Sept 2020	Generative Mechanism	Capabilities	Factor/ Barrier
[00:00:17] Basically my team is me and four other people. And we kind of do all sorts. So we were set up about two years ago to kind of try and transform the way that [our company] delivers props, so to be more kind of lean, agile, digital led, like get your buzzword bingo card out, we know all of them! And we kind of did that on a really small scale and piloted really well. So we did a couple of kind of design centered sprints. And we did three that worked really well. But then the props that came out of them we were like oh how do we actually go and deliver these props because they were in kind of adjacent markets so not really core to BlueHouse. [00:01:04][47.0]	Interview 9 - Company B	**Innovation Lab**: in charge of customer products and propositions - set up to do so in an agile, lean, digital led way	Innovation Capability	Generative mechanism: alignment with core of the business	Business alignment with core business	Development and commercialisation	alignment with core business
[00:01:16] So for the past kind of year or so we've been working out ways in which we would deliver them. So would they be by ventures? So setting them up as totally separate businesses outside of BlueHouse? Do we set them up has a ring fenced venture within BlueHouse? Or do we find a product team and a product owner to do it completely conventionally within BlueHouse. And that journey is kind of led us to a place now where we do experimentation. So we will help core product teams to experiment with brand new ideas that they have. So we will do smoke test for them where you do like a website with nothing behind it. And we can give them kind of propensity to buy Google Analytics that sits behind that. And so that's one service.[00:02:02][45.5]	Interview 9 - Company B	**Innovation Lab**: help teams experiment with ideas that they have; do a smoke test for them	Innovation Capability	...and the strategy around it.		Development Innovation Commercialisation Experimentation	
[00:02:02] Transformation where we try and do a bit of an education piece to get the rest of UK home working in this way. So when we do a sprint, we consciously bring other people in whether they're kind of connected or not. So they get a flavor of how we work. We will hold events that we hold tech talk events, where we can just get people from DTS into UK Home, so they can come and talk about what they do. And, we've got kind of other initiatives and then we've got the real innovation. So I did run five, I now kind of run four actual ventures from my team as well which are kind of like standalone businesses with a business case KPI. We take them to an investment committee once a quarter to see how we're doing it, so the KPIs and investment that we go against them. [00:02:46][44.6]	Interview 9 - Company B	**Innovation Lab**: educate different parts of the business, run tech talks, develop business cases that are taken to an investment committee. Innovation Lab: new business innovation (product/ service innovation)	Collaboration & Communication Capability	Collaboration & Communication Capability as part of the Innovation Capability		Cross-functional collaboration Development Innovation Commercialisation	
So that's one, we then have a couple of kind of just... I'm going to call them corporate failures so products that have been brilliant products, and the whole point of how we work is desirability, feasibility, viability which have been a massive win in desirability. So we believe kind of from our smoke test a 6% conversion rate is good. So if you get 6% of the people that reach your website will give you an indication to buy so they'll carry on the-call-to-action. That's good. If you get 6% percent one of our props got over 20%. And then once we took the website down had a viral effect of 7% so it got shared on social media. We've never seen that before. Unfortunately... [00:05:32][110.9] [00:05:35] So is this an actual website? [00:05:35][0.1] [00:05:35] Yeah. Yeah. So we put it all on Google. Not branded because that would be a struggle. So non-branded web site on Google. [00:05:49][13.4] [00:05:49] No adverts nothing? [00:05:49][0.1] [00:05:49] Google ads and PPC. So this was incredible. And unfortunately though it was in short term loans and the business had quite a adverse reaction to going into short term loans. So we pushed it forward. Through feasibility to see if we could actually do it. We were like Okay we get your concerns but it's unbranded. It's just a trial to like 900 customers we're going to do anyway and just see if we can do it. And then it turned into a	Interview 9 - Company B	- business having an adverse re-action to a certain type of product	Strategic Management Capability	Lack of data led innovation strategy and innovations not being aligned with the core of the business. Doing the things they have always done vs doing the things that are outside their comfort zone.			data-led innovation strategy

9.3.4 Sample of Peer-Review

	A	B	D	E	F	G	R	S
1	Quote	Interview Reference	Perceived Affordance	Actualized Affordance	All affordances (percieved & actualized)	higher level affordance	Notes, thoughts, questions	LDL
9	[00:15:58] I expect I should make switching much quicker, much easier because you know you know the exact read you are not having to estimate reads anymore. You don't have to have people coming to your home to check reads. Your bill should always be right. [00:16:12][13.4]...[00:19:43] Oh I think I think probably the things we expect will be possible but maybe they're not there yet. So, faster switching we need we need to be able to switch customers much much more quickly than they are today. We need we need it to be all these...all the kind of typical things that happen in your life when you change house you know you change supplier, you get married, and you add someone else to your bill, whatever it might be. They all still take too long. Smart metera, one of the benefits should be that because you've got an instant up-to-date meter reading, you pretty can just change things as and when they happen. Not there yet but you know we're not all smart meters yet. [00:20:23][39.1]	Interview 4 - Company B	Quicker energy switching/ near real-time	Reducing the need for manual meter readers	- **Cut costs**: not having meter readers. - **Energy switching**: easier process and near real-time switching of energy suppliers.	- Drive efficiency: near real-time switching between energy suppliers - **Empower Customers**	Is cutting costs a feature? Although companies no longer need meter readers. The government still mandates that companies read the meters once every 2 years.	I agree on the efficiency affordance for the company. Another one here can be 'empowering customers', as you break down barriers and switching costs?
10	[00:34:59] We wanted to look up fraud energy theft where people are stealing energy so there's a team that you know that manage that today. They do it manually they do it based on their own best knowledge they use data but they use data you know in such, in maybe a more naive fashion. Naive is not the right word, they use Excel spreadsheets, I think. They've got lists of where there seems to be an anomaly you know, either it is too high or too low. But there's lots of manual work lots people having to look through that data. So we built a model based on smart meter data. If the meter, not even consumption data just the alarms and alerts that happen from those meters so if someone tampers with it, then it might give off a particular alarm. And we built a model that is as predictive as a whole team of people looking at smart meta data which has led to people getting arrested you know we've actually found genuine tampering happening. [00:36:03][64.0]	Interview 4 - Company B		Detect Energy Fraud	- **detect energy fraud** - **prosecute offenders for energy theft**	- Drive efficiency: detect energy theft & prosecute offenders	- might be worth getting more information about this project...	not sure fraud is related to driving efficienty. It's an undesirable customer behavior, such as churn, you can spot/prevent by using data. This may be discussed.
13	B: [00:16:26] The other thing that makes it kind of hard to work on these prospects. The other thing is like with insurance the pricing of this stuff and pricing of energy is extremely regulated too. So the whole idea behind Smart Meters right you get given a good price for your energy and you can actually start to go towards Pay-as-you-go or all these kind of things exposing customers to the market rate because the market moves on a half hour. That is very slow to change because of data hasn't come into the organization. The data is still being worked on in the organization to get it into a system where it can inform trading and the billing and the pricing. The other thing is when you're working under regulation you have to make sure all your systems are very secure. So it's very hard to feed new data into them because you are breaking these data rules [00:17:34][67.4]	Interview 15 - Company B	- Customers paying for their energy on a pay as you go arrangement - Time of use tarriff: exposing customers to the market		- **Real-time billing**: billing customers based on the energy price at the time of use	- **Price Customisation**	- adhering to regulation almost seen as an inhibitor towards leveraging smart meter data - to what extent is this objective, or is it socially construcuted within the company's culture that is becomes the truth / shared - choices about finances - where should the money be spent? Adhering to regulation is almost seen as more important than capitalizing on the value from smart meter data; therefore, installing meters and avoiding fines is on the top of energy company priorities.	both points are interesting. I agree that regulations are a constraint. But also, as you point out, the 'culture' of risk avoidance may be an interesting mechanism here. finally, I think adaptive pricing (or something like that) could be an additional affordance?