Knowledge Transfer: A Qualitative Investigation of the UK Low Carbon Innovation System

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ABSTRACT

Innovation programmes require organisations to transfer both technology and knowledge to the diverse actors who operate within innovation eco-systems. The changing relationship between science and society has witnessed the growth of public private partnerships (PPP) to create new knowledge, while also triggering the emergence of a 'new role' for universities as catalysts for innovation. This brings many challenges, stemming from the inherent nature of knowledge and the complex interactions involved with inter-disciplinary knowledge transfer. Concurrently, these public-funded programmes come under increasing scrutiny to demonstrate greater societal and economic impact as a return on research investment.

Knowledge generated within the UK low carbon energy innovation system has the potential to facilitate the achievement of national emission targets. However, while knowledge may be successfully created, there is no guarantee that it will be disseminated and utilised in a way that contributes to the achievement of knowledge-related objectives.

Current literature concentrates on the micro level inhibitors and enablers of knowledge transfer; however, a gap in empirical work which investigates system level knowledge interactions is evident. Research and practical application in this field has historically centred on technology transfer whilst under-emphasising the crucial role of knowledge within this complex, socio-technical innovation system. The overall aim of this qualitative study is to achieve a better understanding of the influences of knowledge transfer across a defined innovation system. This is achieved through the perceptions of participants via two case studies; one in a PPP and one in a University. Semi-structured interviews were conducted with twenty-eight participants, along with document analysis and participant observation at workshops, to investigate the participant perceptions. A three tier (macro-, meso- and micro-level) data analysis approach was adopted to reflect the systems level interactions.

The study found that knowledge transfer is often perceived as the dissemination of information via explicit forms of knowledge, which may or may not be used by stakeholders to achieve innovation objectives. The main barriers to stakeholders utilising knowledge included: accessibility to knowledge; fit-for-purpose knowledge; stakeholder motivation/ability to use the knowledge; and viewing knowledge as an object. While there is an emerging impact agenda in academia, cultural and normative influences direct researchers towards traditional academic outputs (e.g. publications).

Knowledge utilisation by stakeholders was found to be maximised through relational, stakeholder driven models, which view knowledge as a process. Knowledge utilisation was context specific, and, due to complex system influences, was never guaranteed to occur. Although planning for knowledge utilisation was undertaken at both the PPP and the University, implementing and measuring results was found to be difficult due to dynamic system influences such as understanding stakeholder motivations, resourcing constraints and complexity in the desired project outcomes. This makes adaptability and responsiveness important qualities for knowledge producers, while also necessitating specific skill sets. Based on this work, a set of principles were developed which should guide more effective utilisation of knowledge and promote more impactful research outcomes.

Keywords: knowledge transfer, knowledge utilisation, innovation systems, research impact, case study, low carbon innovation, energy

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DEDICATION

For James

Aim big, work hard and never give up –
you can achieve anything you put your mind to.

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CHAPTER 1: INTRODUCTION

1.1. RESEARCH BACKGROUND

Innovation is an enabler of national growth and competitiveness and can provide substantial benefits to national economies (Bramwell et al., 2012; Drucker, 1969; Edquist, 1997; Nonaka and Takeuchi, 1995). The past century has witnessed the diminution of traditional production activities and the emergence of the 'knowledge economy', in which the value of knowledge increases and innovation becomes imperative (Drucker, 1969; deMan, 2008; Nonaka and Takeuchi, 1995). In this paradigm, external modes of knowledge acquisition become normalised (Chesbrough, 2003) and the availability of knowledge underpins successful innovation (DuPlessis, 2007; Kiper, 2012). The ability of organisations to effectively manage their knowledge processes can also influence innovation outcomes (Inkinen, 2016). However, innovation is far from a simple linear phenomenon. Indeed, an increase in the complexity of innovation has caused a departure from the previously assumed linear innovation models towards interactive systems perspectives characterised by non-linearity and irrationality (Chiva et al., 2014; Edquist, 1997; Newell et al., 2009). These systems approaches are also characterised by interdependence, where the interactions between actors become as vital as the actors themselves (Edquist, 1997). Each innovation system is unique and conceptually diffuse: context is crucial, there are many influences of innovation, and each actor within the system may define the system and innovation success differently (Edquist, 1997). Innovation systems are also social systems, consisting of both processes and social practices (Brown and Duguid, 2002) that holistically result in institutional norms. Edquist (1997) suggests that institutions and institutional influences are a key factor in the success of innovation regimes. These institutional influences define the norms and social structures within innovation systems. Despite the acknowledgement that social influences are inherent within an innovation system and ultimately influence its success, many studies focus on positivist techno-economic factors. This had led to calls to focus on the 'soft side' of innovation (Byrne et al., 2012**;** Ockwell and Mallett, 2012).

The importance of knowledge is asserted by Drucker (1969; 1985) who suggests a post-war move from an economic paradigm of predominantly goods production to a 'knowledge economy'. This shift has seen an increase in the value of knowledge and significance of innovation, necessitating that governments become instigating forces in delivering national growth and increasing competitiveness (Meyer, 2012; deMan, 2008; Drucker, 1969; 1985; Nonaka and Takeuchi, 1995). The continuing co-evolution of science and society exerts novel pressures on research, new knowledge and innovation, with society demanding greater accountability from the state and

academia (Forrer, 2010; Meyer, 2012, Nowotny, et al., 2001). The Triple Helix model (Etzkowitz and Leydesdorff, 2000) suggests that knowledge is co-created between government, industry and state through a series of complex interactions. The model proposes that academia has become a central catalyst for innovation within national policy frameworks; a role that often incorporates state driven objectives to deliver greater societal and economic benefit which can be difficult to attain (deMan, 2008). Consequently, there is a growing incentive for collaborative engagements, applied research and social impact measures for universities. Etzkowitz and Leydesdorff's (2000) Triple Helix model further suggests that new models of collaborative engagement, such as Public Private Partnerships (PPP), have emerged through the co-evolution of science and society. The Triple Helix model proposes that more permeable boundaries exist between government, academia and industry, thus, providing an enhanced knowledge infrastructure through which knowledge is conducted and applied.

Innovation is an enabler of national competitiveness (Drucker, 1969; Nonaka and Takeuchi, 1995; Swan et al., 2010) and underpinned by the availability of knowledge (Du Plessis, 2007). Organisations must be able to exploit knowledge as a fundamental component in fostering successful innovation (Crichton-Sumners et al., 2013). Knowledge is a perceptual phenomenon, resulting in a multitude of conceptualisations, definitions and categorisations (Newell et al., 2009; Rowley, 2007). In relation to knowledge transfer, authors debate whether knowledge is transferrable, or whether the social connotations of some knowledge epistemologies mean that knowledge cannot actually be transferred. Instead it is seen as a transformational action ingrained in social process and the act of 'knowing' (e.g. Grant, 1996: Tsoukas, 2003). However, there is limited research that specifically investigates social motivations, contexts and individual level factors such as how individual perceptions of knowledge affect knowledge transfer (Crichton-Sumners et al., 2013). These intricacies have led to a vast catalogue of terminology as to what constitutes knowledge transfer. Some authors suggest knowledge transfer consists of a number of individual stages including knowledge diffusion, dissemination and utilisation (e.g. Green et al., 2009). Others propose knowledge transfer and utilisation are separate and distinct multi-stage processes (e.g. Landry et al., 2001). This differentiation, as well as the interchangeable use of these and other terms, has created confusion as to the goals and objectives of these processes and activities (Graham et al., 2006). Although Graham et al. (2006) states that these terms both incorporate the creation of action from knowledge (coining the term 'Knowledge-To-Action process' to represent both), there is limited research on what specifically constitutes knowledge transfer and utilisation success, how this is articulated and how this is measured. Subsequently there is a need to clarify the terminology and conceptualisations of knowledge-to-action processes. Argote and Ingram (2000) suggest there is a

need to investigate measures of success in the knowledge generating organisations. Additionally, Green et al. (2007) highlight a need to clarify terminology to ensure collaborators are all striving for the same goals under the same or similar assumptions. These needs have not yet been fully answered. More recently Heinsch et al. (2016) identify a need for empirical work in the area of knowledge utilisation to re-address an atheoretical imbalance in the field.

1.2. RESEARCH PROBLEM

The growth in UK low carbon innovation is motivated by the UK government's ambitious energy commitments. These obligations have resulted in the government introducing measures that aim to increase renewable energy in the UK's energy mix from 1.3% in 2005 to 15% by 2020; and reduce greenhouse gas emissions by at least 80% by 2050, relative to 1990 levels, via the Climate Change Act (2008) and the EU Renewable Energy Directive (2009) (Energy and Climate Change Committee, 2014:5). Subsequent government manifestos prescribe initiatives designed to develop, diffuse and deliver innovation, through increased collaborative knowledge generation and by influencing stakeholder behaviours (Foxon et al., 2005; van der Schoor and Scholtens, 2015). This includes addressing both technology push and market pull dimensions, which requires the ability to traverse many knowledge boundaries to effectively deliver both technological outputs and social outcomes. These challenges drive inter-disciplinary knowledge transfer, where specialised pools of knowledge are brought together for the purpose of innovation, in environments typified by uncertainty and unclear user impacts. To facilitate interdisciplinary knowledge flows, commonalities must be introduced via common language, common forms of communication and advocated shared meanings (Carlile, 2002; Grant, 1996). This is a notable challenge in the low carbon energy system due to: the novelty and uncertain nature of the innovations; the multiple parties that hold complex specialised knowledge; interdependent flows of knowledge; and the high risk of 'reusing' both existing knowledge and previously held assumptions (Carlile, 2002). The time sensitive nature of the challenge to meet energy related targets by 2050, make the research problem highly relevant, particularly given the long-time frames associated with new innovations becoming socially embedded (Foxon et al., 2005). The ability to create, transfer and apply knowledge within this environment is, therefore, a critical issue to policy makers, academia and industry. However, certain system characteristics make knowledge transfer and application a challenge. The UK low carbon energy system is a complex social-technical system encompassing technological, social, political and economic components (Geels, 2014). The system includes many diverse technologies, each with individual characteristics, policy influences and knowledge requirements, and is epitomised by uncertainty and unclear user impacts. The system is characterised by numerous, fragmented

innovation organisations and regimes that have overlapping priorities and multifaceted, fragmented governance structures (Winskel et al., 2014). Additionally, it comprises of numerous different actors and their cultural values, routines and practices which influence knowledge flows throughout the system (Foxon, 2013). The system has many environmental influences including: complicated economic factors and a short-term policy focus (Winskel et al., 2014); and complex social environments and the effects of historical energy transitions that result in obscure demand influences (Geels, 2014; Grubler, 2012). For further discussion on specific characteristics of the system, see Muchmore, Ragsdell and Walsh (2015; 2016) in Appendix 1 and 2 respectively. The above-mentioned complexity of the system has led to a lack of understanding by potential stakeholders, on how to engage with knowledge creators within the system (National Audit Office, 2013). Additionally, each individual within the system is likely to perceive the system in a different way (Checkland and Poulter, 2010). This thesis adopts an interpretivist stance to examine and include the different perceptions of individual knowledge creators within the system. It then uses this as a base to more deeply investigate how the components of the system defined above, interact and influence knowledge transfer.

The existing literature presents numerous facilitators and inhibitors of knowledge transfer that are found across individual, organisational, partnership and sectorial layers. These facilitators and inhibitors must be identified and controlled, to facilitate successful knowledge management practices and ultimately deliver innovation. Although this micro analysis aids understanding of loosely-related phenomena, innovation systems approaches suggest that individual process improvement, may not correlate with an overall systems improvement (e.g. Edquist, 1997). Instead, extant literature "assumes that [knowledge transfer] is driven by a relatively narrow range of determinants" (Ward et al., 2009:2). However, limited work has been undertaken on the broader knowledge flows, due to predominantly viewing knowledge transfer as a goal, rather than a process (Ward et al., 2009). This oversight often results in the transfer of knowledge being seen as the ultimate objective, rather than investigating what knowledge creators aim to achieve from their knowledge activities.

Knowledge generated within the UK low carbon energy innovation system has the potential to facilitate the achievement of the above-mentioned UK national and supra-national emission targets. However, research and practical application in this field has historically centred on technology transfer whilst under-emphasising the crucial role of knowledge within this complex, socio-technical innovation system. There is also a lack of analysis of the factors that influence low

carbon technology adoption from a systems perspective (Chmutina and Goodier, 2014). Fender (2010) proposes that knowledge transfer in the context of innovation goes beyond technical knowledge capacities: rather it is concerned with the conversion of innovation outputs into value creating mechanisms. Technologies may create value, but successful knowledge exploitation captures value (Robertson and Jacobson, 2011; Wood, 2004). Over-emphasising the techno-economic factors distorts the role of institutional behaviour, by assuming bounded rationality and perfect knowledge (Rutten and Boekema, 2007). As such there is a need to undertake studies that focus on the intangible components (such as knowledge) of innovation (Byrne et al., 2012**;** Ockwell and Mallett, 2012) and the human influences of innovation (Rutten and Boekema, 2007).

Current literature concentrates on the inhibitors and enablers of knowledge transfer where knowledge is viewed as an object that is to be transferred. Studies that include relational models of knowledge utilisation are concentrated in health care and policy environments, with limited application in a socio-technical innovation system. Whilst knowledge may be successfully created, there is no guarantee that it will be disseminated and utilised in a way that contributes to the achievement of objectives. Belkhodja et al. (2007) suggest an increased focus on knowledge transfer due to greater accountability on mechanisms which utilise public funds and the need to achieve impact from research. However, there is an espoused need for qualitative studies that describe impact (Rosli and Rossi, 2016) and for studies that investigate individual, organisational and broader level environmental factors which facilitate the creation of impact (Rossi et al., 2017).

1.3. Research Aims And Objectives

Previous studies have concentrated on identifying and analysing one or a small number of variables when considering the enablers or inhibitors of knowledge transfer. This does not represent the complexity that characterises innovation systems approaches (Edquist, 1997). Empirical work which incorporates the utilisation of knowledge is limited with recent calls being made to address this gap (Heinsch et al. 2016). The well cited, but dated, models of knowledge utilisation offer similar linear processes, which arguably, contain aspects more related to the transfer of information, rather than the actual utilisation of knowledge (e.g. Estabrooks, 1999; Knott and Wildavsky, 1980; Rich, 1997). The various studies of knowledge transfer and utilisation have been conceptually unclear, offering a variety of interchangeable terms, models and definitions (Graham et al., 2006). Concurrently, work pertaining to energy innovation, has predominantly investigated techno-economic facets in a linear innovation environment, while excluding the role of knowledge (e.g. Grubb et al., 2008). This overriding view fails to reflect the complexity of innovation systems' and the wide-ranging influences

that effect the transformation of knowledge into action. Therefore, the aim of this research is to assess the knowledge transfer processes of two organisations and compare the systems influences they are subject to. In order to address the overall aim, the following objectives have been set:

- Conduct a review of the existing relevant literature;
- Examine and identify what participants are trying to achieve through their knowledge activities;
- Develop an understanding of how participants perceive knowledge transfer;
- Analyse the influences which contribute to these perceptions;
- Investigate and identify the systems factors which influence knowledge activities from a macro-, meso- and micro- level analysis;
- Clarify the terminology surrounding knowledge transfer, knowledge utilisation and impact;
- Develop principles to guide more effective knowledge utilisation in line with organisational objectives.

The study is guided by the following research questions:

1. What knowledge activities are undertaken to realise knowledge-related goals?

   This question analyses the types of activity undertaken and facilitates a greater understanding of how these activities enable the attainment of organisational and project objectives. It investigates whether knowledge is viewed as a transferable object or as a process, and whether information and knowledge are perceived as different.

2. How is knowledge transfer perceived by those creating knowledge?

   This question investigates the participants' perceptions of knowledge transfer. It examines whether perceptions vary across organisations and between disciplines and aims to better understand the participants' perceptions of what constitutes knowledge transfer success within their individual contexts.

3. What are the system wide influences on knowledge transfer?

   This question investigates the various influences from a macro-, meso- and micro- level, while understanding how each participant views the system under investigation. In this sense, it aims to evaluate knowledge transfer within a complex innovation system (rather than a linear model of innovation).

For the purposes of this study, a broad interpretation of knowledge transfer is adopted, which reflects the process of transforming knowledge into specific actions that achieve innovation objectives (e.g. Graham et al., 2006).

1.4. Significance Of The Study

This study contributes to both theory and practice in the field of knowledge transfer and utilisation. Regarding the theoretical contributions, the study extends and clarifies conceptualisations of knowledge transfer, knowledge utilisation and impact. It explicitly differentiates between concepts that aim to increase recipient knowledge (knowing), and those which aim to increase the utilisation of knowledge by motivating knowledge recipients to use the knowledge (using). Through clarifying these often interchangeably used terms, the study offers new definitions that can minimise confusion pertaining to the goals of knowledge creators. The study also enhances the literature around Triple Helix innovation systems (Etzkowitz and Leydesdorff, 2000), through the evaluation of barriers that were revealed to exist within this framework. Methodologically, the study views the problem of knowledge transfer and utilisation from an innovation systems perspective, acknowledging the associated complexity and moving away from the predominant analysis within the field, of a small number of variables and the use of a linear view of innovation. It also explicitly adopts an interpretivist approach which includes intangible aspects of innovation systems, to balance the positivist frameworks and techno-economic stances that are present within the low carbon innovation literature. Practically, the study develops principles that guide more effective knowledge utilisation by: linking organisational objectives to specific knowledge activities; emphasising the importance of relational activities in order to motivate knowledge use; and offering support mechanisms that are needed to maximise opportunities for knowledge utilisation.

1.5. Structure Of Thesis

This thesis contains eight chapters and is structured as follows. Chapter 2 analyses and synthesises a review of the current literature from the fields of innovation, the nature of knowledge, knowledge transfer and knowledge utilisation. Chapter 3 then evaluates the different methodological choices and justifies the chosen methodology for this study. This includes analysing and justifying its theoretical underpinnings, the selection of a case study approach, and the use of data collection/ analysis techniques. Chapters 4 and 5 contain the in-depth qualitative analysis for each of the two case studies (presented as individual chapters). This facilitates the provision of detailed rich descriptions of each case study in its own context, presented as inductively derived themes. Chapter 6 then provides the cross-case analysis, providing comparison between the two case studies,

identifying the similarities and differences between the two. Chapter 7 analyses the main findings from the study, incorporating the literature review, the within- and cross-case analysis. It also introduces new literature, which addresses the themes that have emerged throughout the study. Finally, Chapter 8 provides overall conclusions to the study consisting of the research overview and key findings, the nature of the results, the main contributions of the study, its limitations and directions for future studies.

CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

This chapter analyses the extant literature on innovation, knowledge and knowledge transfer in relation to the presented research problem. Section 2.2 critically reviews innovation within the knowledge economy and systems approaches to innovation. Section 2.3 debates what knowledge is and analyses the various frameworks and perceptions surrounding epistemology. Section 2.4 critically reviews the complex concept of knowledge transfer and the various terminology and conceptualisations associated with it. Section 2.5 critiques the enablers and inhibitors of knowledge transfer, while section 2.6 defines the gaps in the literature.

2.2. INNOVATION

This section establishes the role of innovation within the knowledge economy and analyses current concepts of innovation, as a foundation from which to review the literature on knowledge. It reviews innovation systems approaches, before discussing the nature of institutional influences on innovation systems.

2.2.1. SYSTEMS APPROACHES TO INNOVATION

Many definitions of innovation are found in the literature ranging from narrow technical views to more expansive systems perspectives (Lundvall, 2007). Schumpeter is widely cited when defining innovation and, in particular, proposes that innovation consists of new products, processes, markets and organisations (Lundvall, 2007; Vargo et al., 2015). Traditionally, linear models of the innovation process (see Figure 2-1) have been assumed that follow a path from research to diffusion (Godin, 2006).

FIGURE 2-1: LINEAR MODEL OF INNOVATION

These models often segregate producer facets of innovation from consumer ones, leading to a technology push (supply side) versus market pull (demand side) dichotomy (Vargo et al., 2015).

However, innovation is far from linear. Newell et al. (2009) recognise a number of challenges with linear models of innovation, suggesting that: the innovation process is neither linear nor rational; it is not a homogenous concept which can be rigidly applied in different contexts but dependent on social conditions; it lacks predictable outcomes; and supersedes technical capacity in that knowledge and expertise regarding the innovation *process* itself is necessary.

The recognition of innovation as an interactive process, in which organisations are embedded in a wider system, led to conceptualising innovation in terms of systems, rather than as the previously assumed linear model (Lundvall, 2007). Edquist (1997: 20) considers innovation as "a complex web of interactive relationships [that] characterises the transformation of scientific and technical knowledge into new production processes, products and services". This implies that social influences and relationship building are central to innovation success (although this view limits the necessary knowledge type to technical knowledge). Lundvall (2007) suggests the innovation process is "an intricate interplay between micro and macro phenomena where macro-structures condition micro-dynamics and vice versa new macro-structures are shaped by micro-processes". Despite this inclusion of different levels, innovation systems models have been criticised for not sufficiently representing micro-level processes (Hekker et al., 2007; Markard et al., 2015). When considering innovation as a system, Bramwell et al. (2012: 6) propose that "innovation results from the interaction among the specific components of invention, research, technical change, and learning that comprise the system". However, this suggests that innovation is an automatic 'result' from interactions in the system, which is arguably not the case: there is no guaranteed end state due to the absence of any linear causal relationships within innovation systems (Borras and Edquist, 2015). A major challenge associated with innovation systems is the ability to demarcate the actual system under investigation and apply context. However, as Markard et al. (2015) allude to, the innovation system boundary setting, will ultimately be guided by individual research contexts and questions, as well as the perceptions of those actors within the system. Additionally, innovation systems do not adequately reflect the dynamic nature of innovation; instead they offer a static view (Hekkert et al., 2007).

There are a number of models of innovation systems that have evolved, although not sequentially; old models do not become obsolete, rather they operate in a cycle of "endless transition" (Etzkowitz and Leydesdorff, 2000: 113). The current innovation systems landscape therefore, encompasses a number of models, which can simultaneously be in existence within any partnership or organisation

(MacLean et al., 2002). Systems of innovation can be characterised by either geographic region or by social and technical context (Kiper, 2012). A summary of these is provided in Table 2-1.

PARADIGM	CHARACTERISTICS	E.G.
Mode 1	Systematic using prescribed scientific criteria to generate original knowledge Based on positivist framework Theoretical and based on peer review Hierarchical and discipline based Removed from social accountability Knowledge is a public good with government funding Based on Mertonian norms	(Nowotny et al., 2003; MacLean et al., 2002; Schoonmaker and Carayannis, 2012; Slaughter and Rhoades, 2004; van Manen, 2001)
Mode 2	Evolving with society and forces changes to academia Transdisciplinary and problem centric Utilises creative and innovative methods Engages with government, corporations & community Produced in context of application Socially accountable with a diverse range of quality controls Knowledge is a private good (increases academic involvement in market behaviours) Challenges Mertonian norms and traditional social contracts	(Gibbons et al., 1994; Nowotny et al., 2003; MacLean et al., 2002; Schoonmaker and Carayannis, 2012; Slaughter and Rhoades, 2004; van Manen, 2001)
Triple Helix	Triadic but balanced relationship between government, academia and industry Occurs within changing social paradigms Aims to produce a 'knowledge infrastructure' Expands roles of each unit beyond the original designation Forces internal and external changes in the unit operations Increases boundary permeability between organisations Facilitates generation, diffusion and utilization of knowledge	(Etzkowitz, 2003; Etzkowitz and Leydesdorff, 2000; Ranga and Etzkowitz, 2013)
Quadruple/ Quintuple Helix	Includes civil society in the relationship (Quadruple) Contains notions of media communication (Quadruple) Includes socially embedding processes (Quadruple) Includes the natural environment (Quintuple) Includes sustainable development (Quintuple)	(Carayannis and Campbell, 2009; Carayannis et al., 2012; Leydesdorff, and Etzkowitz, 2003). Schoonmaker and Carayannis, 2012)
Technological Systems	Based on economic competence, resource clusters and institutional frameworks Incorporates the diffusion and utilisation of technologies May or may not be restricted by the boundaries of a nation Considers that firms, nations and institutions operate with different knowledge stores and different assumptions	(Stankiewicz and Carlsson, 1991)

Socio-Technical Systems	Scope increased to include the demand side (user environment) and diffusion of knowledge Makes distinctions between: systems (resources, material aspects), actors and institutions Introduces the role of institutions (i.e. rules) in dynamic developments rather than as a stability mechanism	(Geels, 2004)
National Systems of Innovation	Encompasses elements and relationships within the boundaries of a national state National cultural norms facilitate knowledge sharing National level policy initiatives (which may include interaction with other regional levels) Potentially less relevant in a globalised economy (increasingly difficult to define system influences strictly within one nation state) Focuses on both horizontal relationships (competitors) and vertical relationships (buyers, intermediaries and sellers)	(Andersen and Lundvall, 1997; Lundvall, 2010; Lundvall et al., 2002; Freeman, 1995; Nelson and Rosenberg, 1993)
Regional Systems of Innovation	Innovation is seen as a geographical process Emergence of regional clusters of industrial activity (focus on regional scale) Increase in regional level innovation policies as best level for successful innovation Proximity as enabler of innovation Innovation occurs where local capacities exist (skills, knowledge, technology, facilities, networks) Organisations have the leading role in innovation	(Asheim and Isaksen, 2002; Cooke, 2001; Doloreux and Parto, 2005)
Sectorial Systems of Innovation	Focus on products and services for a specific purpose Focus on the distinctive changes occurring within sectors Incorporates interdependencies with associated industries Emphasises dynamics, process and transformation Focus on the organisation as the primary unit Focus on development of knowledge, rather than diffusion (supply side focus)	(Breschi and Malerba, 1997; Malerba, 2002)

TABLE 2-1: SUMMARY OF INNOVATION MODELS

Systems approaches conceptualise innovation as an evolutionary and social process, which is influenced by many actors who collaborate both inside and outside of an organisation (Doloreux and Parto, 2005). These frameworks demonstrate how organisations have to adapt both internally and externally, within the milieu of dramatically shifting social, political and competitive expectations.

Despite these models of various innovation regimes, recent literature suggests a need to analyse the *intersections* of different levels to explore co-existing layers of innovation systems that holistically influence the innovation process (e.g. Meuer et al., 2015). Authors have suggested that the influences of low carbon innovation in particular, need to be investigated from and across a number of systems levels, including at the local level (Hawkey et al., 2013) and a larger socio-political level (Chmutina and Goodier, 2014). Additionally, there have been calls for empirical research on how institutional and individual preferences affect success at a project level (Chmutina and Goodier, 2014)

and at a higher innovation systems level that recognises the complexity of the energy system (Bale et al., 2015; ICCEPT, 2003).

Edquist (1997) offers a number of factors that are present in all systems of innovation (see Table 2-2).

Factor within an innovation system	Characteristic
Innovation and learning	Knowledge as resource
Holistic and interdisciplinary	Contextual, many different influences
Historical local resource availability	Time and resource dependent
Interdependence and non-linearity	Importance of interactions of system elements
Conceptually diffuse	Ambiguity of a systems elements/ different world views of the system
Institutional influences	Structures which affect social functions

TABLE 2-2: CHARACTERISTICS OF SYSTEMS APPROACHES TO INNOVATION (EDQUIST 1997:27)

Innovations and learning are the focus of all systems approaches, where knowledge is the most crucial resource in an economy and learning is the most essential process. A systems approach is *holistic and interdisciplinary,* where multiple actors are involved on a highly contextual basis and influences extend to include organisational, institutional, social and political factors. Both the innovations themselves and the accompanying influences are formed from *historical local resource availability* and policies that maximise local resource utilisation. Hence, various systems (even at a regional level) can develop exclusively, due to the historical localised use of both natural and human resources. As suggested above, the utilisation of knowledge by stakeholders is a crucial component of successful innovation, although multiple influences within a system often confuse any direct cause and effect relationship (Kiper, 2012). Therefore, the systems approach is characterised by *interdependence and non-linearity,* where the interactions between actors become as vital as the actors themselves. Systems approaches are *conceptually diffuse* in that conceptual frameworks (as opposed to theory) are presented. Related to this, a 'real system' is distinguishable from human representations of systems; these representations inherently occur under any human analysis, where interpretation is unique to any individual within the system (Checkland and Poulter, 2010). As such, the ability to comprehend individual perceptions held by the actors within it, can enrich the overall understanding of the system in question.

Edquist and Johnson (1997) suggest that institutions and *institutional influences* are a central component of systems approaches and can affect the success of innovations. Institutions are defined by authors in varying ways, either as 'bodies' in which they are closely linked to organisational boundaries or as the rules and norms that guide social interactions. This second

perspective draws on institutional theory, in which organisations are seen to exist in an environment of institutions (in this case the low carbon innovation system can be defined as an institution). These institutions constrain behaviours through the influences of regulative coercion, normative expectations and individual interpretations of roles (Alexander, 2012; Scott, 2001). Table 2-3 illustrates the three main pillars of institutional theory. These different types of influence interact and can affect the effectiveness of innovation processes within a firm (Alexander, 2012).

	REGULATIVE	**NORMATIVE**	**CULTURAL-COGNITIVE**
Basis of compliance	Expedience	Social obligation	Shared understanding Taken-for-grantedness
Basis of order	Regulative rules	Binding expectations	Constitutive Schema
Mechanisms	Coercive	Normative	Mimetic
Indicators	Rules Laws Sanctions	Certification Accreditation	Common beliefs Shared logics of action Isomorphism

TABLE 2-3: THREE PILLARS OF INSTITUTIONS (SCOTT, 2001)

Therefore, institutions shape the cultural and social contexts in which individuals act, whilst individuals simultaneously shape and re-shape institutions. This interdependency is also espoused by Brown and Duguid (2002: 96): "while process is clearly important to the overall coherence of an organisation, in the end it is the practice of the people who work in the organisation that brings process to life and, indeed life to process".

The systems perspective, therefore, becomes crucial in effectively ascertaining a picture of the influences on innovation outcomes. Although some studies have been undertaken that explore the various institutional influences of energy innovation (e.g. Anders-Speed, 2016), these are mainly theoretical and not empirically designed.

2.2.2. Complexity Within Innovation Systems

Lundvall (2007) suggests caution is needed when applying theory from other fields, referring to the use of systems theory, within the context of innovation systems. However, it is useful to highlight here, some main components of systems in order to understand the complexity involved when

moving away from linear models of innovation. Dominant modes of thinking are based on Newtonian mechanics, which assert a unit can be dissected into its parts, and by determining the governance of each individual part, the whole unit becomes more predictable and, therefore, easier to control (Stacey et al., 2000). However, this approach (particularly in a social world) does not reflect the complexity in causation (Byrne, 1998). Businesses do not operate in a predictable 'cause and effect' paradigm, but one of uncertainty and ambiguity, where systems are viewed as emergent, living and adaptable (Mitleton-Kelly and Birkenkrahe, 2004). A system is multi-layered, although individual levels (i.e. a part or whole) cannot be comparatively analysed as they are 'qualitatively different' (Richardson, 2004a; 2004b; 2005). Markham and Lee (2014), in recognising the usefulness of this approach, suggest that a limitation of current product development literature is an over-emphasis on only one or few variables to explain the complexities of a system.

Human systems are innately complex due to characteristics of human neurological, psychological and behavioural processes which encompass choice and autonomy (Markham and Lee, 2014; Stacey et al., 2000; Wood, 2004). Human processing may involve irrational interpretations and decisions (Capra, 1997) based on both fact and human bias (Teale et al., 2003). Human memory function, thought processing and decision making are never truly rational, completely conscious or reliant solely on neurological functions (Capra, 1997). This results in uncertain environments where the unknown is slowly revealed through the continuous process of multi-directional communication and interaction (Stacey et al., 2000). Both organisational behaviour and complexity theory give insight into the dynamics of human interaction and also reference the inherent uncertainty in human responses to changing stimulus from their environment (i.e. open systems that are subject to inputs). The complexities of human engagement result in the system constantly changing through interaction (Stacey et al., 2000), whilst the dynamics of a defined system are based on subjective views of those involved at any one point in time (Checkland and Poulter, 2010). Bottom and Kong (2010) suggest that any divided or bounded set of individuals (e.g. departments, functions or organisations) will have different foci for knowledge sharing and decision making, dependent on group objectives. Concurrently the individuals that form the structure of the group will also influence internal group sharing processes and outcomes depending on individual dynamics and individual perceived or actual power distribution.

Complexity within a system is also increased due to the nature of reality being unique to each individual. Described as 'conflicting worldviews', the interaction of humans generates tensions due to each individual subjectively ascribing unique meaning to a situation, dependent on their own

knowledge, background and experiences. Furthermore, these views are constantly changing. Subsequently, any attempt to describe a situation only reflects one perspective of it at any given time (Cilliers, 2004). In this sense, systems descriptions are only representations of a system and not the actual system itself. However, multiples actors, processes, perspectives and structures are inherently part of innovation and knowledge transfer (Bressers and Gerrits, 2015; Crichton-Sumners et al., 2013), with each actor holding different perceptions of the system. Bressers and Gerrits (2015: 51) assert a direct link between complexity and the attainment of goals of knowledge and innovation programmes: "we expect systemic complexity to interfere with the process of goal achievement, both in terms of how policy programmes impact the real world and in terms of how such impacts can be measured". They also suggest that multi-actor engagements add to the complexity and, therefore, the attainment of goals. Commenting on public private partnerships where 'societal change' was a common programme objective, they state (p. 52):

> "Multi-actor participation means that the relationship between action undertaken and effects realized becomes more diffuse. The more stakeholders and opinions present, the higher the complexity. The diversity of the participating institutions and organisations could easily lead to differing objectives and interests, which means the direction of the programme is not as unified and pre-set as initially assumed".

This analysis suggests the importance of exploring the multiple influences of the systems environment. However, extent literature pertaining to knowledge and innovation programmes, focuses on a single or a limited number of variables. This approach does not recognise or represent the nature of complex systems environments or allow for adequate exploration of the institutional influences of knowledge transfer within innovation systems.

2.2.3. The Link Between Innovation And Knowledge

The growth of the knowledge economy has seen a post war move from an economic paradigm of predominantly goods production to a 'knowledge economy' (Drucker, 1969). This shift has contributed to an increase in the value of knowledge and the significance of innovation (Carayannis et al., 2015; deMan, 2008; Estabrooks et al., 2008; Nonaka and Takeuchi, 1995). Knowledge is now highly mobilised, widely distributed and more easily accessible. Additionally, the utilisation of knowledge by stakeholders is an inherent part of innovation success (Kiper, 2012). This leads actors to engage in multiple interactions with external parties, to facilitate the supply and assimilation of externally located knowledge for innovation and to achieve economic impact (Bathelt and Gluckler,

2011; Chesbrough, 2003; Gassmann et al., 2010). This necessitates new structures, mechanisms and skills development to manage the complexity of the innovation process (Du Chatenier et al., 2010). Previous studies have suggested that an organisations ability to adopt practices that effectively manage knowledge, is critical in successful innovation (Hecker and Ganter, 2016; Inkinen, 2016). Wood (2004: 144) suggests that "innovation creates value, good business models capture value" (see Table 2-4). However, little empirical work exists that focuses on how organisations capture value through their business models and knowledge infrastructures.

OLD BUSINESS MODEL	NEW BUSINESS MODEL
Material and financial capital	Human and social capital
Efficient machine	Living adaptable system
Simple cause and effect	Emergent system dynamics
Managing to end state	Managing to context
Fixed organisation and boundary	Shifting webs and permeable boundaries
Control for best practice	Influence for adaptive tension

TABLE 2-4: OLD AND NEW BUSINESS MODELS (WOOD, 2004: 70)

Innovation is irrefutably critical to the growth of nations, organisations and individuals. It can be viewed as an enabler of national growth and competitiveness (Bramwell et al., 2012; Drucker, 1969; Edquist and Johnson, 1997; Nonaka and Takeuchi, 1995), and can facilitate sustainable practices and increase social welfare (Carroll and Buchholtz, 2012; Komninos, 2002). Knowledge can function as both an input and output of innovation (Cohen and Levinthal, 1989; 1990; Kiper, 2012; Landry and Amara, 2012).

Burns and Stalker (1994: 19) present a symbiotic relationship between innovation and social change suggesting that the actors involved in science, innovation and social change are interdependent and increasingly influential on innovation systems (Burns and Stalker, 1994; Nowotny et al., 2001). Innovation and society, therefore, act as complementarities; reinforcing each other through continuing interactive loops of new innovations, new knowledge and changes in consumer behaviour, which results in higher economic growth (Afonso et al., 2012; Matsuyama, 1995). Furthermore, society has become increasingly demanding in the innovation agenda through the increased exertion of 'bottom up' influences, combined with a proliferation of the 'rights' movement (Carroll and Buchholtz, 2012; Nowotny et al., 2001) and increases in information availability and communication technologies that enrich knowledge sharing (Afonso et al., 2012).

The above changes have influenced new innovation models (Burns and Stalker, 1994). The government, industry and academia increasingly cooperate in various public-private partnerships,

which offer the potential to leverage the resources and expertise of others to generate new knowledge and innovations (Szulecki et al., 2011). These engagements redefine traditional activities and typically blur the traditional boundaries between the actors involved (Etzkowitz and Leydesdorff, 2000; Slaughter and Rhoades, 2004). A new role has subsequently emerged for universities as catalysts for innovation within national innovation policy frameworks. Knowledge has moved from being deemed a 'public good' to that of a 'private good', in which a new 'social contract' has been formed between society and academia (Slaughter and Rhoades, 2004). This has resulted in greater academic participation in market behaviours and applied research (Slaughter and Rhoades, 2004); an increased focus on 'social impact' as a measurement of research quality (Hicks, 2012; Smith et al., 2011); and generates multiple barriers in engaging in knowledge work outside of the academic environment (Francis-Smythe, 2008). However, while the above literature asserts a change of academic focus to include impact, there is limited research that empirically investigates what impact is or how it can be maximised (Rosli and Rossi, 2016; Rossi et al., 2017).

Knowledge can be seen as an input to the innovation process, which facilitates the development of new products, services, processes and policies (e.g. Amabile, 1988; Cassiman and Valentini, 2016; Chesbrough, 2003). However, for the purposes of this study, the focus is on the knowledge that is produced as a result of the innovation process. For example, Kiper (2012) suggests that organisations undertake a period of learning through innovating, with new knowledge subsequently becoming an output of the innovation process. Innovation is dependent on the successful transfer of knowledge (Kiper, 2012), where the knowledge produced needs to be converted into products and processes that achieve some kind of economic impact. Accordingly, Du Plessis (2007: 21) suggests that innovation is: "the creation of new knowledge and ideas to facilitate new business outcomes, aimed at improving internal business processes and structures and to create market driven products and services". Edquist (1997:16) describes this as a transformational process, asserting: "Innovation is a matter of producing new knowledge or combining existing knowledge in new ways – and of transforming this into economically significant products and processes". The process of developing economically significant products and processes is far from simple. Additionally, Van de Ven (1986: 591) alludes to the many influences that are found within this process, suggesting innovation is: "the development and implementation of new ideas by people who over time engage in transactions with others within an institutional context". Cooke (2001) further emphasises the wider institutional influences of innovation, suggesting that the route from innovator to consumer of innovation is not straightforward and often involves many intermediaries. This perspective has resulted in the traditional models of linear innovation being challenged by

interactive systems approaches, where interactions between intermediaries are considered (Edquist, 1997; Newell et al., 2009; Rickards, 1985). However, there is little empirical work that explicitly adopts this systems view to investigate how knowledge, as an output of an innovation process, is exploited for success (Jenson et al., 2016).

Given the above analysis on innovation and its link to knowledge, this study defines innovation as: "the utilisation of new knowledge by stakeholders, in a way that adds value for the organisation and the stakeholders through generating positive economic and social impact". This definition recognises the systems and relational aspects of the innovation process and the necessity of knowledge being exploited to create the above mentioned economic impact.

2.2.4. Defining The UK Low Carbon Innovation System

The UK low carbon energy innovation system consists of multiple technological sectors and a complex network of interacting actors. There are a number of environmental influences to consider including numerous policy initiatives, research agendas, economic mechanisms and social factors. Knowledge is both an input and an output of this system, with knowledge transfer activities aiming to: create and diffuse new knowledge; supply tangible and intangible resources; build research capacity; and create positive economic movement (Szulecki et al. 2011). Foxon et al. (2005) offer a trichotomic perspective of the innovation system that is used here to identify the main components of the innovation system environment. Firstly, the innovation regime encompasses knowledge activities from basic research and development, through to diffusion of technology and knowledge to end users. The knowledge flows throughout the innovation system are complex due to the multiple parties which hold specialised knowledge; interdependent flows of knowledge; and the high risk of 'reusing' both existing knowledge and previously held assumptions (Carlile, 2002). Secondly, the system is characterised by a high degree of complex political and regulatory mechanisms to support innovation. However, there are a number of policy challenges within the wider environment, including creating long-term targets and stability to encourage commitment in knowledge collaborations (Heffron et al., 2013; Kruckenberg, 2015); and establishing optimal structures to fund, coordinate and facilitate KT activities (Kruckenberg, 2015). Thirdly, there are a number of complex demand factors when considering the wider environment. Influencing the technology adoption of domestic and industrial end users, is a multifaceted problem with no easy solution and requires extensive knowledge to realise large scale, sustainable adoptions (Kruckenberg, 2015; van der Schoor and Scholtens, 2015). The complexity of climate change is challenging for energy users to fully grasp and not easily understood without a contextual knowledge base from

which to interpret the circulated information (Heffron et al., 2013). This complexity must be addressed as part of a portfolio of coordinated approaches of relevant information sharing with the public. The complex environment means that there are many knowledge boundaries to be overcome. The above system and its environment factors are represented in Figure 2-2.

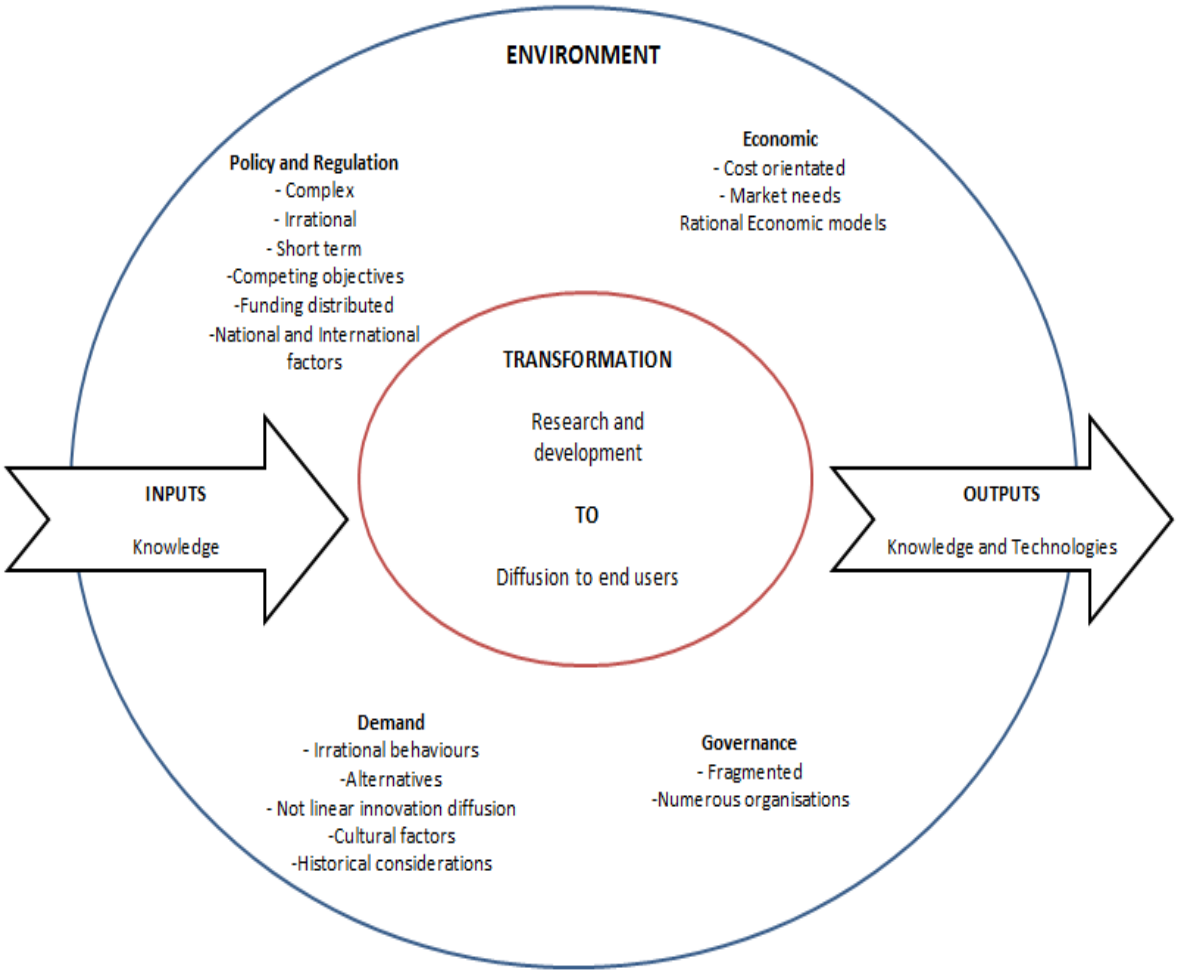


FIGURE 2-2: DEPICTION OF THE UK LOW CARBON INNOVATION SYSTEM

This system has been defined by analysing current literature on the low carbon innovation system. However, as section 2.2.2 suggests, each individual within a system may have different representations of the system. This thesis aims to investigate individual perceptions of the innovation system, as a basis to explore the influences of knowledge transfer.

2.3. KNOWLEDGE

This section reviews the various arguments of what knowledge is and examines the challenges of providing a conclusive definition. It then evaluates different knowledge components and frameworks.

2.3.1. Defining Knowledge

Effective knowledge transfer and utilisation are fundamental components in fostering successful innovation (Crichton-Sumners et al., 2013). But can knowledge actually be transferred? There is an array of definitions, categorisations and conceptualisations of knowledge, triggered by the perceptual nature of knowledge (Newell et al., 2009; Rowley, 2007). Nonaka et al., (2000: 14) support Plato's earlier notions of knowledge, defining it as "a justified true belief". However, even this is open to interpretation, dependent on an epistemological foundation that asserts the belief in one 'true' version of knowledge. The following definition is offered by Davenport and Prusak (1998: 5) and incorporates the constructivist underpinnings of this research. It states knowledge is:

> "A fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices, and norms".

This definition provides a useful insight into how knowledge has been categorised according to its different facets. Firstly, the reference to expertise and documented knowledge represents 'explicit' knowledge, whilst the integration of experiences refers to 'tacit' knowledge. Secondly, there is a distinction between information and knowledge. Thirdly, knowledge can be viewed as an object or as a process. Fourthly, context is inherent in knowledge application.

Table 2-5 summarises these views of knowledge and demonstrates how they can be mapped against different research paradigms, which suggest either a 'true' reality or 'multiple realities'. Given the subjective nature of tacit knowledge, the next section will analyse whether tacit knowledge can be moved from one person to another.

POSITIVIST RESEARCH PARADIGM	→	**INTERPRETIVIST RESEARCH PARADIGM**
Explicit		Tacit
Information		Knowledge
Knowledge-as-object		Knowledge-as-process
Objective		Subjective

TABLE 2-5: VIEWS OF KNOWLEDGE AGAINST RESEARCH PARADIGMS (SHEFFIELD, 2009: 8)

2.3.2. EXPLICIT AND TACIT KNOWLEDGE

Explicit knowledge has a number of characteristics: it can be articulated (Busch, 2008; Newell et al., 2009) in a formal and systematic language (Nonaka et al., 2000); can be easily transmitted (Liyanage et al., 2009); is exposed mainly through communication (Grant, 1996); can be stored (Nonaka et al., 2000); can be held in documents and repositories (Busch, 2008; Riege, 2005) and allows deliberate managerial planning (Busch, 2008). These descriptions suggest knowledge can be viewed as an object, separate from a person or human thought. However, this is arguably impossible: human interactions are necessary for the formation and assimilation of documentation through the processes of reading, understanding and writing (Busch, 2008). Nowotny et al. (2001: 118) support the inextricable link between knowledge and human interaction, stating that "all knowledge in the end will be related to people".

Tacit knowledge is far more complex, with suggested characteristics including: it cannot be easily expressed (Busch, 2008); is difficult to teach (Newell et al., 2009); can be taken for granted by the person who holds it and influenced by individual beliefs (Polanyi, 1958); is highly personal and intuitive (Nonaka et al., 2000; Polanyi, 1967) and adds more value to organisations compared to explicit knowledge (Liyanage et al., 2009).

Nonaka and Takeuchi (1995: 62) developed the SECI model, which suggests methods in which explicit and tacit knowledge can be converted or transformed between the two types (see Figure 2-3).

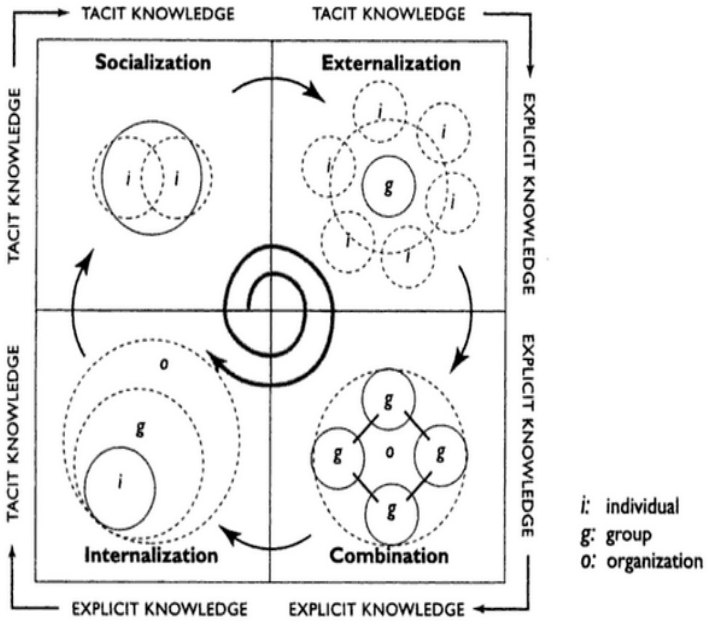


FIGURE 2-3: THE SECI MODEL (NONAKA AND TAKEUCHI, 1995: 62)

This is done through one of four ways:

- Socialisation (Tacit to tacit): this is an individual to individual socialisation process in which common understandings and perspectives are generated through guidance and informal meetings. A focus is given to proximity of individuals.
- Externalisation (Tacit to explicit): in which "the sum of the individuals' intentions and ideas fuse and become integrated with the group's mental world". This process requires the articulation of tacit knowledge into understandable forms and codified sources (e.g. documents and databases).
- Combination (Explicit to explicit): is a process of sorting, combining and disseminating codified knowledge sources into a 'knowledge system'. New knowledge can also be created.
- Internalisation (Explicit to tacit): is the process of 'embodying' explicit knowledge to develop tacit knowledge in the form of both technical skills and know-how.

The externalisation process, as described by Nonaka and Takeuchi (1995), does not reflect the ineffable nature of knowledge. Grant (1996: 111) states that "tacit knowledge cannot be codified and can only be observed through its application and acquired through practice". Tsoukas (2003) proposes that tacit knowledge can only be revealed and manifested in the act of doing and not via an act of transference or conversion. These views both question whether all knowledge is strictly transferable. In this sense, a fallacy of the model appears to be the proposed separate nature of knowledge, as a distinct object that can be moved and transformed into tacit experience.

2.3.3. Data, Information, Knowledge And Wisdom

The Data-Information-Knowledge-Wisdom (DIKW) hierarchy (Ackoff, 1989) is a tool to examine the relationship between the components of data, information, knowledge and wisdom (see Figure 2-4). It suggests that there is a growing value in the components as the hierarchy is ascended.

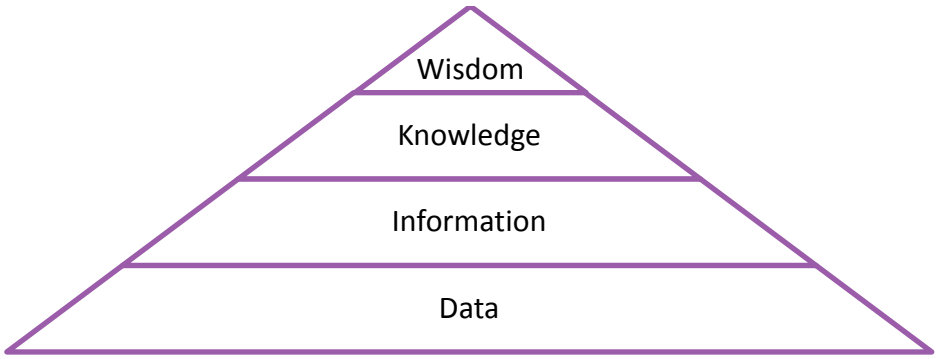


FIGURE 2-4: THE DATA-INFORMATION-KNOWLEDGE-WISDOM (DIKW) HIERARCHY (ACKOFF, 1989)

Ackoff (1989) offers the following definitions:

- Data: Symbols that represent properties of objects, but are not (in this form) useful.
- Information: inferred from data and contained in descriptions; answers 'who, what, when and how many' questions.
- Knowledge: know-how (instructions) that can be obtained by either transmission from another who has it, by instruction or through experience.
- Wisdom: The value adding capacity to increase effectiveness.

One cited criticism of this model, is that it suggests that knowledge can be transmitted from one person to another, offering little difference between explicit knowledge and information (Rowley, 2007). From the definitions given above it is assumed that both information and knowledge are objects that are containable and obtainable. However, the analysis in the previous section has determined that tacit knowledge, in particular, is a highly intuitive phenomenon that is subject to the recipient's abilities and experiences. There is no guarantee that individuals 'obtain knowledge' as suggested in the definitions above. The model neglects the relational nature of knowledge as distinct from information: knowledge requires the recipient understands information (Shin et al., 2001). Further to this, while the DIKW model suggests that wisdom encompasses the ability to increase effectiveness, it falls short of considering how action is created from knowledge. Instead, action remains only a potential outcome of the model. This presents two challenges: what mechanisms can determine if the level of knowledge has been increased in the recipients mind and what influences action, if knowledge levels are increased?

2.3.4. Distinguishing Knowledge As An Object And As A Process

Knowledge can be viewed as an object or a process. These distinctive stances have consequences for the transferability of knowledge and whether managerial efforts are focussed on the management of knowledge *per se* or the contextual arena in which knowledge is created (Sveiby, 2007).

Cook and Brown's (1999) duality model offers two models of knowledge: the epistemology of knowledge as a possession and the epistemology of knowledge as a practice. These epistemologies offer different views of the social context of knowledge, the location of knowledge and, therefore, the processes and tasks pertaining to the management and transfer of knowledge (Newell et al., 2009). Knowledge as a possession implies there is a solid, arguably context-free truth behind knowledge, which is easily packaged and recognised as an external individual possession or

organisational asset (Landry and Amara, 2012; Paulin and Suneson, 2012; Sveiby, 2007). However, this view of knowledge can overlook critical process-related inhibitors and affect perceptions of both knowledge tasks and the value of knowledge (Sveiby, 2007).

Knowledge-as-a-process contains not only the concept of 'knowledge' but the action of 'knowing' (Cook and Brown, 1999). This view incorporates complex individual understanding and social processes (Newell et al., 2009) and builds on Polanyi's (1958) concept of 'personal knowledge', in which knowledge is viewed as a social construction. This view can provide insight into difficulties involved with the *process* of knowledge transfer (Szulanski, 1996; 2000). Individual social constructions of knowledge and the action of knowing, imply that knowledge needs to be interpreted between knowledge recipient and sender in an act of communication (Newell et al., 2009). Effective communication is, therefore, intrinsically linked to knowledge-as-a-process (Grant, 1996; Liyanage et al., 2009; Nonaka, 1994).

Knowledge-as-a-process sees the action of knowing being context specific to how each individual views and interacts with the world (Cook and Brown, 1999). This subjective view of knowledge is consistent with the processes by which humans acquire, process and disseminate knowledge via declarative and non-declarative knowledge stocks. Declarative knowledge consists of both stores of facts about the world and the ability to remember the context in which these facts were originally encountered. Non-declarative knowledge deals with subconsciously 'knowing-how' to perform certain tasks and is developed through doing rather than being told how to do something. These current stores of knowledge act as filters, through which new information is processed and ultimately influences the individual construct of knowledge (Bender and Fish, 2000; Bierly et al., 2000). The various views of knowledge provide insight into its nature and highlight both the complexity of epistemology and the challenges with defining knowledge. The complex perceptual and multifaceted nature of knowledge questions whether knowledge can be strictly 'transferred'.

2.4. KNOWLEDGE TRANSFER

This section reviews the various definitions and conceptualisations of knowledge transfer (KT). It distinguishes KT from technology transfer and looks at how knowledge transfer success is defined. It also investigates the problematic nature of the term 'knowledge transfer' and analyses how knowledge transfer activities are deemed successful.

2.4.1. Defining Knowledge Transfer

The epistemologies of knowledge as both an object and a process influence the conceptualisation of KT. These differing views contribute to difficulty in providing a succinct concept of KT, with definitions and concepts being reliant on an epistemological foundation. The transfer of knowledge is arguably not possible due to the inherent nature of tacit knowledge (Busch, 2008; Grant, 1996; Polanyi, 1958; Tsoukas, 2003). However, the word 'transfer,' by definition, suggests that knowledge can be packaged and relocated from one position to another. Liyanage et al. (2009: 122) define knowledge transfer as "the conveyance of knowledge from one place, person or ownership to another". The underlying assumption of this definition conforms to the knowledge-as-an-object perspective, where knowledge can be moved and remains homogenous throughout the process.

Levin and Cross (2004) propose that KT is the relationship between the nature of knowledge, the relationships needed to perform a transfer and the structures that support the processes. They suggest three important and interdependent factors: the multiple senders and receivers of knowledge in a network setting; the knowledge that is being transferred, and the structures that add value to the process. However, this model focusses mainly on the structural facets of the knowledge transfer process without considering the processes that occur between these factors.

Albino et al. (2004) present a model of KT that they suggest encompasses the knowledge transfer 'process'. The model commences with knowledge at a source location and ends with knowledge with a recipient. This, however, limits knowledge transfer to being a goal (i.e. knowledge to the recipient) rather than focussing on what the recipient does with that knowledge.

It is worthwhile commenting on the differences between knowledge and technology transfer, to elucidate the calls in the literature to focus on the 'soft side' of innovation (e.g. Byrne et al., 2012; Ockwell and Mallett, 2012) referring to intangible assets. Intangible assets can include the value-adding factors of: R&D, know-how, distribution models and communication (den Hertog et al., 1990); technical and non-technical knowledge and competences (Castellacci, 2006); and networks, trust and institutions/norms (Rutten and Boekema, 2007). The terms 'knowledge transfer' and 'technology transfer' are used interchangeably (Grimpe and Hussinger, 2013; Osabutey and Jin, 2016), with some authors suggesting that knowledge transfer is embedded in the technology transfer process (Argote et al., 2000). However, Gopalakrishnan and Santoro (2004:59) suggest that while technology transfer is more explicit and tangible (i.e. "a set of tools"), knowledge transfer specifically relates to a personal process that involves the process of accessing knowledge stored in

people's heads, and increasing the knowledge stored in the minds of recipients (less tangible and more behavioural based). Crichton-Sumners et al. (2013) consider the differences, proposing that KT is more open to interpretation, vague, individually analysed and incorporates greater 'trial and error'. Technology transfer is concurrently less subjective, organisationally analysed and involves more experimental testing. However, it is important that both activities are effectively incorporated into innovation processes and are allocated appropriate resources (Crichton-Sumners et al., 2013). Davenport (2013) suggests that knowledge transfer encompasses a wider range of disciplines to collaborative problem solve. Table 2-6 provides a synthesis of the differences offered in the literature.

DIMENSIONS	TECHNOLOGY	KNOWLEDGE
Scope	Narrow /specific; technology is an instrument for change; science and technology focus; technology expertise	Broad/inclusive; interdisciplinary; knowledge embodies underlying theories; collaborative problem solving; wide ranging expertise
Results of process	Tangible; precise; easily measured; commercial focus	Less tangible; vague; difficult to measure; commercial and non-commercial
Knowledge characteristics	Explicit and codified information (e.g. manuals, databases); linear	Explicit and tacit (e.g. information in people's heads); linear and two way
Generation of knowledge	Controlled experiments; simulations; pilot-tests	More trial and error, wider use of gestalts
Nature of interactions	Inter and intra organisational interactions; how things work; spin outs; licensing; collaborative research; incubators	Inter and intra organisational interactions; strategic issues; why things work; collaborative research; consultancy; secondments

TABLE 2-6: KEY DIMENSIONS OF TECHNOLOGY AND KNOWLEDGE TRANSFER (CRICHTON-SUMNERS ET AL., 2013; DAVENPORT, 2013; GOPALAKRISHNAN AND SANTORO, 2004)

There is a variety of definitions of technology transfer, depending on the process, goals and parties involved in transfer activities. In defining effective technology transfer, Kiper (2012: 95) emphasises the link between technologies, knowledge and institutions, stating:

> "Technology transfer is the imparting of knowledge, skills, and methodologies involved in the whole production cycle. Technology transfer is a system that encompasses the social and economic fabric of a country. Where technology has been effectively transferred, there should be a visible change from the person to the production system. Such change should be in compatibility with the needs and take place in the institutional framework…and in appreciation of the natural environment of the recipient country. Technology transfer also has to do with disseminating information on the technologies themselves".

This extended definition draws attention to two important concerns. Firstly, there is an undisputed link between technology and KT. Gopalakrishnan and Santoro (2004) suggest that the two are 'intertwined', but can be differentiated due to: different constructs and activities; the intangibility, tacitness and perceptual nature of knowledge; the broader application of knowledge; the extended use of knowledge throughout the pre-commercialisation phases of the innovation chain and the conceptualisation of technology as a tool to make environmental change. Secondly, knowledge is required throughout the technology transfer system. However, no attempt is made to suggest what successful knowledge transfer is, whereas successful technology transfer is argued to be more tangible and thus easier to define. Fender (2010) proposes that KT encompasses knowledge beyond technical capacities, but also that which relates to converting innovation outputs into value creating mechanisms. New technology and innovation may create value, but the successful exploitation of knowledge is what captures that value (Robertson and Jacobson, 2011: Wood, 2004). Sveiby (2001) also comments that although both knowledge and technology are assets, technology, when transferred (i.e. used), depreciates in value. This is in contrast to knowledge, which grows due to the fact that knowledge never leaves the creator; it only develops between the creator and recipients. The above analysis concludes that although the concept of technology transfer and KT are intrinsically linked and interdependent, they are different constructs. Importantly it has been found that they require different processes to move: while technology is a tangible asset, knowledge is contained within people's minds and requires the knowledge recipient to understand what is being received.

2.4.2. TERMINOLOGY

Greenhalgh and Wieringa (2011) suggest that the literature is in 'discord' regarding the terminology of KT. The sheer number of terms relating to KT can cause confusion about what processes, activities and objectives relate to KT. Graham et al. (2006) review different terms employed in the literature and explore the suggested conceptualisations of each term. They suggest that all terms embrace a holistic function referred to as the 'knowledge-to-action' (KTA) process (encompassing the process of knowledge generation and its application in practice). Their study revealed that common terms used include: knowledge translation; knowledge transfer; knowledge exchange; knowledge utilisation; knowledge implementation; knowledge dissemination; and knowledge diffusion, with various terms being favoured by specific professions or nations. They supplement this by identifying twenty-nine different terms employed by thirty-three applied research funding agencies across nine countries. They suggest that 'knowledge transfer' is a unidirectional process

that considers only the initial component of knowledge sending. They propose organisations and institutions adopt additional terms to try and explicate the nature of the interactive two-way process that incorporates the assimilation of knowledge by a recipient to their satisfaction. An example is the adoption of the term 'knowledge exchange' by the Canadian Health Services Research Foundation to clarify the reciprocal nature of two or more distinct parties that collaborate, each bringing differing backgrounds, organisational cultures and norms and knowledge expertise, with the purpose of exchanging the inherently differing views to expand on existing knowledge. This incorporates knowledge flows across multi stakeholders, in which the distinct perceptions of groups and individuals are a critical contextual dynamic. They further suggest that the term 'utilisation' specifically relates to the application of knowledge into practice, therefore bridging a perceived knowledge-to-practice gap. Liyanage et al. (2009: 122) also characterise 'knowledge transfer' as a one-way movement of knowledge from one place to another, where a party communicates what they know. This is distinguished from a two-way 'knowledge sharing' process, defined as a 'people-to-people' practice in which 'individuals mutually exchange their knowledge'. They subsequently introduce the terms 'knowledge translation and interpretation', suggesting these are methods to contextualise the knowledge that is transferred to make it applicable and useful to the receiving unit (and, therefore, an integral process to maximise the effectiveness of KT). The myriad of terms and array of concepts is inherently linked to the complexity in identifying and defining a process for both 'knowledge-as-an-object' and 'knowledge-as-a-process' movements. The language used by organisations may, therefore, effect how knowledge goals and activities are perceived within organisations.

2.4.3. KNOWLEDGE UTILISATION

The previous section suggested that the term knowledge utilisation (KU) bridges the gap between research and practice. This is important when considering the research problem of this study, as it has been illustrated that for innovation to be successful, knowledge must be turned into products and processes that have economic benefit (knowledge must be utilised in a way that facilitates this). However, there is no overarching definition or single conceptualisation of knowledge utilisation (Landry et al., 2001). While some authors have developed a multi-stage model of KU (e.g. Landry et al., 2001), others propose it is a single stage in a larger process that encompasses knowledge creation, transfer and uptake (e.g. Graham et al., 2006). Still others present lists of variables that may affect knowledge utilisation (e.g. Belkhodja et al., 2007) or epistemological factors to consider (e.g. Jacobson, 2007). However, this portfolio of research is predominantly theory based, with

limited empirical studies in the area (Heinsch et al., 2016). Table 2-7 analyses and synthesises characteristics of the predominant models and theories in the field of knowledge utilisation.

Model or theory	Prominent Characteristics
Seven standards of utilisation (Knott and Wildavsky, 1980)	7 stage process model (reception, cognition, reference, effort, adaption, implementation, impact); theoretical
Ladder of utilisation (Landry et al., 2001a)	6 stage process model (transmission, cognition, reference, effort, influence, application); quantitative methods using Knott and Wildavsky (1980) scale;
Variables of knowledge utilisation (Landry et al., 2001b)	7 variables (list) which affect knowledge utilisation; quantitative methods using Knott and Wildavsky (1980) scale
Science push and Socio-organisational models (Landry et al., 2003)	Two overarching models: Science push (linear and technical) and Socio-organisational (interactive and relational); quantitative data based on Knott and Wildavsky (1980) scale
Knowledge to action (Graham et al., 2006)	Cyclical phases from knowledge creation to action (as a goal); conceptual model
Organisational determinants of research knowledge utilisation (Belkhodja et al. 2007)	Organisational variables to research utilisation (organisational learning, culture and absorptive capacity); quantitative methods using Knott and Wildavsky (1980) scale
Fourth wave of knowledge transfer and exchange (Jacobson, 2007)	Social epistemology as basis for researchers to better understand knowledge properties (knowledge as a social process); theoretical
Solution-oriented knowledge (Gredig and Sommerfield, 2007)	Cooperative model of knowledge utilisation; the context of where knowledge is being utilised is key; theoretical
Determinants of research knowledge utilisation (Chagnon et al., 2010)	List of 10 variables which affect utilisation; quantitative
Knowledge and technology transfer value chain (Landry and Amara, 2012)	Conceptual model of knowledge and technology transfer as a value chain (recognise value – transform into actual value – appropriation of value); theoretical
Influencers of social science research utilisation (Cherney et al., 2013)	List of variables (user context, researcher context, dissemination and interactions); quantitative data based on Knott and Wildavsky (1980) scale

TABLE 2-7: SYNTHESIS OF CHARACTERISTICS OF THE PREDOMINANT MODELS AND THEORIES IN THE FIELD OF KNOWLEDGE UTILISATION

Backer (1991:26) defines KU as "activities aimed at increasing the use of knowledge to solve a problem". Importantly, it is distinguished here from knowledge dissemination, which is the "conscious effort to spread new knowledge…to specific target audiences" (Green et al., 2009:152). Whilst both dissemination and utilisation are interpersonal processes, KU incorporates the motivations and cognitive abilities of the user (Aita et al., 2007). Subsequently, non-utilisation can occur when knowledge does not reach intended users or users are unable or unwilling to apply it (Knott and Wildavsky, 1980; Weiss, 1979). Rich (1997) scrutinises what is meant by knowledge use, suggesting four different conceptualisations for knowledge use (see Figure 2-5).

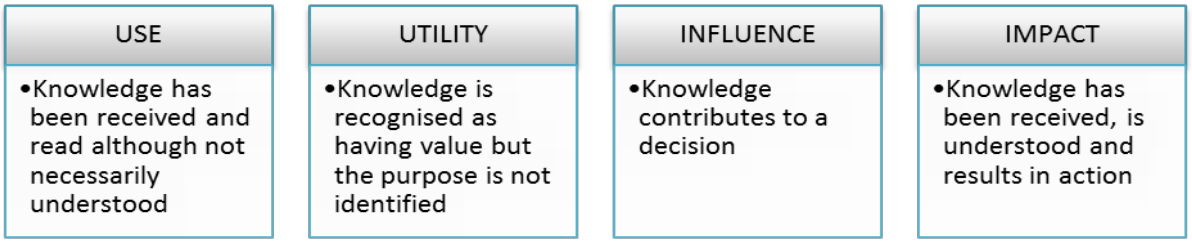


FIGURE 2-5: FOUR DISTINCTIONS OF KNOWLEDGE UTILISATION (RICH, 1997:15)

Importantly, each of the distinctions proposed in this model are viewed as differing goals of KU. It is, therefore, critical for this study to understand the perceived goals of individuals and organisations (i.e. is the transfer of knowledge a goal or the creation of impact from that knowledge)? However, it can be argued that if the knowledge has been received but not understood ('use' in Rich's conceptualisation), can the knowledge actually be seen to be used, given that knowledge encompasses know-how (e.g. Grant, 1996; Nonaka and Takeuchi, 1995; Tsoukas, 2003)? Indeed, in the process models offered by Knott and Wildavsky (1980) and Landry et al. (2001a), the *receipt* of knowledge is considered to be a legitimate component of KU, despite not necessarily resulting in action.

The nature of knowledge, and what it encompasses, brings specific challenges to the conceptualisation of KU. It is a challenge to succinctly map any cause and effect relationships between specific knowledge inputs and specific outcomes. This is due to: various types of knowledge (Gredig and Sommerfeld, 2008; Lomas, 2005); the non-linear path of knowledge and non-rational use of knowledge (Rich, 1997); differences in user preferences and cultural influences (Head, 2010); irrationality in decision making (Foxon and Pearson, 2008); and institutional influences (Dunlop, 2014; Jordan and Russel, 2014). In political environs, knowledge is more likely to inform policy rather than be a pre-requisite for policy formation, due to the strong influence of political alliances and risk mitigation on policy formation (Head, 2010). Therefore, process models that depict linear progressions from knowledge creation to utilisation may not actually progress as suggested or may be impossible to map.

KU can be science-driven, emphasising the delivery of robust technical evidence that will be adopted by end users (Gano et al., 2007; Landry et al., 2001b). This approach suggests a linear process where knowledge is an object that will be transferred and utilised. Empirical evidence from the health sciences suggests this linear approach does not contribute to practice changes. Subsequently, there is growing realisation of the importance of social factors to KU although studies which incorporate this are limited (Heinsch et al., 2016). This relational outlook generates iterative process models of

KU, influenced by system dynamics and context (Best et al., 2008; Dobrow et al., 2006; Green et al., 2009; Nutley et al., 2003). Despite this, empirical studies within the energy sector are sparse, and limited primarily to techno-economic analysis underpinned by positivist foundations (Byrne et al., 2012**;** Foxon, 2005; Ockwell and Mallett, 2012). There are limited studies that adopt an explicitly interpretivist philosophy to investigate these relational aspects. The need for such studies is particularly crucial given: the complexity of socio-technical innovation systems (Chmutina and Goodier, 2014); the greater accountability on innovation mechanisms that utilise public funds (Belkhodja et al., 2007); and the urgency of action needed to be taken by wide-ranging stakeholders to achieve national emissions targets (Vincent, 2012). The above synthesis of the knowledge utilisation models reveals a need for qualitative empirical work that reflects the complex relational and non-linear nature of knowledge utilisation.

2.4.4. KNOWLEDGE TRANSFER CHANNELS

The literature focuses on the commercialisation activities (particularly of University partnerships) as the predominant KT mechanism. However, there are a number of additional engagement mechanisms encompassed in the KT process (Hughes and Kitson, 2012). Schartinger et al. (2002) suggest sixteen different 'knowledge interactions' which are categorised into four clusters: joint research; contract research; mobility; and training. They further suggest that the type of engagement undertaken is dependent on the characteristics of knowledge and the economic value of the knowledge. Perkmann and Walsh (2007) distinguish between 'University-industry links' and 'University-industry relationships' through a typology that examines the extent of relational involvement. The 'links' offered include: research partnerships and services at the high involvement end of the scale, academic entrepreneurship and human resource transfer in the middle and commercialisation activities at the low end. Additionally, they suggest that utilisation of the labels 'channels' and 'mechanisms' does not accurately reflect that both media channels and social processes are considered forms of KT (e.g. publications are a media channel, but collaborative networks are a social process). Minshall (2009) define a number of 'activities', including placement of people, publications, events, collaborative research, consultancy, licensing and new business. Geuna and Muscio (2009) present 'mechanisms' to University-industry engagement encompassing: recruitment of graduates, personnel exchanges, joint research, licencing, spin-off companies and informal contact that occurs at different levels (e.g. on an individual, departmental or organisational basis). Hughes et al. (2011) summarise 'routes to engagement' between academia and business as: courses and programs, research, publications, conferences, knowledge networks, academic consulting. They suggest that various routes will also involve intermediaries, such as professional

bodies and consultants. Schmidt (2012) suggests that each of these types of engagement may be governed or implemented in a variety of ways, dependent on individual organisational structures. The multifarious nature of these engagement channels is a contributing factor to the emergence of a number of similar terms (such as knowledge exchange, transfer, translation and transformation). This epitomises the challenge of defining a conceptual KT framework (Graham et al., 2006) and subsequently can cause confusion for practitioners. The literature summarised above primarily deals with the tangible nature of the interactions (e.g. publications, research and commercialisation as tangible forms of knowledge as an object); however, they fail to integrate the intangible nature of knowledge (knowledge as a process).

2.4.5. Defining Success

The literature recognises the link between the ability to manage knowledge and outcomes, such as: obtaining a sustainable competitive advantage (Bierly et al., 2000; Grant, 1996); increased organisational performance (Filieri et al., 2014); and changes in knowledge levels within the recipients (Argote and Ingram, 2000). This suggests these factors are measures of success. However, Bierly et al., (2000) argue that *more* knowledge does not equal success, rather what is done with that knowledge. Appleyard (1996) illustrates a number of challenges with measuring successful knowledge 'flows'. These include: overly focusing on knowledge stock (amount) instead of knowledge flows (movement); a lack of emphasis on determining relevant and beneficial uses of knowledge; failing to measure the outcomes and consequences of knowledge; and an inability to effectively merge the different knowledge that is generated. Cummings and Teng (2003) suggest researchers have distinguished four categories for defining successful KT, namely: number of engagements over a specific timeframe; whether a process is on time, within budget and the recipient is satisfied; successful knowledge assimilation by the recipient; and the recipient's level of ownership of, commitment to, and satisfaction with the knowledge. Much of the literature views these broad level successes that are predominantly situated within the recipient. However, there is limited research on what specifically constitutes success (particularly in multi stakeholder endeavours), how this is articulated at the start of a project and how this is measured throughout the process. There is also relatively little literature, beyond financial gains and network expansion, on the measures of success of the organisations and institutes that, initially, are the predominant generators of the knowledge (Argote and Ingram, 2000). If engagements are undertaken as equal partnerships, then arguably the responsibility for KT should at least, in part, be measured on the successes of the predominant knowledge generator. The degree of success, in the form of knowledge changes, is also problematic to measure, due to the embedded nature of tacit knowledge

and because knowledge is entrenched in a multi-dimensional capacity, being located within tools, tasks and people (Argote and Ingram, 2000). It, therefore, also stands to reason that the complexity of measures of success is, in part, due to the multi-level perspectives from which to view successes (e.g. project, network, organisational, departmental and individual successes). Crichton-Sumners et al., (2013) further highlight these literature gaps, revealing that studies relating to individual level influences are limited. This includes exploring social motivations and contexts, as well as the perceived value to knowledge. The need to understand how individuals constitute success, would, therefore, contribute to enhancing the literature.

2.4.6. Supply And Demand Dimensions Of Knowledge Transfer

Green et al. (2009: 152) affirm that knowledge diffusion, knowledge dissemination and knowledge utilisation are all burgeoning 'sub-species' of knowledge transfer, but assert important differences between these three concepts. Knowledge diffusion concerns the natural flows of information and knowledge in social systems, whilst dissemination is described as "conscious efforts to spread new knowledge, ideas, policies, and practices to specific target audiences or to a public at large". By contrast, implementation theory has recently extended these concepts to introduce the dynamic of the application of knowledge, a process that is not guaranteed to occur when dissemination is successful. Dennis et al. (1990) suggest the historical dissemination of energy related knowledge has been ineffective due to dissemination strategies being based on the 'Rational Economic Model'. That is, individual consumers are assumed to be driven by economic incentives. However, this base principle does not consider psychological factors, such as: the inability to accurately determine real cost savings from energy consumption behaviours; consumers being biased to their current practices and, therefore, rejecting efficiency claims; and consumers favouring lower short-term pay-outs despite longer term pay-backs being greater in value (Dennis et al., 1990: 1110). This demonstrates a need to investigate beyond economic facets of energy related knowledge transfer.

Green et al. (2009:164) provide a framework for the multiple influences on whether knowledge is implemented or not. These influences are characterised according to their source, content, medium, user and context (see Table 2-8). In the table, Green et al. (2014) propose many demand-side considerations necessary to facilitate effect knowledge transfer (e.g. user characteristics). However, the emphasis within the low carbon literature remains on the dissemination and the supply side of technology development (Byrne et al., 2012; Chmutina and Goodier, 2014; Vincent, 2012). There is, therefore, a need to analyse interactions within the stakeholder environment and to empirically investigate these demand side factors, to rebalance the supply side literature. Additionally, the

facilitators of knowledge utilisation, as presented by Green et al. (2014), depict a linear model of communication, from knowledge source to user. This does not adequately reflect the complex nature of a socio-technical innovation system.

SOURCE	CONTENT	MEDIUM	USER	CONTEXT
Credibility	Accessibility	Multiple sources or forums for exchange	Early and sustained involvement in the research process	Resources
Relation building with potential users	Adaptability	Intermediary, linking mechanisms	Readiness to change	Support for long term interactive relationships
Realistic expectations of use	Advantage	Concerns for equity	Links among users	A champion for new knowledge
Building in considerations of use	Compatibility with values, expectations or policy agenda	Personal interaction	Level of acquisition effort	Leadership by example
	Challenges the status quo	Timeliness	Interest and ideology	No strong political opposition
	Emphasis on positive behaviour with clear, low-cost, action implications	Communicating language		Incentives to change

TABLE 2-8: FACILITATORS TO THE UTILISATION OF KNOWLEDGE (GREEN ET AL., 2014)

2.4.7. Knowledge Boundaries And Boundary Objects

It has been stated that in the current economic climate and turbulent business environment, organisations are required to work with a diverse and dispersed group of stakeholders to create and capture knowledge as a foundation of innovation (Bogers et al., 2017; Chesbrough, 2017). This involves intricate networks of organisations, where knowledge (either as an object or as a process) spans multiple boundaries of culture, process and physical space over individual, department and organisational levels, to enable the effective movement and assimilation of knowledge (Akkerman and Bakker, 2011; Easterby-Smith et al., 2008; Engeström, 2001; Kimble et al., 2010). It is these boundaries that can create barriers when managing KT. It is, therefore, important that they are identified, managed and controlled.

Boundaries can be organisational, national, industrial, cultural or process-based (Easterby-Smith et al., 2008). Aldrich (1971) compares an organisation to other organisms, suggesting organisations can be delineated from the environment by their 'skin' or outer covering and that bi-directional interactions occur between the environment and the organisation. Aldrich also suggests that organisations are defined by their member and non-member populations via controlling mechanisms to enter and leave the organisation. Members of a particular group may share common language, common forms of symbolic communication, commonality of specialised knowledge, shared meanings and recognition of individual knowledge domains. These commonalities are referred to as boundary objects and can increase the effectiveness of knowledge flows between different 'member' groups (Carlile, 2002; 2004; Fox, 2011; Star, 1989).

Carlile (2002) suggests that different types of knowledge boundaries (syntax, semantic and pragmatic) require progressively complex knowledge processes: transfer, translation and transformation (see Table 2-9).

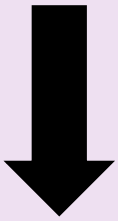
TYPE OF KNOWLEDGE BOUNDARY	LEVEL OF COMPLEXITY
Syntactic Formed by absence of shared language for communication	Increasing complexity in knowledge processes to cross boundaries 
Semantic Formed by variation in interpretation	
Pragmatic Formed by differences, dependences and novelty	

TABLE 2-9: NATURE OF KNOWLEDGE BOUNDARY AND THE CATEGORIES AND CHARACTERISTICS OF BOUNDARY OBJECTS (CARLILE, 2002)

Carlile (2002) suggests that innovation brings significant complications to boundary management due to: the ambiguous impact of a new innovation (*knowledge novelty*); multiple parties holding segregated pools of often complex, specialised knowledge (i.e. different terminology, levels of experience and incentives) (*knowledge difference*); and the need to collaborate to understand different perspectives and requirements (*knowledge dependency*). This is particularly relevant for this study, as the low carbon innovation sector is characterised by high degrees of knowledge novelty, difference and dependency (e.g. Foxon, 2005; 2011; 2013). The reusing of existing knowledge occurs when actors use current frames of reference for looking at new ideas, due to viewing existing knowledge stores as a valuable commodity (Carlile, 2002). This can alter the effectiveness of KT in innovation, if previously held assumptions are utilised inappropriately (e.g.

designers using the same metrics for testing new technology on the basis that it was optimal for previous technologies).

An alternate way to view boundaries is as distances which need to be lessened for optimisation of KT. Dawes et al., (2012) present a model of KT based on 'contextual distances'. They suggest that each party in a collaborative engagement hold national, organisational and informational contexts, generated by institutional norms and individual experiences. Crucially, the contextual distances ultimately affect the process and interactions in KT between participants (see Figure 2-6).

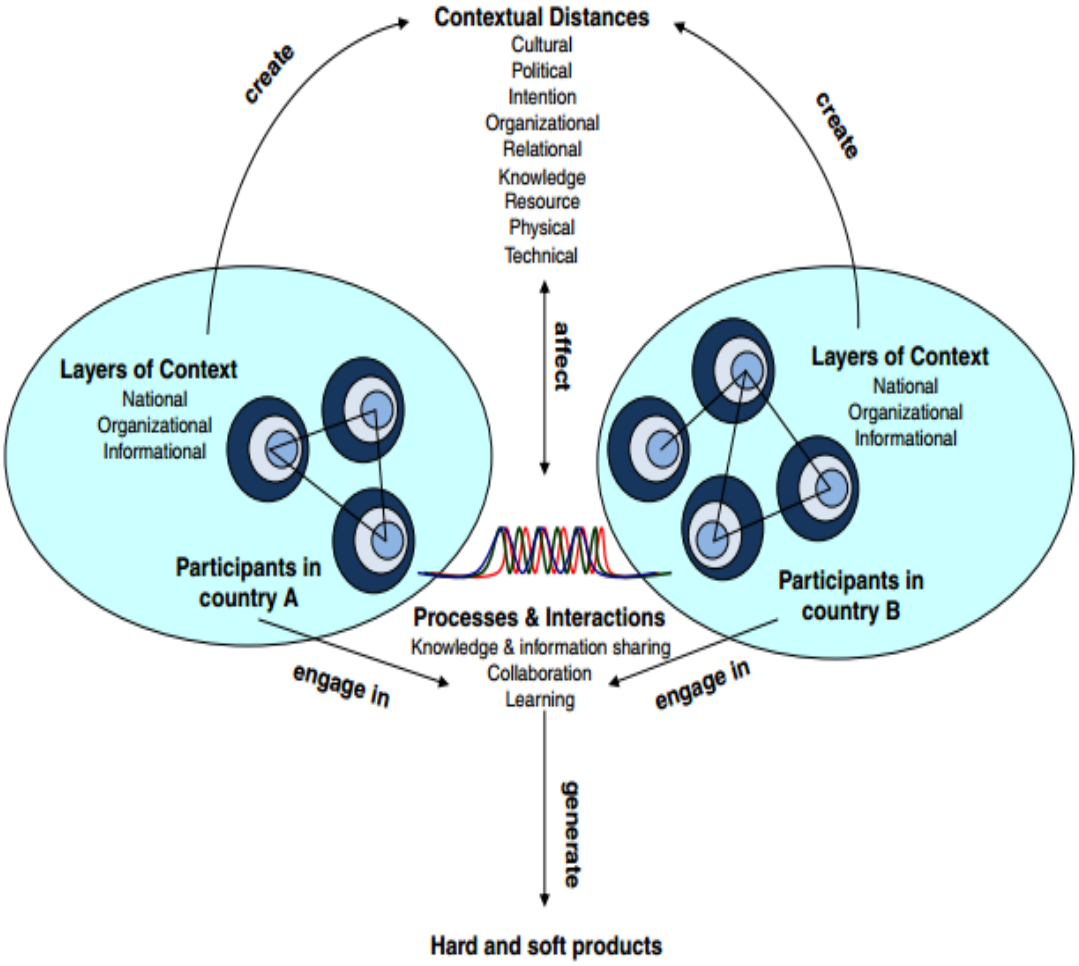


FIGURE 2-6: DYNAMIC MODEL OF TRANSNATIONAL KNOWLEDGE NETWORKS (DAWES ET AL., 2012: S118)

The categories of contextual distances suggested are: cultural; political; intention; organisational; relational; knowledge; resource; physical; and technical. If the demand side factors are crucial facilitators of knowledge utilisation, as the previous section proposed, it becomes vital to apply the work of knowledge boundaries and contextual distances to the stakeholder environment in order to maximise opportunities for knowledge transfer and utilisation to occur.

2.5. Enablers And Inhibitors Of Knowledge Transfer

There is extensive literature focusing on the structures, processes and relations that inhibit or enable the transfer and utilisation of knowledge. The following section critiques the commonly identified enablers and inhibitors of KT.

2.5.1. Reducing Cultural Distance Through Establishing Joint Norms And Objectives

Cameron and Quinn (2006: 16) define organisational culture as encompassing "the underlying assumptions, expectations, collective memories, and definitions present in an organisation". Numerous authors have cited cultural difference as a major barrier to effective KT (Agrawal, 2001; Cummings and Teng, 2003; Dooley and Kirk, 2007; Hughes and Kitson, 2012; Philbin, 2008; Riege, 2005). Where different cultural contexts are present, there needs to be mechanisms in place that build a hybrid culture, to develop enabling norms, processes and assumptions and define what is acceptable in the work environment.

Academic-industry engagement encompasses many cultural differences that need to be managed in order to optimise knowledge flows. Academic and industry cultures arguably operate on inherently different value systems that are externalised in different objectives over differing perceptions of timescales (Dooley and Kirk, 2007). Strategic management models suggest various organisational facets that need to be coordinated across firms to maximise strategic success (e.g. systems, staff skills and values) (Kaplan, 2005). However, there are a number of cultural dimensions that differentiate how universities strategically operate. Sporn (1996) suggests that universities have distinct cultures encompassing: ambiguous decision-making processes; people rather than profit orientation; diverse range of services (making goal attainment difficult); and contain cohorts of interdisciplinary academic staff with a focus of autonomy. Universities can be seen as: possessing fuzzy, segregated and hard to measure goals (Bartell, 2003); being department dominant (not institution), leading to a dichotomised integration of industry engaging activities (Slaughter and Rhoades, 2004); and consisting of disciplinary tribes (Mendoza, 2009). They are also suggested to: contain wide-ranging individual goals, motivations and attitudes towards industry engagement (Lam, 2010); have limited coordination and steering capabilities of the collective, having high levels of uncertainty attached to public research outcomes and timeframes; be governed by external peer review to determine staff achievement and promotion; and rely on externally located cohorts of experts to determine emerging research themes (Whitley, 2008). In short, University administration becomes a facilitator of smaller group activities, rather than hierarchical political structures, as in

private sector businesses. Methods to overcome cultural barriers in relation to knowledge flows and innovation, include the use of a bridging agent to: translate the different norms, objectives, languages and processes (Cummings and Teng, 2003); manage the multi-disciplinary teams, coordinate activities, keep momentum and motivation levels high and work across technical, business and commercial work programmes (Philbin, 2008); and adopt appropriate values and reward systems (Gattringer et al., 2014; Lach and Schankerman, 2008).

Government funded programmes establish norms and 'rules for interaction' (Filieri et al., 2014). However, they also add complication in cultural alignment due to the addition of societal and economic level goals (deMan, 2008; Pinkse and Kolk, 2012), which extend beyond cultural norms of academia and industry: "the current set up of national and international public projects aiming to develop innovation through knowledge sharing in networks…often does not meet the basic requirements of effective network knowledge management" (deMan, 2008: 206). This is relevant to the context of this study, where organisational objectives often include providing benefit to society and economy.

2.5.2. Adequate Time Allocation

Building knowledge and forming effective KT environments takes significant commitment (Hughes and Kitson, 2012; McNichols, 2010) and is a cost to organisations (Riege, 2005). Time requirements are increased if physical distance is great (Cummings and Teng, 2003) or complex technical knowledge needs to be exchanged and assimilated multi-laterally across a variety of sectors or cultures (Cummings and Teng, 2003; Philbin, 2008; Pinkse and Kolk, 2012). Additionally, effective assimilation of knowledge by intended recipients also requires time, effort and energy to fully 'own' the knowledge (Cummings and Teng, 2003). In collaborative engagements, sufficient time and effort is required by all contributing parties. However, limited commitment from collaboration may weaken innovation outputs (Landaeta, 2008). Time restraints may also be perceived differently between academia and industry. Academics are often engaged on multiple longer-term projects, whereas industry looks to 'solve problems' over much shorter timeframes (Lockett et al., 2008). However, the number of diverse actors and the complex knowledge within the low carbon innovation system necessitates increased time allocation for projects. Time requirements are amplified due to the extended time frames in energy innovation transitions and the diffusion to a decentralised public. Given these characteristics, the low carbon energy innovation system is a good context to study knowledge transfer.

2.5.3. Generation Of Trust

Developing trusting relationships is essential for successful knowledge sharing across networks (Arranz and de Arroyabe, 2012; Filieri et al., 2014; Levin and Cross, 2004; McNichols, 2010) and can act as a form of risk mitigation (Easterby-Smith et al., 2008). It is facilitated when both formal and informal opportunities exist to share knowledge over extended time periods (Philbin, 2008; Riege, 2005) and when there is perceived power equality between partners (Easterby-Smith et al., 2008; van Burg and Oorschot, 2013). The voluntary nature of trust developed in informal networks develops enhanced proactive collaboration (Riege, 2005). A high level of trust between partners instigates the desire for future ongoing relationships and is, therefore, self-reinforcing (Duysters and Lemmens, 2003). Levin and Cross (2004) reiterate the positive effects trust have on knowledge-sharing, suggesting that trust: makes people more willing to be vulnerable; makes people more open to absorbing others knowledge; and reduces conflicts, costs and lengthy knowledge verification processes. A loss of trust may result in the project being jeopardised and difficult to get 'back on track' (Philbin, 2008). While trust may increase knowledge sharing, its role in motivating the utilisation of knowledge is unknown.

2.5.4. Flexibility In Intellectual Property Management

The move for universities to engage in more market orientated behaviours has resulted in the increase of Technology Transfer Offices (or similar commercialisation functions) as a conduit for Intellectual Property (IP) and contract management, amongst other activities (Lawton-Smith and Bagchi-Sen, 2012). However, there are a variety of mechanisms, strategies and operating functions within these units, dependent on regional differences, individual University characteristics and the researcher motivation for commercialisations (Geuna and Muscio, 2009). Although these transfer institutions are seen as a prerequisite for successful commercialisation (Lawton-Smith and Bagchi-Sen, 2012), they are often inefficient and inconsistent in their operations (Geuna and Muscio, 2009). This can delay contract negotiations and create friction between partners (Bstieler et al., 2015), which needs to be managed to optimise KT efficiency. Where governments lead funding programmes, they may stipulate standard terms. These contractual obligations can create clarity in collaborations, but concurrently may inhibit trust formation (Malhotra and Lumineau, 2011). Industrial partners are more likely to engage when contract management employs a flexible, customised approach, which considers each partner's vulnerabilities (Bstieler et al., 2015; Malhotra and Lumineau, 2011). However, the contractual obligations present within commercialisation activities, is only one form of knowledge transfer, which concerns mainly the more tangible aspects of technology development.

2.5.5. Social Capacity Development

Bourdieu (1986: 88) defines social capital as "membership in a group which provides each of its members with the backing of the collectively owned capital". Social capital enables the access to collectively owned assets that deliver returns to individuals and organisations including: access to restricted knowledge, enhanced reputation, exclusive insight into network norms (Inkpen and Tsang, 2005); and improved learning capabilities, resource development and opportunities for new collaborations (Philbin, 2008). Critically, social capital has a direct bearing on the success of industry-University partnerships (Filieri et al., 2014; Philbin, 2008). The absence of social capital in academic-industry relations may lead to a deterioration of trust towards the academic partner due to incompatible work patterns (an individualistic preference by academia and team based for industry), increased anxiety over IP management and fear of opportunistic behaviour (Filieri et al., 2014). However, network connections are not an organically occurring phenomenon: time, effort and investment into network relationships is needed to maintain a condition where benefits and capital can be exchanged (Bourdieu, 1986). Social capital is optimised by the development of: strong network ties developed through repeated exchanges, a presence of multiple knowledge connections between all partners, goal clarity and tolerance for organisational cultural diversity (Inkpen and Tsang, 2005); trust, common frames of reference and joint commitment to collaborative efforts (Philbin, 2008); and a cohesive, engaged network and a long-term view to collaboration and frequent interactions (Filieri et al., 2014). However, low carbon innovation is influenced by a short-term policy focus due to limited governmental terms. Cohesiveness may also be affected due to the number of collaborative stakeholders who hold diverse objectives and represent different cultures. Ultimately, the development of social capital is crucial when viewing KT as a relational process.

2.5.6. Absorptive Capacity Development

Absorptive capacity is the ability to recognise the value of new external knowledge and assimilate it internally, and to enhance learning and innovation through knowledge transformation and exploitation (Bishop et al., 2011; Cohen and Levinthal, 1989; Cohen and Levinthal, 1990; Fabrizio, 2009; Zahra and George, 2002). Diversity in knowledge is essential to generate new and distinct knowledge for innovation, but is challenging to assimilate due to existing knowledge stores being contextually based (Cummings and Teng, 2003). Current complementary stocks of knowledge are a necessary foundation for the development of new knowledge and act as a facilitator of KT (Cohen and Levinthal, 1990; Cummings and Teng, 2003; Easterby-Smith et al., 2008). Therefore, absorptive capacity is increased when there is a commonality in contextual language (Cummings and Teng, 2003). Commonality in knowledge can be maximised through staff rotation in different

departments/organisations to gain exposure to functional idiosyncrasies and aid development of interdisciplinary knowledge (Cohen and Levinthal, 1990). However, just because commonalities exist between parties, there is no guarantee that a knowledge recipient is motivated to use the knowledge they have received. The ability to use it and the motivation to do so can be seen as two separate inhibitors.

2.5.7. Provision Of Training And Skills Development

Training programmes may assist actors within an innovation system to develop both diverse technical knowledge and the 'soft skills' of business and communication (Donofrio et al., 2010). This can occur through informal channels and via forums and workshops (Easterby-Smith et al., 2008; Geuna and Muscio, 2009; Riege, 2005) and, additionally, provides an opportunity to foster social networks (Geuna and Muscio, 2009). Workshops can help to create a common understanding of process expectations, generate awareness and provide opportunities to foster social networks (Geuna and Muscio, 2009). In particular, where social impact is an espoused project objective, training can be utilised to realise the potential of making this a joint value driver (Donofrio et al., 2010). Krykova et al. (2016) further suggest that improvising (i.e. the ability to translate knowledge to new people or contexts) is an important skill to have, although go on to suggest that studies of knowledge transfer within different contexts is limited.

Donofrio et al. (2010) provide an outline of the skills sets of those involved in innovation and knowledge work (see Table 2-10).

PROFESSIONAL SHAPE	CHARACTERISTICS	SKILLS PROFILE
'I' Shaped	Highly specialised in one area	Work well as a "lone innovator" Works well with a same field specialist(s) Difficulties in cross disciplinary collaboration Lacks business and communication skills
Dash ('-') Shaped	A generalist with no specific specification	Good collaborators Lack specialist knowledge, therefore lack innovative problem-solving abilities
'H' Shaped	Highly specialised in two areas	Work well as innovator and collaborator Has broad business and communication skills Takes time to build specialisation in two areas so less common in some disciplines
'T' Shaped	Highly specialised in one area but with broad knowledge and communication skills	Work well as innovator and collaborator Has broad business and communication skills Takes time to build both skill sets so less common

TABLE 2-10: SUMMARY OF PROFESSIONAL SHAPES (DONOFRIO ET AL., 2010)

Stemming from communications theory, this model provides a framework from which to view and optimise transfers on the basis of technical requirements and business imperatives. An awareness of skills sets can help determine the training needed to both collaborate and innovate. Due to the multiple areas of expertise and different organisations engaged in low carbon innovation, training and skills development can be used to develop an effective skills base that encompasses technical innovation and any business objectives that are stipulated as part of funding programmes.

This section has reviewed the cited enablers and inhibitors of KT. Although the literature is dominated by this micro analysis, which aids understanding of loosely-related phenomena, innovation systems approaches suggest that individual process improvement may not correlate with an overall systems improvement. This literature "assumes that [KT] is driven by a relatively narrow range of determinants" (Ward et al., 2009:2). However, limited work has been undertaken on the broader knowledge flows and the current literature predominantly views KT as a goal, rather than a process (e.g. Albino et al., 2004). Recent theoretical studies have also suggested that the knowledge transfer literature lacks analysis of the interaction of different factors that affect KT (e.g. Frank et al., 2015).

2.6. Gaps In The Literature

A number of gaps were established from this literature review. Research is limited that investigates social motivations and contexts, individual level factors, as well as the perceived value to knowledge. Rutten and Boekema (2007) suggest a lack of understanding of human influences in innovation. There is a need to understand what specifically constitutes knowledge transfer success, how this is articulated, how this is measured and whether it includes the utilisation of knowledge. Indeed, the knowledge utilisation literature offers some well-cited models (e.g. Knott and Wildavsky, 1980; Rich, 1997); however, these suggest the *transmission* of knowledge constitutes knowledge utilisation. Extant literature suggests further investigations are needed to measure success *in knowledge generating organisations*, which looks beyond financial gains (Argote and Ingram, 2000). The literature contains many terms related to knowledge transfer, which leads to confusion. Therefore, definition and clarification of terminology is needed, to ensure collaborators are all striving for the same goals under the same, or similar, assumptions (Graham et al., 2006; Rosli and Rossi, 2016). There are only a few studies that focus on the 'soft side' of innovation, which includes investigating intangible assets, such as knowledge (Byrne et al., 2012**;** Ockwell and Mallett, 2012). Additional analysis is needed pertaining to the factors that influence technology adoption from a systemic perspective (Chmutina and Goodier, 2014). More focus is needed beyond technology transfer:

whilst innovation may generate value, business models which successfully exploit knowledge are what realise value (Wood, 2004). Additionally, in complex socio-technical innovation systems, broader societal benefits are only realised when innovation solutions are adopted by a range of stakeholders. There is a need for empirical research on how institutional and individual preferences affect success at a project level (Chmutina and Goodier, 2014) and at the higher innovation systems level (Bale et al., 2015; ICCEPT, 2003). Similarly, Szulecki et al. (2011) suggest more research is needed to obtain a greater understanding of how multi-stakeholder partnerships vary in their effectiveness. Lastly, there are explicit calls for further research to analyse individual, organisational and broader-level environmental factors that facilitate the creation of impact (Rossi et al., 2017).

2.7. CHAPTER SUMMARY

This chapter established a link between innovation and knowledge, whilst also emphasising the importance of systems approaches to innovation. It has also undertaken an in-depth review of the knowledge to action literature encompassing both knowledge transfer and utilisation. It was found that knowledge underpins innovation and that the systems approach to innovation aims to identify the many system influences on innovation systems. Knowledge and KT were presented as complex phenomena, which are open to perceptions and interpretations. It was established that the lack of solid definitions and constructs for KT often confuse any associated activities, goals and objectives. There were also a number of inhibitors and enablers that were analysed. These have to be managed within the context of systems dynamics and under institutional influences. Lastly, the literature identified a number of gaps and analysed the calls for further research, which this study aims to address.

CHAPTER 3: METHODOLOGY

3.1. INTRODUCTION

The research design, methodology and methods are used to answer the research questions and fulfil the aims detailed in Chapter 1. Before undertaking this study, a comparative analysis was conducted of philosophical paradigms and the corresponding methodologies and methods, to ensure that an appropriate choice was made regarding the research design.

This chapter is structured as follows: firstly, it analyses the research design considerations, subsequently analysing the predominant research paradigms (section 3.2.1) and stating the adopted paradigm for this study (section 3.2.2). Section 3.3 evaluates quantitative and qualitative methodologies and states the reasoning for this study's position. Section 3.4 justifies the chosen research method, before sections 3.5 and 3.6 explain the research techniques employed and the research instrument, in line with the assumed philosophical foundations of the study. Section 3.7 analyses what constitutes research quality before 3.8 reviews the ethical considers for the study.

3.2. RESEARCH DESIGN CONSIDERATIONS

Pickard (2013) presents a model of all the components of the research process (see Figure 3-1). Entitled 'the research hierarchy', it proposes a list of considerations that need to be taken into account when designing a research study. Furthermore, it can aid the researcher to understand how the different elements are linked. This chapter uses the research hierarchy to analyse and justify the various components, applying them to this particular study.

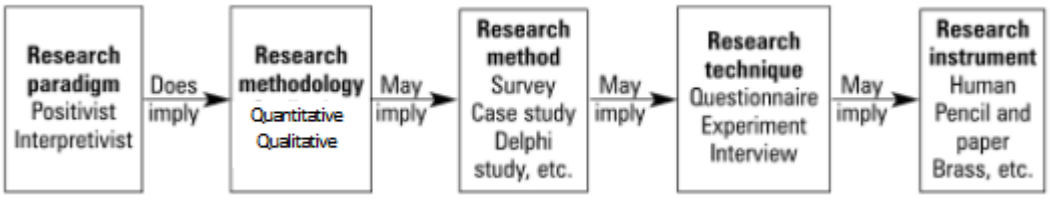


FIGURE 3-1: THE RESEARCH HIERARCHY (PICKARD, 2013:XVIII)

3.2.1. RESEARCH PARADIGM

Research paradigms or philosophical perspectives are the foundation of research (Corbin and Strauss, 2008; Creswell, 2007). Guba (1990:17) define a research paradigm as "a basic set of beliefs that guide action". Researchers should question themselves and their preference for a particular lens

through which to view reality (Silverman, 2005), as any particular perspective brings a set of assumptions regarding the nature of reality and knowledge (Corbin and Strauss, 2008; Creswell, 2007). A researcher's belief system encompasses various factors, including: theoretical perspectives (Crotty, 1998; Gray, 2013); models (Silverman, 2005); and worldviews (Creswell, 2007; 2003). Adopting a research paradigm is fundamental to establishing an overall research design that will appropriately enable the achievement of a set of objectives (Gray, 2013). Good research makes this position explicit (Creswell, 2007). The perspective held will be influenced by the beliefs, background and experiences of the individual researcher (Corbin and Strauss, 2008; Creswell, 2007; Denzin and Lincoln, 2000). It will also influence a series of activities, including: the choice of research questions; proposed theoretical frameworks; establishment of contextual settings; and data management techniques (Anfara and Mertz, 2006; Denzin and Lincoln, 2000). These philosophical perspectives act as a foundation for the researcher to place their work on continuums within different methodologies.

Guba and Lincoln (1994) suggest that a research paradigm encompasses ontological, epistemological, methodological and axiological positions. They further suggest that a researcher can reflect on which research paradigm they are asserting, through answering three questions pertaining to the ontology, epistemology and methodology of the research. Ontology is concerned with assumptions about the nature of existence or 'what is' (Crotty, 1998). Guba and Lincoln (1994) suggest that when deciding on an ontological position, the researcher should question the nature of reality and what can be known about it. There are two major ontological views: objective and subjective (Klakegg and Parsian, 2015). The objective view asserts that social reality is independent from the people associated with it. The subjective view proposes that social phenomenon is formed and continuously altered by the interactions of those associated with it (Bryman, 2015). This study assumes the latter position, assuming that social interactions lead to multiple, and potentially conflicting, realities that are subject to change as individual perceptions change.

Epistemology encompasses 'what it means to know', how we understand the world and deciding what knowledge is legitimate (Crotty, 1998). Guba and Lincoln (1994) propose the question needed to assume an epistemological position concerns the nature of the relationship between the 'knower' and 'what can be known'. In line with the corresponding ontological view, this can be expressed as either: a true reality, where findings are definitively true; or a constructed reality, where the findings themselves are created (Guba and Lincoln, 1994). Research that adopts a positivist stance usually entails deductive analysis that starts with hypotheses and theories, and then looks to test them

through observations (Bernard, 2013). Studies that adopt a constructed reality position are usually approached using inductive methods that look for the uncovering of meanings and the development of explanations (Bernard, 2013). This study adopts (in line with the ontological view), a position in which the researcher and the research participants create the findings as the research progresses, using inductive means.

Guba and Lincoln (1994) assert that researchers should question how they can go about finding out, whatever they believe can be known (methodological considerations). As this study assumes there is no independent social reality, the methodological positioning refers to the researcher interpreting the constructed social realities of participants.

Axiology deals with values and ethics within research (Lincoln and Guba, 2013). As suggested by the ontological and epistemological position adopted, this study assumes that values are inherent and consist of both researcher and participants' value systems. This is compared to objective positions where the research is value-free (Kumar, 2011).

3.2.2. Adopting A Research Paradigm

The adopted research paradigm is expressed and justified in this section, given the ontological, epistemological, methodological and axiological positions assumed above. Guba and Lincoln (1994) present four paradigms of positivism, post-positivism, critical theory and constructivism and detail the underpinning ontological, epistemological and methodological positions (see Table 3-1).

	Positivism	**Post-Positivism**	**Critical Theory**	**Constructivism**
Ontology	Naive realism – "real" reality but apprehendable	Critical realism - "real" reality but only imperfectly and probabilistically apprehendable	Historical realism – virtual reality shaped by social, political, cultural, economic (etc.), values; crystalized over time	Relativism – local and specific constructed realities
Epistemology	Dualist/ objectivist; findings true	Modified dualist/ objectivist; findings probably true	Transactional/ subjectivist; value-mediated findings	Transactional/ subjectivist/created findings
Methodology	Experimental; verification of hypotheses; predominantly quantitative methods	Modified experimental; critical multiplism; may include qualitative methods	Dialogic/dialectical	Hermeneutical/ dialectical

TABLE 3-1: BASIC BELIEF (METAPHYSICS) OF ALTERNATIVE INQUIRY PARADIGMS (GUBA AND LINCOLN, 1994: 109)

The various paradigms hold differing ontological and epistemological assumptions and lend themselves to different methods. The philosophical underpinnings must, therefore, be carefully considered, in order to deliver a valid research design that enables the achievement of aims (Guba and Lincoln, 1994). This study is characterised by the need to understand phenomenon that is situated in contextual situations. It also recognises the multiplicity in knowledge and the individual realities of each participant while acknowledging institutional and social influences of meaning. Additionally, it identifies a link between researcher and participant where meanings are constructed, reconstructed and interpreted through relationships with an external world (Bryman 2015; Crotty 1998). Given the philosophical assertions in the previous section, this study is positioned from a constructivism or interpretivist perspective.

The central thought behind interpretivist beliefs is that social and human reality is contextually bound. In the social world, the notion of subjectivity (human interpretation) is considered fundamental (contrary to positivist stances). The distinction can be drawn that human consciousness is not subject to the rigid natural laws of the natural sciences (Crotty, 1998; Gray, 2013). Interpretive perspectives are formed on the basis that to understand any action, an interpretive understanding (or verstehen) of the contextual meanings of the action is necessary. Schwandt (2000: 192) proposes three ways of theorising verstehen. Firstly, an understanding is gained through "psychological re-enactment…getting inside the head of an actor to understand…motives, beliefs, desires, thoughts". Secondly, verstehen is formed through an understanding of how actors interpret their own and others actions as meaningful. This is done through understanding how everyday life is instituted in both conversation and interaction. Thirdly, action is understood through understanding the system of meanings to which the action belongs. The system of meanings is formed from "institutional and cultural norms [and] action-constituting rules".

The interpretivist belief is in contrast to the positivist and post-positivist paradigms. Gray (2013) suggests that for positivists "both the natural and social worlds operated within a strict set of laws, which science had to discover through empirical inquiry". The premise of these positivist paradigms is that there is a world in existence, external to the researcher, that can be measured by observation (Gray, 2013), and that efforts should concentrate on remaining objective and controlling the objectivity (Guba and Lincoln, 1994). Scientific knowledge is seen as objective, accurate and certain (Crotty, 1998). The researcher and object of observation are seen as independent and the findings of observations are seen as 'true' (Guba and Lincoln, 1994; Lincoln and Guba, 2000). Post-positivism

questions the positivist argument of accurate and certain knowledge. Layers of uncertainty are introduced: epistemological uncertainty (science cannot always accurately know how a phenomenon occurs) and ontological uncertainty (science does not always know the state (reality) of certain phenomenon) (Crotty, 1998; Guba and Lincoln, 1994). As such, objectivity is measured against existing findings, rather than being absolute. Post-positivist methodologies incorporate notions of discovery in more contextual situations (Guba and Lincoln, 1994). The underpinning philosophy of this study is that reality is constructed, and knowledge is subjective rather than objective. The research questions focus on understanding the perceptions of all the participants and not an absolute reality. Therefore, the positivist and post-positivist positions are inappropriate for this study, its aims, objectives and the research questions.

Critical theory asserts that, similar to interpretivist views, reality is subjective and moulded by the interactions of social, political, economic and institutional influences (Guba and Lincoln, 1994; Kincheloe and McLaren, 2000). In particular the power relations in society are analysed and researchers are prompted to question a society's structures and values to facilitate change (Crotty, 1998; Gray, 2013). The researcher and participant are linked, with the researcher's values influencing the findings of the study (Guba and Lincoln, 1994). In line with the above-mentioned aim of questioning a society's structure, methodologies adopt a dialogue that enables the altering of historically dominant perspectives between researcher and the participant (Guba and Lincoln, 1994). However, critical research goes further than interpretivism by challenging the interpretations of reality. As such, the interrelatedness of researcher and participant changes the boundaries between epistemology and ontology as the findings of these interactions are co-created (Guba and Lincoln, 1994). This study does not aim to challenge interpretations, but rather seeks to understand them. As such, critical theory is not applicable to the aims of this study.

3.3. Research Methodology

A methodology is an angle a researcher takes, on the questions being asked in the research study (Pickard, 2013). The predominant three methodologies are quantitative, qualitative and mixed methods. The different perspectives are suited to answering different types of questions (Bernard, 2013) and employ different methods and practices to do so (Creswell, 2003). However, to define qualitative and quantitative research as opposites is unhelpful (Blaxter et al., 2001; Cassell et al., 2006; Denzin and Lincoln, 2000). Rather they should be viewed on a continuum (Creswell, 2003) as both research styles reflect "different ways of addressing the same set of issues" (Denzin and Lincoln, 2000: 9). Ultimately, the adoption of either angle is founded in the researcher's philosophical

assumptions (Cassell and Symon, 2004; Corbin and Strauss, 2008;). This study adopts a qualitative methodological angle, which usually aligns with interpretivist stances using inductive logic (Guba and Lincoln, 1994). Yardley (2000: 218) states that the purpose of a researcher within the qualitative paradigm is "to offer just one of many possible interpretations of a phenomenon". This is compared to the quantitative choice which aligns with a positivist approach, where measurement of a true reality is sought (Guba and Lincoln, 1994).

Quantitative research is based on theory or hypothesis testing (Creswell, 2013) or some type of measurement (Kumar, 2011). It involves the statistical and mathematical analysis of numeric data or turning words into numbers for analysis (Bernard, 2013). It is a structured approach that is rigid and adopts a narrow scope of enquiry, but with large data sets for statistical relevance (Kumar, 2011). It is useful for answering questions such as 'how many' or 'how much' (Pickard, 2013). This study focuses on the exploration of perceptions and the study of multiple issues uncovered during the research process. The adoption of a quantitative approach is, therefore, not applicable.

Qualitative research is a complex array of terms and concepts (Denzin and Lincoln, 2000; Yardley, 2000). Gorman et al. (2005: 3) suggests qualitative research is:

> "a process of enquiry that draws data from the context in which events occur, in an attempt to describe these occurrences, as a means of determining the process in which events are embedded and the perspectives of those participating in the events, using induction to derive possible explanations based on observed phenomena".

Table 3-2 summarises the main characteristics of qualitative research and demonstrates the applicability to this study.

Characteristics of qualitative research	Applicability to this study
Focuses on emerging themes through a process conducted in a specific context (Yin, 2003); take a flexible approach to tackle complex research questions (Gorman et al., 2005; Kumar, 2011)	Themes and factors emerge throughout the research (conducted within the specific contexts of research within innovation system)
Analyses experiences/meanings/perceptions/ feelings (Gorman et al., 2005; Kumar, 2011); learn about people and discover meanings in complex relationships (Corbin and Strauss, 2008)	Aims to investigate multiple perceptions of knowledge transfer and understanding of influences

Frames the role of the researcher as delivering possible explanations through an interpretative mechanism (Corbin and Strauss, 2008; Guba and Lincoln, 1994)	Researcher, as human instrument, interprets multiple meanings from the research participants
Answers how and why questions (Yin, 2009)	The research questions are how and why questions
Uses rich descriptions, inductive means and multiple theoretical lenses (Corbin and Strauss, 2008; Doz, 2011; Guba and Lincoln, 1994); Uses inductive means to derive meanings (Gorman et al., 2005)	In-depth within-case and cross-case analysis conducted via inductive theme development to derive meanings
Suited to the intricacies of organisational life when in-depth details are required (Cassell and Symon, 2004; Cassell et al., 2006); Works with smaller data sets but from an in-depth perspective (Kumar, 2011)	In-depth details derived from 28 semi-structured interviews; focus on the organisational level of two organisations
Focuses on the aspects of processes which may be difficult to measure (Denzin and Lincoln, 2000)	Focus on perceptions and meanings of participants experiences; difficult to quantitatively measure or baseline
Useful for investigating the complex interactions of different levels: "[it] gives capacity to explain how the 'macro' is translated into the 'micro' (i.e. everyday practices, understanding and interactions)" (Barbour, 2008: 13)	Focus on interactions between different levels of the innovation system
Narrative reporting using words as opposed to numbers (Bernard, 2013)	Analysis and reporting is via text not numbers or statistics

TABLE 3-2: THE MAIN CHARACTERISTICS OF QUALITATIVE RESEARCH

3.4. RESEARCH METHOD

Research methods can be defined as: "the bounded system created by the researcher to engage in empirical investigation – the overall approach, often referred to as a strategy…the driving purpose of the investigation" (Pickard: 2013:xix). This study adopted a qualitative (inductive) case study method, from an interpretivist research paradigm. This research paradigm highlights the importance of cultural interpretations and context, in the absence of no one true external reality. This study used a multi-case study design with two case studies (i.e. two organisations). The first of these case studies explores the research problem within a public private partnership (PPP), whilst the second explores a University. This combination of case studies allows comparison between the two organisational structures and contexts, while still allowing for in-depth analysis. In order to achieve this both within-case and cross-case analysis is conducted. Table 3-3 summarises the research design of this study.

ITEM	DESCRIPTION
Main research Questions	What are the system wide influences on knowledge transfer? How is knowledge transfer perceived by those creating knowledge? What knowledge activities are undertaken to realise knowledge-related goals?
Philosophical Framework	Qualitative, Interpretivist, inductive
Methodology	Descriptive/exploratory case study
Unit of Analysis	Organisation (with embedded units: individual and external environment)
Case Design	Multiple case study (two cases); within and cross case
Case selection	Two organisations have been purposefully chosen to compare perceptions and activities
Data Collection	Interviews, document analysis, observations
Data Analysis	Coding, multiple methods of display, iterative throughout the collection process. A three-tiered analysis: Macro, meso and micro levels.

TABLE 3-3: SUMMARY OF THE RESEARCH DESIGN OF THIS STUDY

This study is characterised by: 'what' and 'how' questions; the investigation of contemporary phenomenon within a specific context; the investigation of how organisational processes occur within the wider environment; and aims to provide in-depth analysis and rich descriptions within context. This study required a flexible approach that allows for any adaptations throughout the research process, which a case study method allows (Stake, 1995).

Case studies can be defined as: "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" Yin (2003: 13). Pickard (2013:101) suggests that "the purpose of a case study is to provide a holistic account of a case and in-depth knowledge of the specific through rich descriptions situated in context". Case studies are appropriate when 'what', 'why' and 'how' questions are being posed and for investigating contemporary phenomenon within real-life context, where the researcher has little control over events' (Yin, 2003: 1). Additionally, they are useful when detailed understanding of organisational processes is needed, within the context of a wider environment (Hartley, 2004). Veal (2005: 170) states: "case study method can be particularly useful in business research since the focus of research in this setting is often the workings of organisation". Case studies are also a relevant option to make in-depth analysis; greater details, richness and wholeness (Gerring, 2007). Case study research can deliver both propositional and experiential knowledge (Stake, 2008) through describing the case itself and analysing those descriptions. The

case study is a flexible research approach: expectations as to the importance of certain issues, influences, relationships and problems may change over the course of the study (Pickard, 2013). Yin (2009) suggests that theory development and reviewing the existing literature at the initial stages of design, is essential to define the areas of investigation, and was carried out in this study.

Case studies can be exploratory, descriptive or explanatory (Yin, 2009). Descriptive case studies can provide "illustrative portraits of social entities or patterns thought to be typical, representative, or average" (Hakim, 1987: 61). Gerring (2004: 347) suggests: "descriptive inference remains an important, if undervalued, trope within the social sciences". In providing a description of activities and outcomes, the researcher gains a better understanding of those activities within a specific environment. This can allow for the identification of important factors in relation to a phenomenon (Yin, 2009). Exploratory case studies are usually conducted when little is known about a phenomenon and there is intention to use findings for further studies (Yin, 2009). Explanatory case studies aim to establish causal factors within the topic of study (Yin, 2009). Stake (2008) categorises case studies as intrinsic, instrumental or collective. Intrinsic studies are where the case itself is the subject of interest because of its uniqueness. Instrumental studies are analysed to provide understanding of a certain phenomenon. Collective studies are geared towards investigation of a general phenomenon. These categorisations of case studies help identify whether attention should be given to the uniqueness of a case or whether focus should be on generalisability. However, research does not often fit into a single category and is often situated between or across categories (Stake, 2008; Yin, 1993). The research questions in this study, pertain to the understanding the influences of knowledge transfer within UK low carbon innovation system, through the perceptions of participants. The case study will be both descriptive (of participant's perceptions) and exploratory (in investigating the influences). The descriptive nature of the case study allows for analysis of the current state of the situation in hand, while simultaneously exploring a contemporary phenomenon. This sets the intention and opportunity to undertake further studies within the field (Stake, 2008).

A case study can consist of a single case or multiple cases, although are usually restricted to a limited number in order to maintain research depth within resource availability (Hartley, 2004). However, there is no agreement on an optimal number of case studies in a multiple case study design (Shakir, 2002). Gerring (2007: 49) suggests that researchers "face a choice between knowing more about less, or less about more". That is, there is a choice between depth and breadth in a case study. Overall, this element of design should concur with the aims or the study and the espoused scope (Yin, 2009). A single case study provides valuable and rich detail into a case. Yin (2009) suggests five

rationales for the adoption of a single case study. These suggest that the case represents: a critical case; a unique case; a typical case; a revelatory case (which has not previously been accessible); or is longitudinal. In these situations, it is appropriate to adopt a single case study design to gain the in-depth knowledge pertaining to these rationales, which would not be suitable for a multiple case study design. The advantage of a single case study is therefore the depth it provides. However, single case studies also have documented limitations. Yin (2009) suggests that transferability may be limited with this design and researchers may exaggerate certain aspects due to the data available.

Yin (2003: 46) suggests that multiple case designs can be considered more robust. Multiple case studies allow for cross-case analysis and better facilitate credibility and robustness of research; however, they do need more resources (Gerring, 2007; Yin, 2003). Flyvbjerg (2006) suggests that the strategic, rather than random, selection of cases increases the amount of information to better understand a phenomenon. This may not occur in random samples where 'representative cases' may not deliver a richness of information that is achievable in information orientated case selection. This information orientated case selection can be used to gain an understanding of the complex circumstance behind any problem situation and the subsequent consequences. The case studies selected for this study, have been selected to obtain rich information from different organisational structures. This study employed a two-case study design. This facilitates in-depth descriptions about the phenomenon under investigation within the limits of the resources available (i.e. a single researcher; designated time frame; accessibility to organisations). However, it also strengthens the research findings through performing both within-case and cross-case analysis.

3.4.1. Defining The Unit Of Analysis

A major activity for case study researchers is to define the case as the object of study and what is to be emphasised (Stake, 2008). Miles and Huberman (1994: 25) define a case as "a phenomenon of some sort occurring in a bounded context". The importance of bounding a case is highlighted by Gerring (2007: 19): "A case may be created out of any phenomenon so long as it has identifiable boundaries and comprises the primary object of an inference". Methods were undertaken to help delineate the case. These included the researcher questioning their own motivation as to what they want to analyse (Baxter and Jack, 2008); reflecting on the research questions and considering resource limitation (Stake, 2008); and discussing the bounds of the case with colleagues (Baxter and Jack, 2008; Yin, 2003).

Yin (2003) suggests that case study design may be holistic or embedded (see Figure 3-2). A holistic design analyses the established unit of analysis from a global perspective (e.g. examining an organisation). An embedded design establishes more than one unit of analysis, such as organisations, programmes and individuals.

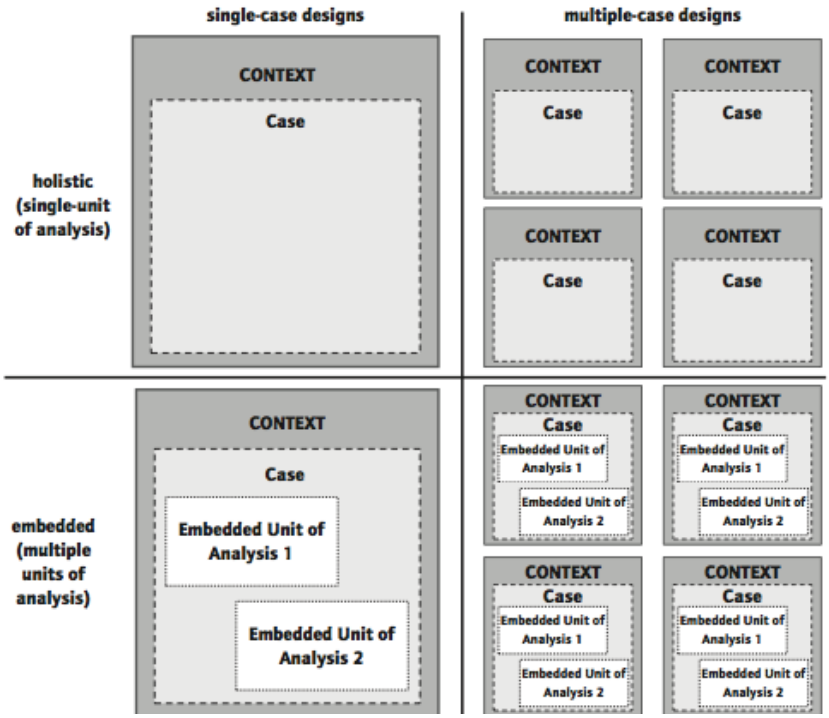


FIGURE 3-2: BASIC TYPES OF DESIGN FOR CASE STUDIES (YIN, 2003: 40)

In the case of embedded design, research outcomes may include the analysis from these embedded subunits. Both of these designs have strengths and weaknesses. Holistic designs may lose the focus of the case study, and the study itself may lack attention to any specific details, which results in 'lacking any clear measures of data' (Yin, 2003: 45). Using an embedded design may help to overcome this and may also enrich the research. However, researchers utilising an embedded design must remain focussed on the main unit of analysis – not direct all analyses to the sub units (Yin, 2009). This case study adopts an embedded unit of analysis which best aligns with exploring the innovation system, and understanding the wider innovation systems influences of knowledge transfer and utilisation.

In this study, the main unit of analysis was the organisation. However, to understand the complexities within the innovation system context, additional units of analysis are used, in what Yin (2003: 42-43) defines as an 'embedded case study'. The representation of the different levels can be seen in Figure 3-3. Each unit of analysis represents a different analytical level (macro-, meso- and

micro-level). A common problem with this type of study is the potential loss of focus of the original target of the study (Yin, 2009). However, with the awareness of this problem, attention was given to ensure that the organisation remained the unit of focus.

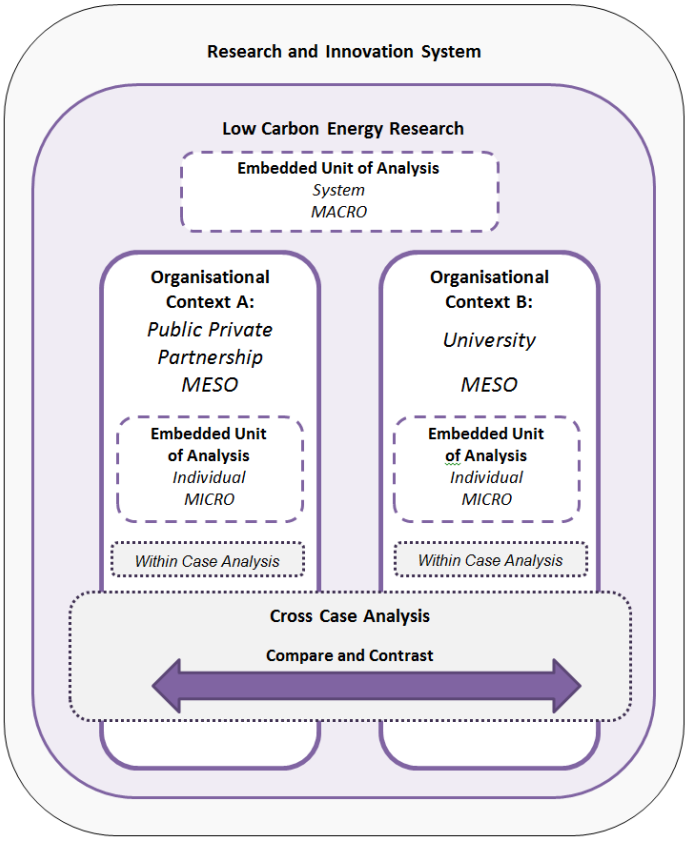


FIGURE 3-3: REPRESENTATION OF THE EMBEDDED UNIT OF ANALYSIS DESIGN

Anaf et al. (2007) suggest that investigating a system within a case study methodology, provides a complementary agenda, which increases the depth of understanding with greater real-world applicability. They also state that there are defined linkages between the interpretivist philosophical paradigm presented above and systems aspects (see Table 3-4).

INTERPRETIVIST CHARACTERSTICS		SYSTEMS ASPECTS
Exploration of depth and feelings	➔	Participants influence the system via own roles, goals and identities
A member of post positivist methodologies	➔	Exploration of human elements and complexity in the system
Interpretations are historically and socially situated	➔	Investigation of social factors is crucial in improving system performance
Guided by purposeful sampling, rich descriptions and field techniques	➔	Data sources are sought which provide understandings and perceptions rather than generalising in a positivist manner

TABLE 3-4: ALIGNING ASPECTS OF SYSTEMS WITH INTERPRETIVIST PARADIGMS (ANAF ET AL., 2007: 1314)

While it is understood that not all existing complexity can be studied, the researcher must make a strategic decision to choose how much complexity is incorporated (Stake, 2008).

3.4.2. Justification For Using A Case Study

The above discussions have highlighted a number of points which demonstrate the justification for adopting a case study. The case study is appropriate because:

- The case study is used for answering 'what' and 'how' questions.
- It is appropriate when exploring contemporary phenomenon in which the researcher has little control over events.
- Allows for an in-depth investigation of the perceptions and influences; thus, it aligns with the research questions and aim posed in Chapter 1.
- An embedded research design facilitates the investigation of different units of analysis to understand the wider innovation system environment.
- A case study is appropriate for investigating the diversity of contexts and issues (Stake, 2008).

3.4.3. Limitations Of Case Study Approaches

Although the case study method has many advantages, it does have some limitations. These concern a lack of rigour, inability to generalise and the introduction of researcher bias. There is a perceived lack of rigour, influenced by other methodologies prescribing exacting guidelines for the completion of research (Yin, 2009). Yin (2009) points out that all researchers should present findings fairly, but that even research methods undertaken utilising 'scientific methods' are subject to researcher bias. It has been argued that generalisability is not necessarily a strength or focus of the case study method. Schwandt (1998: 90) states "the end result regularly presents something unique…uniqueness is likely to be pervasive". Stake (2008) further suggests that the uniqueness and particularities of a case are likely to be revealed in a number of instances: the nature of the case, its background and history, the location and physical aspects, the external environmental influences and the participants who provide versions of understanding of a case. This study does not assume that findings can be exactly replicated in all situations (as with a positivist method). However, the case study method may reveal new understandings, a depth of understanding and new theoretical considerations that are relevant in other situations (Yin, 2009).

Case studies are considered time consuming in relation to positivist methods, which may be due to confusing certain methods, such as ethnography, with case studies. However, all case studies do not

need to be overly time consuming (Yin, 2009). Steps have been taken in the design of this study, to ensure there is adequate resource allocation for the research, including ensuring accessibility and limiting the number of case studies. Flyvbjerg (2006) suggests that case studies are often laden with misunderstandings and oversimplifications. However, this is based on the notion that context dependent knowledge is less valuable then context-free knowledge. Despite these views, case studies remain a well utilised and indispensable methodology in studies involving human behaviours and social practice theorists:

> "the case study is a necessary and sufficient method for certain important research tasks in the social sciences, and it is a method that holds up well when compared to other methods in the gamut of social science research methodology" (Flyvbjerg, 2006: 241).

3.5. Research Techniques

This section analyses the data collection and analysis techniques employed by this study. It evaluates the different sources of evidence used and the analysis techniques. It then appraises the two types of analysis used (within-case and cross-case) and the levels of analysis that have been adopted in line with the embedded design of this case study.

3.5.1. Data Collection

Data for case studies can be collected from a number of different sources and, traditionally, includes documents and records, interviews and observations (Yin, 2009). The use of multiple sources of evidence can be considered an intrinsic need of quality case study research, in order to facilitate data triangulation (Yin, 2009). Data triangulation ensures that the case study report is more convincing and that multiple methods have been utilised to try and obtain the various understandings of the phenomenon in line with the interpretivist paradigm. The study did not aim to use statistic or theory testing as a foundation. Therefore, purposeful sampling methods (not random) were used for this study. This sampling method involves the selection of organisations and individuals that are knowledgeable about the subject under investigation and have a willingness to participate (Bernard, 2013). Furthermore, snowball sampling was employed where participants referred the researchers to other potentially useful participants. Participants represented the different organisational functions and hierarchical levels (participants are detailed in the analysis chapters of this thesis).

Semi-structured interviews were undertaken with twenty-eight participants in compliance with established ethical Codes of Practice. Semi-structured interviews allow for further probing of participants responses to gain an in-depth perspective and uncover perspectives and attitudes (Flick, 2008; Kvale and Brinkmann, 2008; Rubin and Rubin, 2005). They are useful when a flexible approach is required as they allow for adaptation of questions (Rowley, 2012). However, interviews do have some limitations. These include question bias (poorly formed questioned), response bias (responding to please the investigator) and inaccurate responses (Yin, 2009). To overcome these weaknesses, an interview schedule was designed comprising of ten questions, which centred on the aims, benefits, activities and success measures of the knowledge activities that were undertaken by the participants (see Appendix 3). Also, feedback was received from both supervisors and within the organisations as to the appropriateness of the questions. The interview questions were grounded in the literature review, care was taken not to ask leading questions and, when appropriate, respondents were asked for examples to clarify any responses (Rowley, 2012).

Informed consent was obtained prior to all interviews, and participants were aware that participation was voluntary and confidential. All interviews were recorded using a digital voice recorder, only after obtaining participants permission to do so. All interviews lasted between thirty and fifty minutes, and were subsequently transcribed verbatim. Notes were made immediately after each interview and memos were recorded as analysis progressed (Corbin and Strauss, 2008), an example of which is given in Appendix 4. Additionally, a number of different sources of evidence were utilised, including documentation and participant observations, to develop a more comprehensive understanding of the phenomenon under investigation and facilitate triangulation. Each source of data had potential strengths and weaknesses (see Table 3-5).

SOURCE OF EVIDENCE	USE IN THIS CASE STUDY	STRENGTHS	WEAKNESSES
Interviews	- Semi-structured interviews were undertaken with twenty-eight participants; facilitated detailed discussions and allowed for flexibility	- Targeted – focuses directly on case study topic - Insightful – provide perceived causal inferences	- Bias due to poorly constructed questions - Response bias - Inaccuracies due to poor recall - Reflexivity – interviewee gives what interviewer wants to hear

Documentation	- Publicly available and private reports, presentations, Request for Proposals (RfP); websites and news items.	- Stable – can be reviewed repeatedly - Unobtrusive – not created from case study - Exact – contains exact names and references - Broad coverage –many events, and settings	- Retrievability –low - Biased selectivity, if collection is incomplete - Reporting bias – reflects (unknown) bias of author - Access – may be deliberately blocked
Participant Observation	- Participants observations at workshops in both organisations	- [same as above] - Insightful into interpersonal behaviour and motives	- [same as above] - Bias due to investigator's manipulation of events

TABLE 3-5: THE SOURCES OF EVIDENCE USED IN THIS CASE STUDY AND THEIR STRENGTHS AND WEAKNESSES (BASED ON YIN, 2003: 86)

3.5.2. DATA ANALYSIS

Data analysis encompasses examination, categorisation and testing of evidence (Yin, 2009). Yin (2009) also acknowledges that to optimise the benefits of analytic tools, an analytic strategy must relate to: the posed research questions; the researcher's individual style; and the ability to consider a range of alternative analytical methods.

Huberman and Miles (2002) suggest that analysis in qualitative research occurs prior, during and post data collection. Anticipatory analysis prior to the research should consider how much 'structuring' occurs before data collection. How much structure is cemented before the collection should consider the time available, how much is known about the object under study, and if there are any currently available instruments. The more structure that is added prior to collection will result in greater ability to generalise results, but reduce the ability to analyse the uniqueness of any given context. In short, it is suggested that structure is a trade off the researcher has to decide upon. In this study a semi-structured approach was used that allowed for induction themes to emerge from the data, while permitting a reiterative approach to the analysis between the emerging themes and comparison across the cases (Eisenhardt, 1989). Analysis during data collection can be beneficial for providing interim reports and as an ongoing improvement process where new collection strategies can be devised by reviewing existing data (Huberman and Miles, 2002).

In the study thematic analysis was used as a basis for analysing the textual data to explore underlying metaphors beyond descriptive theme identification. This is relevant when subjective interpretation is an underlying philosophical foundation, as it allows for emerging themes through systematic coding (Braun and Clarke, 2006). Thematic analysis was also an appropriate analysis method for this study as it is flexible, accessible to all level of researchers and can facilitate the

identification of similarities and differences (Braun and Clarke, 2006). High level conceptual themes were drawn from basic descriptive themes and codes in a 'bottom up' approach (see Figure 3-4).

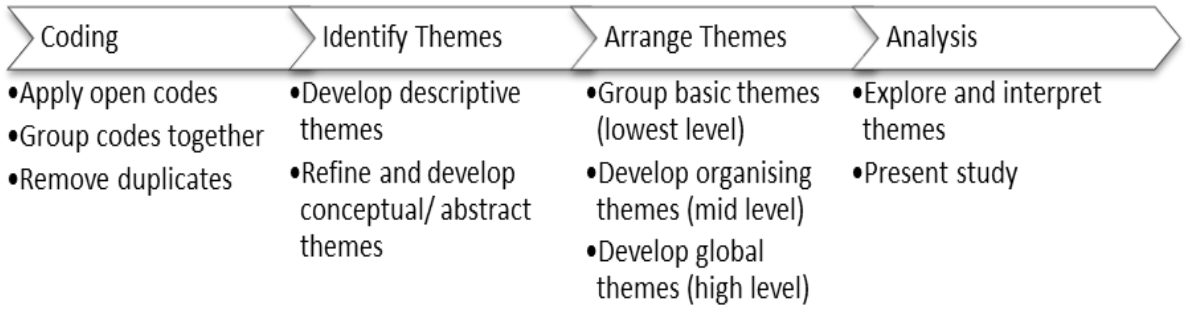


FIGURE 3-4: DIAGRAM OF CODING AND ANALYSIS PROCESS

This was achieved using Nvivo 10 software to create nodes within the software, which were then reviewed, refined and developed into higher level themes (an example of the nodes created in Nvivo can be found in Appendix 5). Nvivo can help researchers manage and sort data and search for patterns across data sets using queries (Rowley, 2012).

The study undertakes two types of case study analysis: within-case analysis and cross-case analysis. The within-case analysis allows the researcher to examine rich details and gain in-depth familiarity with each case study in its own context (Eisenhardt, 1989; 2007; Miles and Huberman, 1994; Yin, 2009). Stake (2000: 439) suggests: "what should be said about a single case is quite different from what should be said about all cases. Each case has important atypical features, happenings, relationships, and situations". Accordingly, within-case analysis allows the exploration of the unique factors of the case, before seeking patterns, differences and similarities across the case studies. This study, therefore, includes in-depth, rich descriptions of each case as separate chapters (Chapters 4 and 5). This facilitates the exploration of unique factors of each individual case before any comparative analysis occurs. Cross-case analysis aims to compare and contrast any similarities and differences between a number of cases (Yin, 2009). This strengthens research findings, provides deeper understanding of phenomena and helps to better answer research questions (Miles and Huberman, 1994). A number of techniques are used for cross-case analysis, including looking for patterns and presenting data using tables and matrices, which aid comparison (Miles and Huberman, 1994). The cross-case analysis is presented in Chapter 6.

The primarily inductive nature of the analysis means that the identified themes are not identical across the two case studies. However, the cross-case analysis presented in Chapter 6 aims to explore the similarities and differences across these three tiers, in further support of the study

objectives. The inductive nature of this study means that analysis occurred concurrently with data collection (Creswell, 2007).

3.5.3. Levels Of Analysis

This study will consider the characteristics of an innovation system in order to address the established gaps within the literature. Subsequently it aims to explore the multi-level systems influences on knowledge transfer. The use of multi-level theory has been highlighted as a way to bridge more predominant macro- and micro- level research which tend to focus on a specific level (e.g. Li, 2012; Turner and Boyns, 2001). Studies within the field of social sciences have previously adopted systems approaches utilising Bio-Ecological systems theory (Bronfenbrenners, 1979). This proposes that behaviours and perceptions are based within a series of complex ecosystems, including macro-, meso- and micro- level systems (see Figure 3-5).

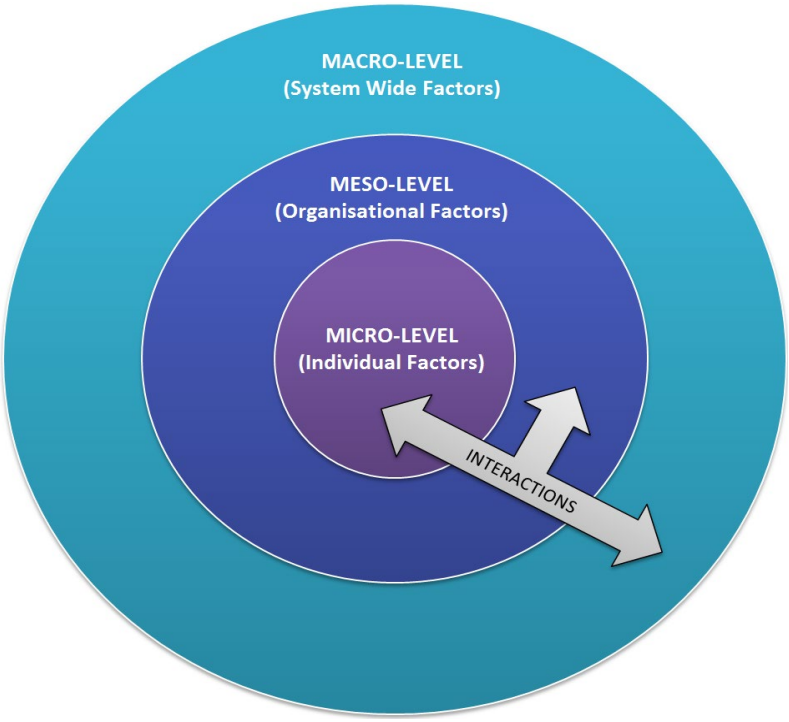


FIGURE 3-5: THEORETICAL MULTI LEVEL APPROACH TO ANALYSIS

It is the multi-way interactions between these systems levels which influence these inherent norms of behaviour throughout the whole system. While this research does not strictly follow ecological theory, it does aim to present a multi-level analysis which reflects the complexity in the system under investigation as the literature review suggested. The use of these multi-system levels as part of the approach to data analysis is therefore relevant to the study, and aligns with the embedded unit case study design.

The themes identified in the analysis chapters, are presented in relation to the different systems level in which they appear, namely: macro-level (system wide factors), meso-level (organisational factors) and micro-level (individual factors). The aim is to present a holistic view of the interacting levels of influence on knowledge utilisation. In line with the research paradigm adopted and the corresponding use of induction, the themes were allowed to emerge from the data before being categorised according to their systems level. The factors and themes presented serve to illustrate the various elements of the system under investigation that emerged from the analysis, rather than being labels for deductive based coding across the two case studies.

3.6. Research Instrument

The researcher adopts a pivotal position in interpretivist research, in that the data is mediated by a human instrument (i.e. the researcher). The researcher can choose whether to take an involved, inside (emic) role or a detached, outsider (etic) role (Denzin and Lincoln, 2000). These roles are situated on a continuum rather than a dichotomy and may move during the research process (Walsham, 2006). Whilst the outsider role is more akin to being neutral, this neutrality does not equate to unbiased. Recognition of any researcher bias should be an inherent part of the research process to minimise any unforeseen influences on the study. The involved researcher role acts to willingly influence and change a situation for one they would, subjectively, view as for the best. In this study, the role of outsider was chosen as a means to best present the perceptions belonging to those participants. This was achieved by remaining neutral as Walsham (2006) suggests, but through the use of probing questions to enhance understanding of the participant's perceptions and best reflect these in the analysis.

3.7. Research Quality

Distinctions can be made between criteria that assess the quality of quantitative and qualitative research (Lincoln and Guba, 1994; Yin, 2003). Quantitative work has historically utilised measures, such as generalisability, validity, reliability. These have been adapted for use in the qualitative research environment, (Shenton, 2004). Interpretivist research has been subject to a number of emerging and changing quality criteria that have best tried to represent scientific rigour in relation to qualitative studies (Seale, 1999). Some authors have proposed that separate and distinct criteria are necessary in qualitative research (e.g. Stenbacka, 2009). In particular, the four criteria of credibility, transferability, dependability and confirmability, proposed by Guba (1981) as alternatives for naturalistic enquiry, have received much attention for ensuring the trustworthiness of qualitative

research. Shenton (2004) offers meanings for each of these four criteria (see Table 3-6) which are discussed below.

Criteria	Alternative criteria	Meaning
Credibility	internal validity	Findings are congruent with reality
Transferability	generalisability	Findings are transferable to other settings
Dependability	reliability	The work is repeatable
Confirmability	objectivity	The findings are the result of participants' experiences

TABLE 3-6: COMPARISON OF QUALITY CRITERIA (SHENTON, 2004).

3.7.1. CREDIBILITY

Credibility is concerned with ensuring that findings are congruent with reality (Guba, 1981). However, in the interpretivist tradition, this often means synthesising the multiple realities of participants. There are a number of methods employed by this study to establish the credibility of the research, as suggested by Guba (1981) and Shenton (2004). Firstly, appropriate and recognised research methods have been undertaken, as discussed and justified in this chapter. Triangulation was established by using many different types of source (e.g. interviews, documents etc.) and different hierarchical levels of participant to represent both organisations. Iterative questioning and exploring participants' responses were employed via the use of semi-structured interview schedules. Memo writing was utilised as the research progressed to reflect on the data collected and patterns as they emerged. Lastly, thick and detailed descriptions have been presented for each case study organisation as separate chapters of this thesis (chapters 4 and 5).

3.7.2. TRANSFERABILITY

Guba (1981) suggests that transferability is the ability to transfer findings to other research settings. However, the case study approach stretches the continuum between seeking uniqueness and commonality. This has generated some criticism of the approach, with much emphasis being placed on the ability to transfer research findings as central to the value of research. Stake (2008) suggests that the uniqueness and particularities of a case are likely to be revealed in a number of instances: the nature of the case, its background and history, the location and physical aspects, the external environmental influences and the participants who provide versions of understanding of a case. When discussing generalisability, Stake (2008) suggests that the intrinsic motivation of qualitative researchers results in how much emphasis is given to applying research to other settings. Whether the focus is on uniqueness or commonality, Guba (1981) suggests that the full research context should be established so that others can make comparisons. Accordingly, this study provides a

research context in the introduction, with additional information supplied in the analysis chapters for each organisation. The context supplied aims to allow for comparison by other researchers, whilst also maintaining confidentiality and anonymity in line with the ethical considerations discussed in section 3.8.

3.7.3. Dependability

In quantitative work, the quality concept of reliability suggests that if research was conducted under exactly the same circumstances (e.g. same context and methods), the same results would be achieved (Shenton, 2004). While Guba (1981:80) recognise that reliability is "not an unreasonable expectation when one begins with an assumption of a single reality upon which inquiry can converge", the nature of qualitative work in traditions that acknowledge multiple realities, questions how qualitative work can be considered reliable. Furthermore, Stenbacka (2001) argues that, as the method and researchers are intertwined and not separate phenomenon in a qualitative context, results may not be repeatable. As such, Shenton (2004) suggests qualitative methods ensure that the research is repeatable (although acknowledges that results may not be the same). To ensure dependability, this study has provided an in-depth methodological description in this chapter, so that the method may be followed by others again (Shenton, 2004).

3.7.4. Confirmability

Shenton (2004:72) suggests that confirmability is to "ensure as far as possible that the work's findings are the result of the experiences and ideas of the informants, rather than the characteristics and preferences of the researcher". This study has taken steps to reduce or recognize any research bias by providing an in-depth methodological description, addressing the limitations of the work in the conclusions (Chapter 8) and utilizing a number of different data sources (triangulation). Additionally, an etic or outsider role (Denzin and Lincoln, 2003) was adopted by the researcher to reduce bias (see section 3.6 for discussion on the role of the researcher in this study).

3.8. Ethical Issues In Case Studies

Stake (2000: 447) states: "case study research shares an intense interest in personal views and circumstances. Those whose lives and expressions are portrayed risk exposure". When researchers are engaging with human subjects, there is the risk that the researcher values will 'contaminate' the research and the views of those participating (Silverman, 2001). It is also important to review ethical matters through the research; the nature of qualitative research means that changes may occur through the research that can lead to new ethical concerns (Silverman, 2001). This highlights a

number of ethical issues in qualitative research, which can be addressed by utilising a code of ethics (Christians, 2000). This study was undertaken strictly adhering to the established University Code of Ethics. The following steps were taken during the study to reduce any ethical risks:

- A risk assessment was carried out before data collection commenced.
- Informed consent was obtained that enabled interviewees to make a choice about participating (this can be found in Appendix 3 with the interview schedule);
- Anonymity and confidentiality were maintained, protecting the identity of participating organisations and people, by removing identifying characteristics of both the organisations and the participants. A coding system was used to identify each participant.
- The accuracy of data was maintained by using a voice recorder to record interviews (with individuals consent) and by transcribing the interviews verbatim.

3.9. CHAPTER SUMMARY

This chapter aimed to present an in-depth account of the adopted methodology for this study. It commenced by analysing the different factors of the research process in line with the research hierarchy (Pickard, 2012). Subsequently, it analysed the predominant research paradigms and stated the adopted paradigm for this study (section 3.2). It was stated that this research has adopted an interpretivist research paradigm. Section 3.3 evaluates quantitative and qualitative methodologies and stated the reasoning for this study employing a qualitative methodological choice. Section 3.4 critiques and justifies the case study method chosen for this study. It found that while the case study method has some limitations, it has numerous advantages that can be applied to this study. Section 3.5 analysed the research techniques utilised within the study, including the data collections and analysis processes that were followed. Section 3.6 analysed the role of the researcher as a human instrument in the research. Section 3.7 presented the quality criteria of qualitative research and debated the methods employed to ensure this study met the suggested criteria. Sections 3.8 reviewed the ethical issues of research and how this study made ethical considerations. The next two chapters (Chapter 4 and 5) present the within case analysis for each case study organisation.

CHAPTER 4: WITHIN-CASE ANALYSIS – PUBLIC PRIVATE PARTNERSHIP

4.1. INTRODUCTION

The preceding chapter discussed and justified the chosen methodology for answering the proposed research questions and detailed the two types of case study analysis undertaken in this study: within-case analysis and cross-case analysis. The next two chapters aim to analyse each case study and present such unique factors from each individual case (the within-case analysis). Additionally, in case study research, it is important to define the phenomenon that is under investigation (Yin, 2003). Therefore, the next two chapters also aim to sufficiently illustrate each of the case study organisations, while maintaining confidentiality of the participants and organisation. The Public Private Partnership case study analysis is presented in Chapter 4, and the University case study analysis Chapter 5. Each chapter is structured similarly, firstly providing background and context for each organisation, followed by the themes that have been identified, as consistent with the study methodology and proposed research questions. The themes have been arranged to best align with the three-tier analysis detailed in the methodology, to reveal macro-, meso- and micro-level factors. During the iterative analysis of the first case study (the PPP), a differentiation between knowledge transfer and knowledge utilisation became apparent, with participants indicating activities geared towards the transfer of knowledge as a goal, rather than stakeholder's utilisation knowledge. It also became apparent, during the interviews at the PPP, that there was a need for stakeholders to utilise knowledge in order for the PPP to meet its objectives. In response to this, the data collection and analysis turned to exploring whether participants perceptions encompassed the utilisation of knowledge, beyond knowledge transfer. This is reflected in the language used within the following chapters, where knowledge utilisation becomes a focus for the study.

4.2. ORGANISATIONAL BACKGROUND

The research organisation is a public-private partnership (PPP) established by the UK government and in partnership with major industrial companies. The PPP was established for a limited 10-year duration, thus, making the organisation a temporary one, although its purpose is to accelerate low carbon technologies to deliver both near term and longer-term benefits. This includes contributing to the achievement of the governments legally binding 2050 energy targets. Strategic objectives include: building research capacity; producing nationwide economic benefits; and facilitating the attainment of national and supra-national energy targets. These objectives are pursued via a broad

portfolio of project work, structured into different programme areas that focus on a particular technology theme. The organisation's funding is provided by contributions from its public and private membership, which was determined at the establishment of the PPP, for the set period of its lifespan. Consequently, the PPP funds projects as an investor in technology development, rather than strictly as a grant awarding body, through a competitive distribution of funds in which it selects partners to work with. The project work is completed via a network of academic, government and private actors.

The PPP operates through three main functions: strategy, programme delivery and stakeholder engagement. In line with the espoused strategic objectives, the PPP's knowledge management strategy identifies knowledge as a key product and recognises that knowledge needs to go to, and be received from, stakeholders to add value. Knowledge management objectives include: actively seeking feedback from stakeholders; strengthening organisational credibility and capabilities; and supporting staff in knowledge activities. Value creation for the PPP is achieved through the ability to acquire, organise, disseminate and utilise knowledge to deliver outputs, achieve outcomes and produce impact. The knowledge that the PPP produces is potentially used by many stakeholders for a variety of purposes. This includes use by:

- **The PPP itself -** delivering capability and credibility by driving technologies to commercialisation;
- **Member organisations -** delivering value to members and meeting their expectations;
- **Other stakeholders -** informing policy, developing supply chain and building industry confidence.

The PPP is a fairly recent organisational arrangement, having been commissioned within the past 10 years to undertake its portfolio of work and seek to achieve organisational objectives. The newness of the organisation should be considered in relation to the work it undertakes; that is, many of the projects operationalised by the PPP are multi-year projects with the impact from projects being realised over longer timeframes.

4.3. CASE STUDY PARTICIPANTS

Participants represented the different organisational functions (strategic, delivery and stakeholder engagement) and hierarchical levels (up to executive level of each function). Table 4-1 gives an overview of the participants interviewed (the specific job roles have been omitted to preserve confidentiality of participants).

Function (Abbreviation)	Number of Participants
Stakeholder Engagement (SE)	3
Strategic (S)	6
Delivery (D)	5
Total Participants	**14**

TABLE 4-1: FUNCTIONAL COMPOSITION OF PARTICIPANTS

The abbreviated function codes, seen in brackets, are found in each quote to indicate that participant's function. The randomly assigned participant number in each quote protects the participant's identity, while the letter represents each organisation. For example, in the participant code 'A3SE', 'A' represents the PPP, '3' is a randomly assigned number and 'SE' represents the Stakeholder Engagement function.

4.3.1. Other Sources Of Evidence

In addition to the 14 interviews undertaken, a number of other sources of evidence were utilised, in line with the presented methodology of the study. This included analysing publicly available documents, such as reports, Request for Proposals (RfPs), presentations, news articles and responses to call from governments regarding low carbon energy matters. Additionally, there was an opportunity to participate at a two-day training workshop within the organisation, where detailed observations and notes were taken.

4.3.2. Timing Of The Case Study

Figure 4-1 shows the timeframes involved in the data collection for this case study.

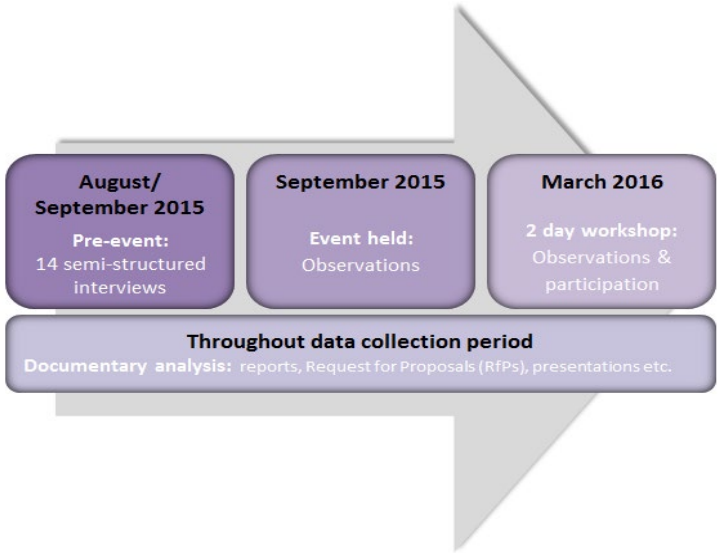


FIGURE 4-1: TIMELINE OF DATA COLLECTION FOR THE PPP CASE STUDY

The interviews undertaken for this case study were centred on a planned stakeholder event taking place in September 2015. Participants were interviewed prior to the event (before receiving any internal briefings about the event). The event was used as a basis to explore the perceptions of knowledge transfer in relation to organisational objectives, and the expected outcomes for the knowledge produced within the organisation. Participation at an internal organisational workshop occurred 6 months after the event and gave an ideal opportunity to explore if and how perceptions uncovered in the interviews had changed. This section has provided a brief overview to the PPP and its knowledge management strategy, which is used in this study as a foundation for exploring the themes identified from analysing the interview transcripts and other documentation.

4.4. Macro-Level Analysis

This section contains the macro-level analysis; that is the contextual factors that appear at the cross-system level and their influence on knowledge utilisation. This section firstly reviews the perceived stakeholders within the innovation system before presenting the analysis on how and why the PPP aims to reach a wider range of stakeholders. Lastly, it analyses the perceived relationship with other stakeholders in the innovation system, suggesting how this influences knowledge utilisation.

4.4.1. Stakeholders

The participants perceived a number of different stakeholders who engaged with the organisational knowledge outputs. These include member organisations, government, industry, academics and project partners. The majority of stakeholders were positioned within the supply side of the innovation system, either in a capacity as a technology developer, funder or policy influencer. The participants described distinct stakeholder groups, such as academics, policy makers and industry. Additionally, they often referred to general characteristics that they thought applied to the target audience. These included titles, such as, 'decision-makers', 'influencers' and 'existing contacts'. The decision makers and influencers were seen to be those with a legitimate form of political power (e.g. Secretaries of State for various portfolios). The existing contacts were stakeholders with whom participants have had previous relationships, either in the form of prior project collaborators or existing network contacts. Figure 4-2 represents the stakeholders mentioned by participants; the larger the word, the more times that stakeholder was mentioned. A frequently mentioned group were the organisational 'members'. The PPP operates via a membership model, with both industry and government member organisations contributing financially to the organisation. The analysis revealed that these member organisations were seen as a particular priority, due to their significant financial investment.

FIGURE 4-2: THE STAKEHOLDERS DISCUSSED BY PARTICIPANTS

Consequently, it was felt that they should receive a return on that financial investment through commercial opportunities, royalties or other organisational advantages gained by the creation of new knowledge and/or technologies. Participant A3SE suggests: *"the target audience [for the event] are our members, because we can't forget that they invested in us".*

Participant A10S explains that although the members may have viewed their position as enabling exclusive access to knowledge outputs for their own gain, they have moved away from this protectionist mentality:

> *"The private sector members originally saw that the value of [the PPP] would be through the generation of IP, and that they would generate value from that. I think [the members] realised that they aren't the right companies to own the IP and that they get most value through having a broad understanding of areas that they don't invest in, but could be potentially disruptive in. So understanding that broad picture helps them position their bit of the business better. I think that they see that they get more value from influencing the landscape than they do from holding the knowledge to themselves. There's no value in that".*

Thus, a membership model may present challenges for knowledge utilisation that need to be effectively managed. The financial outlay of members suggests they should get a return on their investment as a priority, through new knowledge, efficiencies or technologies. However, in order to create an impact within the larger system (and subsequently meet organisational objectives), knowledge must be available for utilisation amongst a far wider range of stakeholders. Participant A3SE explains the importance of reaching beyond this group of "*core stakeholders"* (i.e. members), implying that while members may understand and value the knowledge the PPP creates, this is not the case with other stakeholders:

> *"There are a broad range of stakeholders who have an interest. That includes academics, government members, trade associations and industry, as well as financiers. It's very important, getting them interested in what we do as well….we wanted to make sure that we are going out to more than just our members who know what we do anyway".*

The recognition and inclusion of a broader set of stakeholders at the event was seen to be a recent change; the PPP historically had targeted individual groups of stakeholders who were interested in specific knowledge about individual technology areas. It was suggested that the PPP had historically held a position of engaging with predominantly "*technology people*" (participant A4S) as a main stakeholder group. This participant further suggests that the composition of stakeholders for the PPP is complex. It encompasses a wide variety of individuals and groups with different world views, which need to be considered when creating knowledge outputs, beyond the identified *"technology people*":

> *"You tend to find that technology people, in their natural disciplinary way of thinking about things, tend to say 'what we need is effective logical planning to sort things out'. Whereas your typical economist will say 'what we need is economic signals to sort things out'. You've got other people who may have more of an environmental focus…or you've got people that have got a consumer focus".*

This suggests that not only do stakeholders themselves have to be identified through detailed analysis, but establishing their *views* is crucial. It also suggests that disciplinary differences create boundaries to understanding or embracing the views of others.

Participants A3SE, A5S, A7D and A10S discussed the need to target stakeholders who were 'influencers' or 'decision makers' within the UK energy system. For example, participant A7D states:

> *"I see the target audience as those people that [the PPP] sees as having the ability to influence the future of the UK energy system. And that varies from academics, through to people in industry, through to people in government. Some will be policy makers, but quite a lot of them will be involved in innovation activities. It's trying to tackle those who, with the information from the event, should do a more informed job".*

This distinguishes the stakeholders as having the ability to influence and create action within the UK low carbon energy innovation system, rather than prescribing this as part of the PPP's own role, which is defined here as 'informer'. This presents the knowledge creator and user as two distinct and sequential roles, which may not be beneficial to knowledge utilisation (Kruckenberg, 2015).

Participant A6S suggested that the target audience for the event were *"existing contacts from different projects".* Similarly, participant A7D illustrated how they had targeted attendees: *"I've gone through my contacts list and said 'these are the people I think we should be inviting'".* While there was a prevalence in participants suggesting existing contacts were the main source of invitations to the event, participant A5S recognised the ability to engage new stakeholders as an ongoing development area:

> *"In terms of getting new people, that's something we're still working on. When you're approaching new people it's often easier if you've got a particular carrot there, that they're particularly interested in. Whereas if you start to say: 'look we're doing all of this', they could say 'I may not be interested in all of that'. You've just got to lead them in with something that they are particularly interested in".*

While new stakeholders are needed in order to create a wider impact, the analysis suggests the needs and interests of new stakeholders need to be ascertained, before determining any strategy to engage with them.

The analysis has shown a wide set of stakeholders, with the majority of those identified being positioned at the supply side (or technology push) of the innovation system, due to the organisational mission. This may influence the knowledge that is being produced, being centred on

the supply of technology knowledge, rather than specifically demand-led knowledge production. Priority was placed on member organisations because of their financial investment within the PPP. Whilst it may be easier to understand the knowledge requirements of members, because of their closeness to the PPP, and the associated increased knowledge accessibility, there was an identified need to consider the knowledge needs of other stakeholders. The analysis importantly distinguishes stakeholders and the *views* of stakeholders: understanding the views of stakeholders is crucial in motivating knowledge utilisation. Lastly, existing contacts and those that have previously been exposed to the work of the PPP were identified as key stakeholders. However, there was a recognised need to develop mechanisms to engage new stakeholders, through providing them with relevant knowledge.

4.4.2. The Move To Engaging A Wider Audience

The preceding section suggests that within such a large and complex innovation system, there are many actors who can influence both the PPP's innovation objectives and the low carbon innovation system. However, it has been revealed that emphasis within the PPP has been placed on both members and technology people as priority stakeholders. The analysis suggests that the PPP has been working to move beyond these specific groups to produce knowledge outputs that are applicable for a wider audience. This section analyses how and why the PPP is moving to engage a wider audience.

Participant A4S suggests the need to engage a wider stakeholder group was an inherent part of the organisational strategy. That is, to create a wider influence from the knowledge the PPP produces through targeting those with different motivations:

> *"[The PPP's] strategy is, increasingly now, to have impact on the broader range of stakeholders. So it's not just about creating knowledge and commercial returns for our members, but actually influencing the whole low carbon environment; the market, policy landscape".*

Participant A1SE proposed that the PPP must ensure the wider stakeholder group understands the knowledge that is being produced so as to influence knowledge utilisation:

> *"This year we are focusing on a much broader range of stakeholders. [We] are really trying to make sure that they understand what's coming out, the work that we've been*

doing and giving them a route into engaging with what we're doing, so that we deliver greater impact from that work".

This suggests that boundary spanning mechanisms are needed to help overcome extant knowledge boundaries and promote understanding (Carlile, 2002). Relational activities would assist stakeholders with understanding and valuing the PPP's knowledge outputs, as well as providing the PPP with the opportunity to evaluate how stakeholders are using the knowledge. Thus, relational activities will optimise the opportunity for knowledge to be utilised (Heinsch et al., 2016), *if* the PPP can effectively embed knowledge about stakeholders within its operations.

The analysis revealed a perceived need to produce knowledge outputs that were suitable for non-technical audiences, again to create a greater impact. Participant A4S explains:

"We've always been very narrow…one of the things that I find is that within in the world of R&D, to people who have R&D or technology or science in their job titles, [the PPP] is reasonably well known. But people that have policy or economics or consumer or those sort of things in their job titles have never heard of [the PPP] to a large degree".

This has strong implications for knowledge utilisation from both a 'pull' (i.e. individual stakeholders seeking knowledge from the PPP) and 'push' (i.e. the PPP directs knowledge to multiple stakeholders) perspective. When creating knowledge outputs that are to be utilised by a wide variety of stakeholders, it is vital to understand how and why those stakeholders interact with knowledge in order to maximise the probability that they will use it. Green et al., (2009) propose that stakeholders will utilise knowledge if it is compatible with their own values and motivations, while suggesting that the ability to absorb the knowledge is subject to it being conveyed in a relevant 'communicating language'. Similarly, Dawes et al. (2012) suggest that knowledge boundaries are more easily traversed, if contextual distances between the knowledge creator and potential users are lessened. The PPP, when creating knowledge outputs, needs to recognise these diverse motivations, values, communication styles and engagement processes, so as to maximise the opportunity for the knowledge to be utilised (Head, 2010; Green et al., 2009). If this does not occur, knowledge can become trapped either within the organisation, or within a specific group of people (e.g. between engineers). The micro-level analysis also indicates that individual preferences for engaging 'like-minded stakeholders' reinforces the predominance of engaging existing contacts (see section 5.6.2.). This further sustains knowledge entrapment between certain groups of people.

Figure 4-3 summarises the above analysis, illustrating that while the PPP's strongest knowledge conduit appears to be between like-minded technology focussed individuals within the system, the ability to engage with others according to their views and motivations is essential to encourage knowledge utilisation. The various shapes in the diagram represent the different motivations and views of stakeholders within the system. These must be internalised and reflected by the PPP in the mechanisms it utilises to engage the stakeholders.

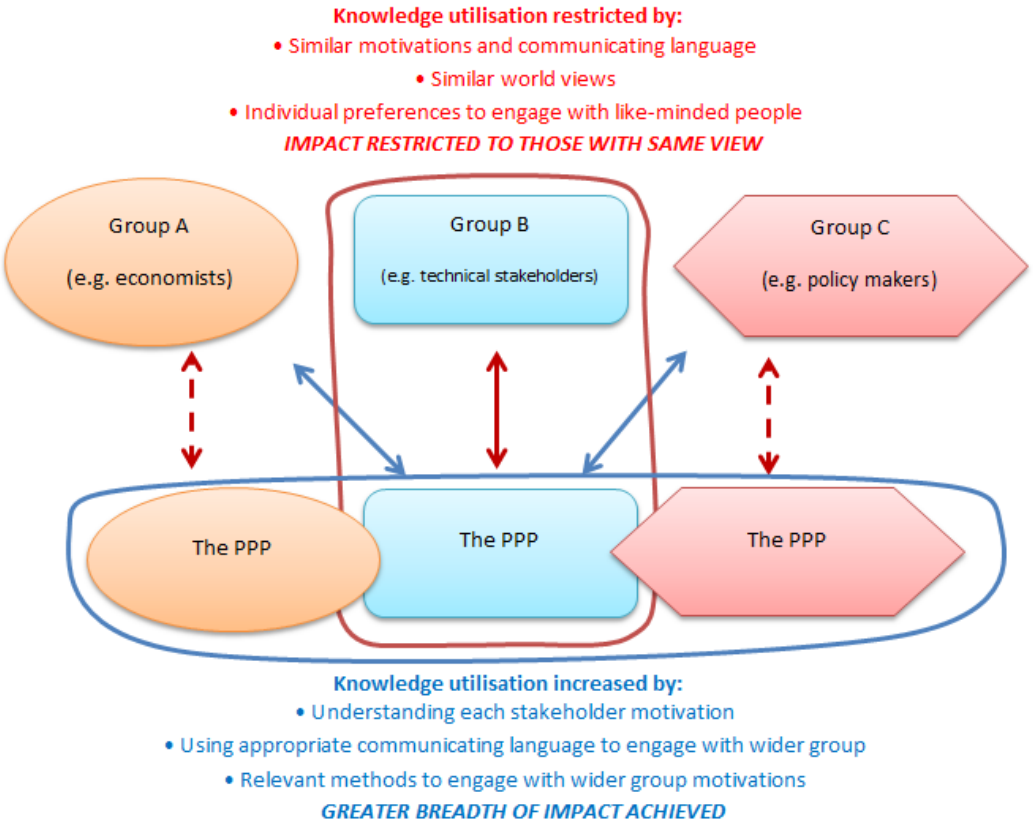


FIGURE 4-3: ILLUSTRATES HOW KNOWLEDGE CAN BECOME TRAPPED IN A DOMINANT KNOWLEDGE CONDUIT

Participant A1SE suggests a difference between creating project outputs and influencing outcomes amongst a wider stakeholder group that needs to be managed:

> *"It is a gulf between delivering project outputs and delivering those outcomes we're talking about. That gulf is filled by ensuring that you get benefits from the project work to stakeholders because, in that way, you deliver the outcomes. So for example, in terms of the policy makers, if you're going to deliver an impact on policy making, you have to understand those policy makers, you have to engage with them and give them the outputs of the work we've been doing, in a form that is relevant to the work they're doing on policy".*

This view emphasises the different strategies needed to deliver project outputs, which are often more tangible aspects of technology development and transfer, and achieving the 'softer' behavioural outcomes that are needed for knowledge utilisation. The latter is seen here to involve a greater degree of relational activities that encompass engagement (i.e. understanding and providing relevant knowledge). This aligns with calls in the literature to pursue the 'softer' side of innovation processes in order to realise innovation objectives (e.g. Byrne et al., 2012; Ockwell and Mallett, 2012).

Participant A5S indicates that a series of recent non-technical reports were seen to reach a wider audience, by putting context around individual technologies and projects that would be attractive to broader groups:

> *"I think historically, when we have issued work, its individual pieces of work about very small part of the programme area or the project. And then when you make that available to other people, it's missing the broader context. The reports are really trying to paint that broader picture, and explain what it means, rather than just this [technology] is the answer, or this is an answer. It's 'what does it mean in terms of the decisions [the stakeholder] has to make'?"*

This infers that whilst project partners have specific technical needs that are identified and met as part of project planning and delivery, there was a challenge in converting these knowledge outputs into something that was relevant for other indirect stakeholders and encouraging knowledge utilisation amongst this wider group.

The portfolio of non-technical reports were also perceived to be more relevant to a wider stakeholder group through reducing the amount of technical complexity within the report, and explicitly highlighting the *benefits* of groups of technologies, rather than the technologies themselves. Participant A13 emphasises the importance of providing *context*, rather than individual technological knowledge to deliver more relevant knowledge outputs for a wider range of stakeholders. They state:

> *"The energy system is a complex beast, and you need to take a long term and a strategic whole systems view. And whilst you might want to look at individual technologies, you have to see them in the context of other things".*

This moves the focus from technology transfer, to the wider notion of knowledge transfer, which Gopalakrishnan and Santoro (2004) suggest concerns the underlying principles of cause and effect relationships, rather than using the technology itself as a tool for change. Participant A4S explains that adding this 'whole systems approach' (multi-technology) context for a wider group of stakeholders provides incentives for stakeholders to use the knowledge. They state:

> *"If you actually want investments to happen in the real world, if you want people to have the incentives to make those investments…you have to create the conditions for that. And that involves creating policy around that and getting the people to understand that it's important, that this is the value at stake. There's lots of work that needs to be done beyond just the pure generation of the underlying techno-economic insight, into turning it into impactful on reality".*

However, participant A8D proposes that there are a number of individual interests within this wider stakeholder group:

> *"People do tend to get factionalised, so you'll end up with the wind lobby, CCS lobby, and actually it's about bringing those people together and looking at this from 'this is what we need to do for a whole system' perspective".*

This 'factionalised' viewpoint raises the question of how to encourage stakeholders to realise the benefits of this 'whole energy systems perspective', given compartmentalised motivations. Participant A4S illustrates these individual stakeholder motivations:

> *"Economists will get fantastically excited about electricity regulation and capacity mechanisms and the contract for difference. But they won't put that in the context of the whole energy system and the whole challenge of decarbonising the UK. We've done that, which I think is very powerful: looking at all these various technologies and how they might be integrated and fit together in a way that's very efficient and saves everyone a lot of money actually in the long run. So that system wide view still has a lot of implications that I don't think are particularly widely understood. And I think everybody [at the PPP] understands that, because that's the way we think. But we don't realise that the rest of world doesn't get it at all, and it's actually really quite a difficult challenge to get it over to them and persuade them and enable them to get it".*

Although a wider stakeholder group has been identified as a means to create impact through action, each stakeholder group will still contain individual motivations and requirements for knowledge utilisation. Reports that are aimed across a blanket group of stakeholders may not immediately align with each of these individual needs. Head (2010:80) suggests that a "poor fit" between research outputs in the form of reports and the practical need of stakeholders may reduce the chances of knowledge utilisation occurring. This creates a challenge between expanding knowledge outputs to be relevant for a 'wider group of stakeholders', but also addressing the various knowledge requirements of individual stakeholders within that wider group. Figure 4-4 summarises the challenge of balancing two views of knowledge outputs that were shown in the analysis.

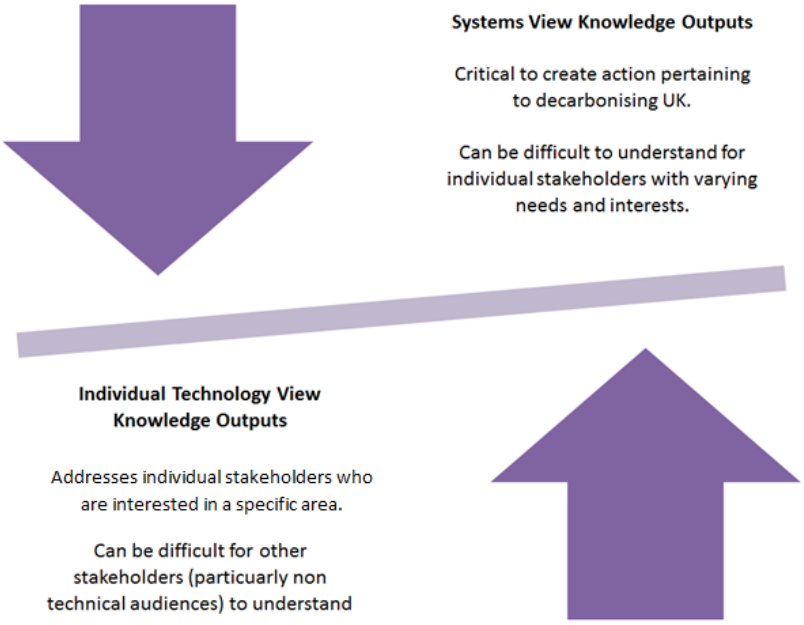


FIGURE 4-4: A WHOLE TECHNOLOGY SYSTEM VERSUS INDIVIDUAL VIEW OF KNOWLEDGE OUTPUTS

Firstly, producing knowledge outputs that are relevant for individual stakeholders (individual technology view) and secondly, producing knowledge outputs for a range of stakeholders (whole technology systems view).

This section has indicated that the PPP is pursuing greater impact within the innovation system, as part of its organisational strategy, by trying to engage a wider range of stakeholders. It suggests that there is a difference between delivering project outputs (a technology transfer mind-set) and encouraging knowledge utilisation from the wider stakeholder groups, which the PPP requires to achieve its innovation objectives. It suggests that the priority group of stakeholders (i.e. members) are often easier to understand and have easier access to knowledge because of their close and

continued association with the PPP. However, in order to motivate more stakeholders, an understanding of their views, goals and motivations, and subsequent development of *relevant* knowledge in a form that aligns with these views is needed. Actively promoting the *benefits* and *context* of multiple technologies, rather than the technology itself was seen to motivate the wider stakeholder group to use the knowledge. However, the challenge lies in encouraging knowledge utilisation to a wider audience, whilst also creating motivations that aligns with each individual stakeholder need and interest.

4.4.3. The PPP's Perceived Role Within The System

This section reviews the perceived role of the PPP within the larger system in relationship to other stakeholders and how this affects knowledge utilisation. The originally espoused objectives of the PPP, as proposed by the government before the PPP commenced, included: increase energy R&D funding; expedite R&D commercialisation; and facilitate network connections amongst the energy R&D community to build R&D capacity. These key strategic objectives were seen to facilitate the attainment of the 2050 energy targets, maintain the reliability of energy supplies, and safeguard energy affordability whilst ensuring sustainable economic growth. The analysis revealed that staff perceived the attainment of the 2050 energy targets as a strategic imperative for the PPP, as well as maintaining the affordability and security of energy. However, the participants commented that in order to meet this broad level goal, the role of the PPP was to encourage shorter term actions. Participant A5S suggested that the PPP was trying to deliver messages to stakeholders that highlighted the importance of nearer term actions:

> *"It's the broad strategy around 'you need to get to this point by 2050'. But we're saying 'well to do that you need to invest in the shorter term': it's a shorter time period that you've got to make that investment, that's what you've got to start building and developing to meet longer term 2050 targets. And that's a core descriptive theme…what needs to happen in the near to medium term to allow the longer-term goals to be achieved".*

Participant A7D added to this stating:

> *"The [PPP] was formed to find objective, evidence-based knowledge that would be used to help formulate the energy system for a low carbon 2050. It's this message of, 'if you*

want to achieve 80% greenhouse gas reduction by 2050, you can't wait to 2050': it's really got to be built into the UK energy system by about 2030, for it to impact on 2050".

These comments convey two key concepts regarding the utilisation of the knowledge. Firstly, whilst knowledge may be created in the PPP, this must lead to short-term, measurable *actions* by others within the system in order to meet high level, long-term goals. This suggests that knowledge utilisation encompasses knowledge and action *that contributes towards a defined goal*. However, knowledge utilisation may be complicated if differing goals are pursued by those who create knowledge and those who are needed to create action (Green et al., 2009), particularly in relation to higher level social goals (deMan, 2008; Geels, 2014; Pinkse and Kolk, 2012). Knowledge can also follow a non-linear path, creating difficulties in tracking created knowledge to a defined action (Rich, 1997). Secondly, the resulting actions (or impacts) may only be witnessed over extended timeframes – in this case the participant suggests that impact may extend 20 years beyond any technology implementation. This shows the importance of distinguishing between technology outputs that may be achievable in the shorter term, and both commercial realities and behavioural-based outcomes that may occur over longer timeframes. This is particularly important for the PPP: although it is a temporary organisation, it must influence longer term knowledge utilisation to meet its innovation objectives and organisation mission to facilitate 2050 targets.

Participants had strong perceptions of what the organisational role was in the context of the wider systems stakeholders regarding the creation of action. Participants identified other actors within the innovation system as having the motivation, authority and capability to make decisions and create action, although did not associate these qualities with the PPP's role. Participant A7D stated:

"What [the PPP] can do is stand up and say these are the areas that are going to matter, and this is the evidence as to why we think it matters or it doesn't matter. We can't make the decisions, because many of the decisions are governed by policy decisions".

This firmly places the PPP within the role of knowledge creator only, suggesting that other actors are those who create action, and appears to contribute to 'influencers' being identified as a separate stakeholder group. Figure 4-5 represents these perceived separate roles and highlights the importance of influencing action. However, this creates distinctive roles between knowledge creator and knowledge user which potentially inhibits knowledge utilisation (Kruckenberg, 2015). These segregated roles suggest the knowledge creator is passively providing knowledge to a potential user,

who may or may not use the knowledge in a fashion that leads to innovation objectives. Importantly, it establishes two different powers: the power to inform compared to the power to create action.

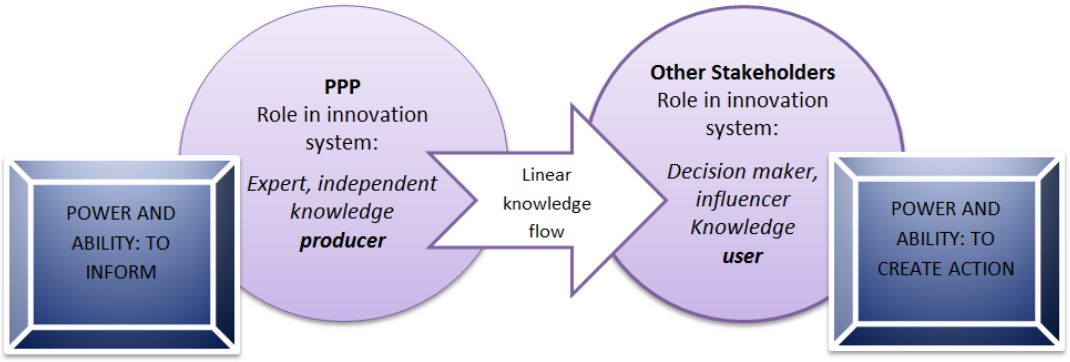


FIGURE 4-5: PERCEIVED ROLES OF SYSTEM STAKEHOLDERS

This section has revealed the importance of encouraging shorter term knowledge utilisation from stakeholders to enable the achievement of longer term organisational goals. However, the perceived role of the organisation as 'informer' leads to more linear knowledge transfer mind-sets, which suggest the PPP is solely a knowledge provider instead of influencer of action.

4.5. MESO-LEVEL ANALYSIS

This section analyses the meso-level factors. This analysis represents the factors that occur at an organisational level and their influence on knowledge utilisation. The section firstly analyses the organisational structure, before reviewing the organisational funding mechanisms, and the perceived organisational capabilities.

4.5.1. ORGANISATIONAL STRUCTURE

The work that the organisation undertakes is structured through various programme areas, each focussing on a thematic technology capacity. Additionally, these are divided into strategic and delivery functions, with additional support services for the whole organisation. Participant A13 explains how the strategic and delivery functions operate together:

> *"[The delivery function] gets the stuff onto contract and delivers the contract and then exploits the outcomes of the project. Whereas strategy sits sort of side by side and frames what the projects ought to be. Then [the strategy team] try and knit together all the learnings from all the different bits of the projects".*

Participant A10S outlines the role of the strategy function:

> *"The strategy team has a role through the life of projects: in the first place they scan the knowledge landscape and have an overview of what's going on in the energy landscape; where are the gaps in terms of research of technology development? [The strategy team] start with where should [the PPP] spend its money and what are the things [the PPP] should be doing. [The strategy team] are the ones who then are very heavily involved in the 'so what?' at the end of the project. So that for me is what it's about: 'so what'? [The PPP] has done a project, generated all these documents, all these outputs: what does it mean? What is it all about? Who needs to know? And how do we get it to them"?*

Participant A7D did, however, suggest the boundary between the roles was blurred:

> *"The strategy manager is responsible for formulating what [the programme] wants to do. Exactly how that boundary [between programme and strategy manager] works [shrugs to indicate they don't know]".*

These descriptions suggest there is a difference between: delivering the project (i.e. the project management processes and outputs of the projects); exploiting project outputs; and synthesising the value from the projects across the programme portfolio for a wider audience. Figure 4-6 illustrates the perceived place and role of knowledge utilisation to a wider audience, as something which occurs at the end of the project.

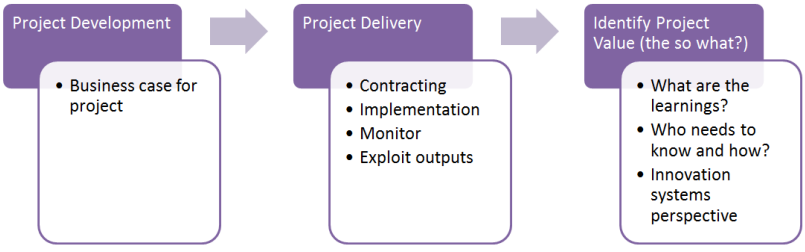


FIGURE 4-6: THE PROJECT PROCESS WITH UTILISATION SEEN AS A LINEAR PROCESS

This analysis suggests that project delivery incorporates the exploitation of project-level deliverables and that knowledge utilisation is a sequential, but separate, facet. However, Green et al., (2009) suggest that, in order to maximise the opportunities for knowledge utilisation to occur, the knowledge user should be involved as early and continuously as possible. While this might be the

case for direct project stakeholders who have identified needs from project deliverables, those stakeholders, who are not directly linked to the project, but can have influence, may only have access to the knowledge at the end. The longer-term nature of some of the projects and the extended timeframes needed for behavioural outcomes to occur, also means that the value, learnings, and crucially, action often emerge over the longer term. This suggests that the PPP, as a temporary organisation, may be challenged to observe any actions and innovation outcomes that occur beyond its lifespan.

The PPP's structure means that overarching organisational goals are pursued through a portfolio of separate projects. This, combined with the nature of research and development projects, results in new knowledge being created as more projects are developed. Participant A11D suggests that this growing organisational maturity has resulted in the PPP having "*more to say"* as more knowledge was created, in line with the emergent nature of research and development work: "*As we've matured as an organisation, I think that the events are becoming much more outward looking, and are much more inclusive".* This suggests that as the breadth of knowledge grows within the PPP, it becomes easier to recognise the value for a wider range of stakeholders. Although as indicated in the macro-level analysis, the new knowledge still needs to be developed into relevant content and media for wider stakeholder groups.

Participant A11D proposes that an increased focus on knowledge utilisation has been led by the organisations executive team. They suggest this has resulted in more attention being given to the development of knowledge utilisation plans:

> *"I think the executive team have realised that doing the project is not the end of the journey, and have wanted us to focus on [knowledge] exploitation…So I think we as individuals we've naturally started to think more and more about influencing, about who you know, what's the right way of disseminating and exploiting the outcomes of what we've done?"*

This suggests that leadership can influence the mentalities and activities undertaken by individuals, so that a greater focus can be given to knowledge utilisation.

The findings presented above suggest that knowledge utilisation is seen as a linear process and reinforces earlier analysis that project boundaries can act as boundaries to engaging other

stakeholders. It also indicates that breadth of knowledge may increase with organisational maturity, although this does not equate to being able to utilise that knowledge more. Lastly, it suggests that leadership can influence the attention that is given to knowledge utilisation as a task to fulfil strategic objectives.

4.5.2. Organisational Funding Mechanisms

As a Public Private Partnership, the PPP utilises funding streams from both public and private sources. The PPP then funds individual projects across its programme portfolio via a public submission of tender process to attract high quality bidders. This process is governed by transparent submissions procedures and governance structures, with existing organisational knowledge used to prioritise technology programmes and project objectives. This places the PPP in the dual role of funding recipient and funder. In its role of funder, the PPP can set the selection criteria for each project and judge the adherence to these established selection criteria through the above-mentioned tender process. Critically, the organisation's selection criteria are purported to align with the aim of the organisation; that is, strategically investing in *technology development*. Whilst exploitation of project outputs is mentioned in generic selection criteria, often this could involve generation of a report for distribution in a public forum or other forms of public dissemination of explicit knowledge. The relationship that the PPP has with its commercial project partners also influences the role of the PPP as a producer of knowledge rather than having more tangible outputs. That is, the PPP was seen to produce knowledge, whereas the individual project partners, were seen to have more commercial outputs. For example, participant A2SE states:

> *"The [PPP] doesn't really have a product as such… knowledge is a product. There are a handful of things that have come out of projects which are commercially available, but the [PPP] doesn't intend to go to market to try and sell them as the project partners take that forward".*

The unique structure of the PPP and its role of project funder mean that it can set project direction and success criteria, but this is often focused on dissemination activities. This is consistent with Head (2010), who proposes that both *topics* of projects and *formats* of project outcomes are most heavily influenced by the funders of projects, because of the necessity of funding as a resource. The funding set-up also results in the PPP producing knowledge as a key project outcome, with commercial exploitation being a domain of the industry partners. However, the following section

evaluates how the commercial exploitation of project outputs is seen as a primary focus to the exclusion of other forms of knowledge utilisation.

4.5.3. Organisational Capabilities

The analysis reveals the perceived organisational capabilities that were deemed necessary in order to fulfil the espoused role of the organisation, and are inherently linked to the organisational level objectives of technology development and deployment. This suggests a traditional organisational hierarchy where staff pursue the attainment of overarching organisationally set objects, through various functions and job roles. Participant A7D viewed the key organisational capability as "*providing the engineer's solution*", further commenting that "*what we're doing, is we're saying these are the technical facts, it's for politicians and others to consider the other risks*". This proposes the PPP is a 'technical evidence provider', instead of considering other avenues through which knowledge will be utilised within the macro environment, such as by policy makers, academics and even consumers.

The participants who represented specific programme areas (i.e. specific technology areas) discussed mainly technical and commercial capabilities/knowledge as the output of the organisation. This included outputs such as: *"things that can be commercially exploited*" (participant A6S); "*providing objective evidence on the future costs of (a technology*)" (participant A7D); *"software tools"* (participant A8D); and *"economic analysis"* (participant A9S). However, a director level participant (participant A13) suggested a unique capability of the PPP was to go beyond purely techno-economic knowledge outputs suggesting:

> *"[We] fill a fairly unique position: knitting all the trade-offs between the different elements of the energy system together and then adding not just the technology but the markets, and the policy and the regulatory [aspects]".*

Participant A4S commented on how the dominance of technical capabilities was caused, in part, by the 'engineering mind-sets' and what this means for knowledge utilisation:

> *"Traditionally we love to create models. Lots of engineers like building things and creating software and models of everything. And these models create pictures of what an ideal world would look like, if engineers were in charge. But how do you actually turn*

that into reality? That involves engaging in the horrible, messy, complex, contradictory world of reality and different people's views of it and different people's motivations".

The above analysis suggests that some participants believe technical knowledge is the predominant capability for the organisation. This indicates that knowledge utilisation within the PPP is science driven and emphasises the linear delivery of robust technical evidence that will be adopted by end users (Gano et al., 2006; Landry et al., 2001). This linear perception of knowledge utilisation may not contribute to action amongst wider stakeholders (Best et al., 2008).

A particular organisational capability was seen to be the ability to generate knowledge pertaining to multiple technologies to provide a holistic approach to transitioning to a low carbon energy system (the 'whole systems approach'). The majority of participants identified this as a key organisational strength. However, this approach still emphasises the technical knowledge as the main knowledge output of the organisation, as Participant A10S states:

"We will continue to generate a lot of knowledge from across our programme areas, but importantly, putting together that system level overview. Because where we differ from a lot of people, from almost every other organisation I know, is that we don't have outputs from a [single technology]. We're not talking here about what I've learnt from a nuclear project or what I've learnt from a heat project, it's what I learn about that in the context of the overall system. So it's about getting that knowledge out and to the parties who need it".

Despite this multi-technology approach being seen as an organisational capability, the earlier macro-level analysis (see section 5.4.2) reveals that stakeholders may not understand or see value in this higher-level approach. Subsequently, they may not be motivated to use that knowledge.

In addition to the technical capabilities and knowledge that the PPP possess, participant A4S suggested an increase in a range of 'softer' capabilities was needed, to effectively engage a wider stakeholder. Participant A4S suggests that to understand stakeholder motivations takes:

"Time consuming, laborious work that actually involves building relationships with stakeholders; making sure that you can communicate, you understand what the messages are that you're trying to communicate and communicating them in a way that

audiences can engage with and find compelling…[We] need to get better at communicating what we've got to offer".

Participant A10S indicated that effective organisational communication capabilities also requires the PPP to listen and establish feedback loops in order to learn and adapt to stakeholder needs:

"We're not preaching a story without listening to what others have to say. It's also a good opportunity to engage with what else is going on, with a large audience to get some feedback. It's really useful when somebody says to you, 'you know I really don't get that bit of the story, can you explain that to me'? It tells me I'm not writing it down properly, but also what's also difficult for other people to grasp".

Similarly, participant A14D suggests that obtaining feedback from stakeholders would be beneficial for the PPP if: *"[the PPP] started doing something in a different way, or if it started rolling out technologies in a different way."* This indicates that organisational learning is an important capability for the PPP to have.

This analysis suggests that to maximise the potential for knowledge utilisation, effective technical *and* communication skills need to be developed. Together these can facilitate value creation through both knowledge content and the channels through which that content interacts with stakeholders (Donofrio et al., 2010). Furthermore, it illustrates the need for a significant amount of time to be invested in the process of building stakeholder relationships in order to understand their needs. Participant A11D reflects on this resource challenge in the context of implementing both project deliverables and knowledge utilisation, although recognises that knowledge utilisation is needed to meet longer term objectives:

"At times we struggle to resource [knowledge exploitation]. There hasn't necessarily been recognition about the workload associated with that. There's a desire to do it and I think, as individuals, as we start to deliver projects, we have quite a clear mission here, and a vision of what we want to achieve. And so you quite quickly say 'well right how am I going to achieve that vision in 2050'?"

Another organisational capability indicated was the credibility that the organisation holds through the production of evidence based, impartial knowledge. Participant A7D suggests this stands out from other actors within the innovation system:

> *"You've got to remember that [the PPP] is providing this objective evidence base. An awful lot of stuff you hear about a UK energy system is provided by pressure groups and others, who are pushing a particular viewpoint. They are either not providing evidence, or are deliberately providing evidence that supports [their] bit and not the rest".*

Therefore, the provision of a systems (multi-technology) based approach to knowledge aligns with this notion of being credible. That is, the PPP does not suggest a *"magic bullet*" (participant A8D) or advocate one particular technology. It also suggests that the PPP refrains from applying pressure in any particular area, so as to remain impartial. This non-pressurised systems view was therefore seen as being more credible. Participant A10S presented some benefits that were realised by the PPP through having a reputation of being credible:

> *"If [politicians] are quoting our figures for the value of, for example, Carbon Capture and Storage, if [politicians] are quoting our numbers, if [industry] are quoting the same numbers it makes, it far more difficult for [the government] to then in the spending review say, 'we're not going to do Carbon Capture and Storage because it's too expensive'. And so it's having that influence. And you get that influence by having credibility with a broad set of stakeholders…you get cited and quoted and people refer to our work and point others in our direction, I think that builds the credibility with stakeholders".*

In this instance, credibility leads to knowledge utilisation in the form of stakeholders citing the knowledge that the PPP produces, suggesting that citations are an important measure of knowledge utilisation. The participant also went on to illustrate how credibility is a benefit for stakeholders and how it may influence knowledge utilisation:

> *"[Stakeholders] believe, because we are very evidence based, because we are neutral, that we're a very credible voice of reason. And so they would see, in this world where everybody shouts and everybody lobbies, they see the value in having a voice of reason".*

However, participant A13 perceives that although credibility is a necessity, in isolation it may not automatically lead to knowledge utilisation: *"We have to be visible and we have to be credible. The benefit for us is that people might go off and do things on the back of what we say. We can't force people to do it".* Additionally, illogical decisions can be found within political environs, due to unseen external pressures and internal irrational decision-making behaviours (Hallsworth et al., 2011).

Again, there are notions of purposefully not pressurising stakeholders to make decisions; instead stakeholders 'may' create action from knowledge. Indeed, Head (2010:80) stipulates that: "The mere availability of reliable research does not ensure its subsequent influence and impact". This emphasises a wide gap between 'knowing' and 'using', particularly when knowledge has to be used in the way envisaged by the knowledge creator.

Table 4-2 illustrates the types of capabilities necessary to engage with a wider audience and meet organisational objectives, as suggested by the analysis.

Knowledge/ skills required	Objectives and benefits	Influence	Under-pinned by
Technical Knowledge	• Demonstrates expertise • Provides evidence (rigour)	Aids knowledge creation and utilisation	*TIME AND RESOURCES TO DEVELOP AND IMPLEMENT A COMPLETE RANGE OF KNOWLEDGE AND SKILLS*
Stakeholder knowledge	• Identifies knowledge about direct stakeholders (project partners with known motivation) • Identifies knowledge about indirect stakeholders (others with potential unknown motivations)	Aids knowledge transfer and utilisation	
Communication skills (conveying of information)	• Generates relevant and compelling messages, content and formats • Emphasises benefits for stakeholders (benefits for many) • Emphasises benefits for stakeholders (benefits for individuals)	Aids knowledge transfer Aids knowledge utilisation	
Relational skills (relating to people)	• Strengthens and maintains current networks • Creates new useful networks • Translates technical knowledge to stakeholder circumstance • Demonstrates benefits of existing knowledge stock to stakeholder circumstance • Creates a need for the knowledge • Aids outcome delivery (influencing)	Aids knowledge utilisation	

TABLE 4-2: SKILL SETS AND THEIR INFLUENCE ON KNOWLEDGE TRANSFER AND UTILISATION

Importantly, it suggests that both technical and stakeholder knowledge are needed to ultimately influence knowledge utilisation (Head, 2010). It further suggests that both communication skills (representing the ability to convey information) are needed, as well as relational skills to influence individual stakeholders, according to their motivations and circumstances (Heinsch et al., 2016). Lastly, it illustrates that time and resources are needed to generate the required knowledge and successfully develop and implement the relevant skills in order to influence knowledge utilisation.

This section has revealed that the perceived organisational capabilities pivot around the ability to provide technical knowledge ("*the engineer's solution*"). This suggests a science driven, linear model of knowledge utilisation that centres on the provision of impartial and credible evidence, which may be cited by others. It was recognised that 'softer' skill sets are needed to motivate knowledge utilisation, including the incorporation of feedback loops that support organisational learning in response to stakeholder knowledge requirements.

4.6. Micro-Level Analysis

This section analyses the micro-level elements, considering the individual level factors and their influence on knowledge utilisation. Firstly, it evaluates the individual perceptions of the knowledge activities that the participants undertake and how these influence knowledge utilisation. It then analyses how individuals perceive value creation from the knowledge produced by the PPP, before appraising how individuals perceive success.

4.6.1. Individual Perceptions Of Knowledge Activities

This section analyses the individual perceptions of what knowledge activities the participants felt they undertake. In relation to the planned knowledge transfer event, the majority of participants suggested that talking to different stakeholders about the project work that they had undertaken, was their predominant activity. Participant A8D commented they would be "*demonstrating a database in the modelling lab*", whilst participant A9S stated:

> *"If [the stakeholders] are interested in the subject, they'll come to that area on the day. And I'll speak with people and talk a little bit about the projects we've done and what we've learnt. And if they're not interested they won't".*

There was a significant emphasis placed on the dissemination of reports as a method to create learnings for the attending stakeholders. Participant A4S stated "*I've got two science reports that I'll*

be there, on a stand, to talk to people about", whilst participant A6S said "*there are three [reports] which are being promoted at this event*". Participant A4S suggested the knowledge activities they would engage in consisted of:

> *"Communicating key messages in a range of different areas, in particular the (non-technical) publications. So that's taking the knowledge that's created by the projects and saying 'well, what does it mean?' 'What are we trying to turn that into'? It is things that are more broadly communicable to a wider audience".*

The overall perceptions about the activities appeared to be based on a linear model of knowledge transfer, which relied heavily on disseminating 'messages' to attendees and publicising the explicit knowledge (i.e. reports and publication). The emphasis was on displaying the actual knowledge developed within projects (demonstrating expertise). This reflects knowledge-as-an-object (Newell et al., 2009; Cook and Brown, 1999) in which knowledge can be 'moved' to another person or place, without necessarily being utilised in a way that contributes towards the achievement of organisational objectives. Nonaka and Takeuchi (1995) propose the process of externalisation, where tacit knowledge is articulated into *assumed* understandable forms and codified sources. However, even if this knowledge is understood by stakeholders, this still does not guarantee utilisation or impact. The knowledge activities stated above reveal a demonstration of expertise, rather than application of expertise to suit individual stakeholder circumstances. They focus on disseminating knowledge and key messages to stakeholders.

4.6.2. Individual Perceptions Of Value Creation

The analysis shows differing perspectives to value creation. One perspective is creating value by *informing* decision makers through the provision of neutral and rigorous evidence. This is closely aligned to the PPP's perceived capability as being credible. Participant A2SE suggested value is created by "*show[ing] that there's good, well respected, independent evidence that [stakeholders] can use to inform their policy and decision making".* Similarly, participant A7D suggests value creation is obtained from providing evidence to inform and support the decision makers within the innovation system:

> *"[The stakeholders] can make informed decisions based on evidence. But [the stakeholders] have to get on with those decisions. This event is around raising the*

profile of the importance of that, getting in some of the messages that would support that decision and getting [the messages] to the policy makers and other stakeholders".

This infers that providing credible, neutral evidence may not influence action. Participant A2SE suggested value would be created when the stakeholders got *"a clearer understanding of what the kind of message is coming out of [the PPP]".* Similarly, participant A11D wanted stakeholders to: "*have an understanding of why [the PPP] has been instrumental in developing that valuable information".* However, understanding does not necessarily equate with utilisation.

These views suggest that value creation is generated through the provision of expert knowledge that may be used by stakeholders, where the focus is on both the *expertise* and the *knowledge* itself. This is congruent with the perceived knowledge activities in the previous section. However, it does not necessarily see value creation in the process of actively encouraging knowledge utilisation, by putting stakeholder needs first. Instead the value is derived from increasing the awareness of the knowledge produced.

Participant A7D differentiates between stakeholders receiving messages and knowing how to implement those messages (i.e. create action): *"[the stakeholders] will want to know how that moves from a set of words, into something that can actually be delivered - what's actually got to happen".* This suggests that stakeholders have to possess both the content knowledge (messages), but also implementation knowledge (know-how). However, the process of influencing is not complete without stakeholders *creating action* towards innovation objectives. This will potentially require ongoing engagements as Participant A1SE suggests, with value creation being realised through encouraging the conditions for future engagement:

"[Stakeholders] see what we've got and then engage more in it subsequently, so that most of what we are creating is hooks to get people to come and find out more. And so I think the benefit of it will actually come from when they engage with us further".

This moves the focus away from the knowledge itself to developing relationships in order to encourage knowledge utilisation. Participant A12S emphasises the building of new relationships and creating value through influencing:

"It will be good to get a bit of exposure to different people, because you're always trying to achieve, whether you actually do or not, you're always trying to achieve some sort of leadership or influential position".

Communication skills have been suggested to be necessary organisational capability at a meso-level (see section 4.5.3.). However, at a micro-level, each individual must see the importance of effective communication and its relevance to influencing action. Participant A2SE highlighted the importance of their colleagues being proactive with communication: "*It's (important) to show the value of good professional communication: some (staff) may think the world is waiting for them to talk and it isn't".* Similarly, participant A4S suggests that individuals will naturally steer towards other stakeholders who they 'like' talking to, which can limit knowledge utilisation:

"It's an organisation that's dominated by technology and engineering people and they like to go and talk to other technology and other engineering people. But actually, to have impact you need to move beyond that into talking to different audiences".

The above analysis has presented how participants view value creation: through informing or influencing. This is suggested to be a continuum rather than two distinct and separate facets. Each of these perspectives has specific factors, which ultimately affect how knowledge is utilised. These are presented (as a continuum) in Table 4-3.

Value creation perspectives		
Factors	**Informing** ⟷	**Influencing**
Value created by	Expert, knowledge creator	Co-created
Value captured in	Dissemination to stakeholders	Motivating action by stakeholders
Value located in	Knowledge creation and provision	Knowledge utilisation and action
Driver	Expert knowledge	Stakeholder motivations
Focus	Organisation (knowledge creator)	Stakeholder (knowledge user)
Knowledge type	Explicit (information), general, content	Explicit/tacit, customised, content, know-how
Engagement	One off, linear, passive	Continuous, iterative, proactive
Learning	Stakeholder learns from expert	Both parties learn from each other
Skills	Technical, communication	Technical, communication and relational

TABLE 4-3: INFORMING AND INFLUENCING VALUE CREATION PERSPECTIVES

The analysis suggests that the role of informer is in line with a more linear approach, which focuses on the transfer of expertly created knowledge. However, the role of influencer suggests a model where relationships with stakeholders and creating action are central.

4.6.3. Measures Of Success

The perceived measures of success give the opportunity to explore how the event was perceived to facilitate organisational objectives and how individuals associate this with knowledge utilisation. Participant A7D suggested that the event could be considered a success already because of the number of people registered. However, this may be a reflection of the fact that a broader audience has been invited. More subjective dimensions of success were identified, with phrases such as 'energy' and 'buzz' used frequently. Participant A4S illustrates this subjective measure: "*I'll measure it by gut feel…it will be the number and the quality of the conversations*".

Particular value was seen to be created if the PPP received invitations to attend other broader audience events, as evidence that the organisation is moving beyond a predominantly technical audience. Measures of success were seen by some to only be visible in future action, which results as a direct consequence of the event: *"[It's] not 'what did people think of the event itself', it's the uptake of the messages after*" (Participant A10S).

Interestingly, there were only limited responses linking success with organisational learning, as participant A1SE states:

> *"There is another level of success, in terms of how effectively we use the event to establish where to go next. If we do something different as a result of the event…then I think there's success".*

More specifically participant A4S suggests an increase in communication skills as a measure of success:

> *"[Exposure] to direct questions from a different range of stakeholders; so that its starts to inform our thinking about how we might want to engage with people, express messages in a way that different types of people can engage with and understand. Just in things like our choice of language, sometimes we're very technical. All of those sorts of things that help everybody get better at communicating our work".*

This section has revealed various layers regarding the measure of success, which are presented in figure 4-7.

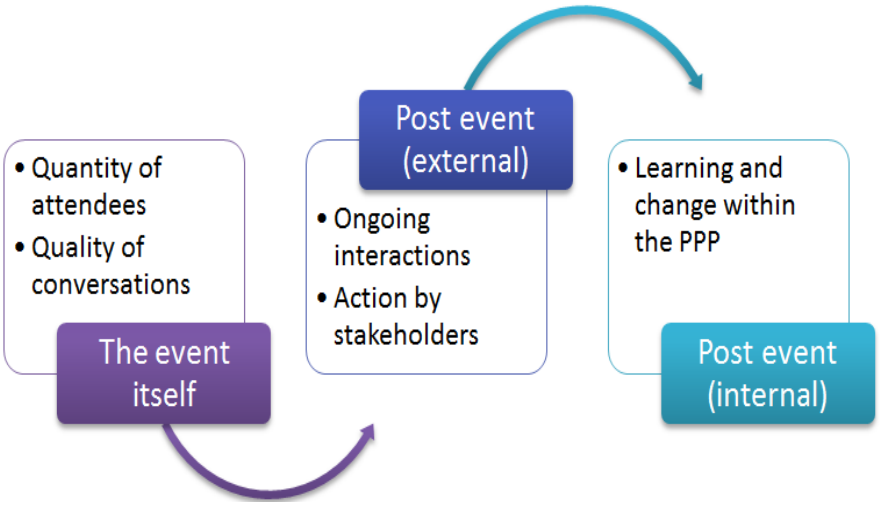


FIGURE 4-7: LAYERS OF SUCCESS

The findings reveal that the measures of success that related to the event itself, were heavily focussed on the dissemination of expert knowledge to a wide range of people. However, when the measures of success encompass ongoing interactions and the change made by stakeholders, the focus shifts more to knowledge utilisation as an objective. Lastly, if changes within the PPP itself are considered, through a process of organisational learning, this was seen to maximise the opportunities for knowledge utilisation, through responding to and adapting to the needs of the stakeholder.

4.7. ORGANISATIONAL INITIATIVES TO IMPROVE KNOWLEDGE UTILISATION

Approximately six months after the initial interviews took place, the opportunity arose to attend a training workshop within the PPP pertaining to maximising the opportunities for knowledge to be utilised amongst stakeholders. The workshop gave the opportunity to observe any changes in perceptions of knowledge activities and knowledge utilisation between the original interviews and the workshop, but also observe how perceptions changed over the time of the workshop.

Participants during the interviews had recognised the need to pursue knowledge utilisation amongst a wider audience and acknowledged an organisational drive to do so, through the development of knowledge utilisation plans (see section 4.5.3). During the workshop, participant A10S suggested that, after reviewing the utilisation plans, they were mainly focussed on commercial exploitation of outputs, but that exploitation was *"more than that"*. The participant further suggested that in order

to create a greater impact, different types of exploitation would need to be considered, beyond commercial ambitions.

The interviews acknowledged that the PPP's mission relates to long term impact; that is to facilitate the achievement of 2050 national energy targets. However, it was realised in the workshop that more emphasis was needed on the short-term actions that would enable the attainment of those long-term goals. Participant A14D suggested that whilst their own programme area had very high level, long-term goals, there needed to be *"baby steps to achieve tangible short-term actions"*. They further suggested that greater consideration of *"how to sell"* what the programme was doing was needed. Another workshop participant summarised the need to *"persuade others to act"* in the short-term, in order to execute the long-term plans and visions. However, participant A10S realised that there is often a conflict when considering knowledge utilisation: often emphasis is placed on work that is deliverable (within the boundaries of project partners) rather than work that is impactful (which requires other stakeholders to use knowledge). Figure 4-8 illustrates how high-level, longer term goals (including the creation of impact) require congruent short term, project-level goals that focus on being deliverable and impactful.

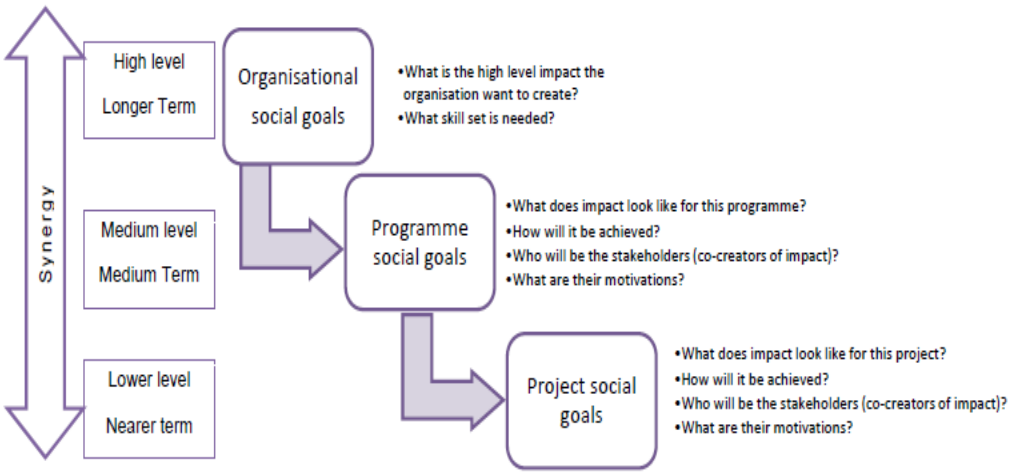


FIGURE 4-8: DEPICTION OF GOAL SYNERGY FOR IMPACT CREATION

This analysis reveals that great attention has been given to the planning function of knowledge utilisation; that is, how the programme aims to achieve these long-term, organisational-level goals. However, during the workshop, the attention turned to how to operationalise these plans and actively provide the motivation that encourages knowledge utilisation amongst stakeholders in the short term.

Following on from the ability to achieve greater influence on others in the short-term, there was recognition as to the complexity of the innovation system, the multitude of actors who influence it, and the environmental influences (particularly in relation to political stakeholders). The workshop presented a complex systems perspective of the innovation system to the participants that demonstrated a necessity to understand individual stakeholders and stakeholder networks and their capacity to change, whilst recognising that the dynamic environmental influences are subject to constant change. It considered how to influence target stakeholders through new third parties that may not have been considered before, such as government departments, which may lie outside of existing networks. Essentially, it put the views and motivations of the stakeholder first and explored how best to tap into those motivations as a catalyst for creating influence and change. As one participant suggested, the focus needs to move away from the expertise and *'story'* of the PPP, to put stakeholder needs first and adapt knowledge outputs to those stakeholder needs. This was thought to be a method for increasing the chance of these stakeholders utilising knowledge. Participant A13 summarised the move away from only engaging with existing stakeholders during the workshop: *"[The PPP] likes talking to people we know, but who don't have any power to do anything about it"* further espousing the need to align with *"differing government priorities".* Participants at the workshops were able to identify specific, and often new, contacts that they wished to connect with in order to achieve greater influence on a range of political stakeholders.

This analysis indicates that the workshop participants comprehend the value of making new connections that they may not have previously considered. This was in line with a realisation that the innovation system is complex and needs methods to try and increase knowledge utilisation that reflect the complex and connected nature of the system. Importantly the analysis demonstrates the importance of understanding, and responding to system context when planning knowledge activities.

The analysis shows a clear difference between the original interviews and training workshop in how creating action from knowledge was viewed. Initially, the focus of the interviews was about disseminating knowledge primarily in the form of reports. This contributed to putting the PPP in the role of expert 'informer', with the PPP's expertise being at the centre. However, the workshops encouraged participants to consider the contacts they would have to make and the motivations of these potential contacts, whilst considering the complex nature of the innovation system and the interactions which occur within the system. This shifted the focus away from more explicit forms of knowledge (or information) to looking at more relational aspects of knowledge to encourage utilisation.

Table 4-4 recognises areas where perceptions within the organisation are potentially evolving over time, and by reinforcing the messages, as revealed by the analysis. This table does not assume that there has been a complete absence of the highlighted 'future directions' prior to the workshop or that the past perceptions are not useful. However, it does acknowledge that the 'delivering impact' workshop and associated impact activities are instrumental in shifting staff perceptions.

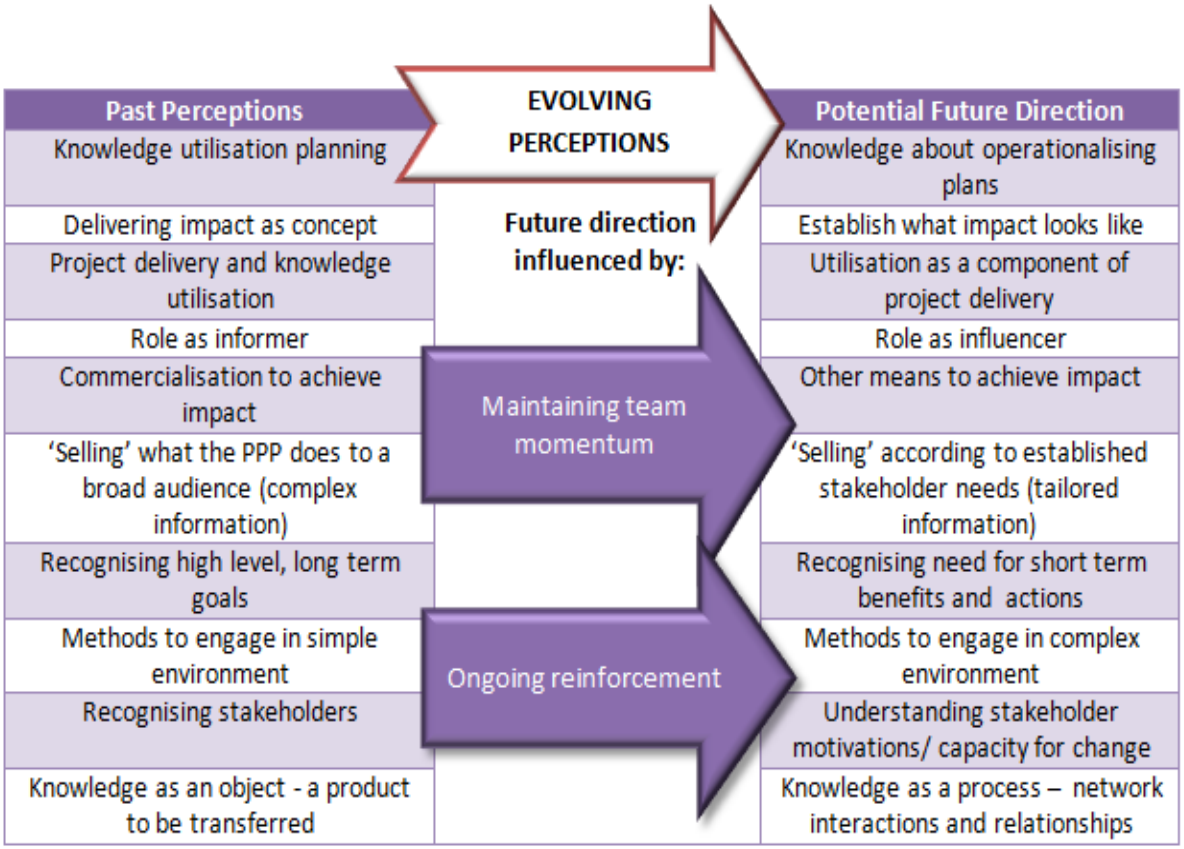


TABLE 4-4: POTENTIALLY EVOLVING PERCEPTIONS OF KNOWLEDGE UTILISATION WITHIN THE PPP REVEALED BY THE ANALYSIS

The perceptual change process is supported by the development of necessary skills and adoption of facilitative processes. It also acknowledges that whilst these perceptual changes are recorded at a point in time (i.e. the workshop), factors, such as team momentum, organisational reinforcement and the systems environment, effect the embedding of perceptual change.

The analysis of the training workshops exposed a potentially evolving mind-set pertaining to knowledge utilisation. This saw perceptions shifts from: planning for knowledge utilisation to operationalising those plans; commercialisation as a main form of knowledge utilisation to broader forms; recognising stakeholders to understanding their motivations and networks; and producing explicit forms of knowledge to be utilised (object based) to relational aspects of knowledge utilisation (process based).

4.8. CROSS-LEVEL ANALYSIS

So far, this chapter has presented themes and factors that have occurred at the different systems levels. This section aims to provide a cross-level analysis in order to better understand the perceptions, activities and environmental factors that ultimately influence knowledge utilisation. Firstly, it synthesises the factors or activities that have been identified in the analysis, as influences of knowledge utilisation. In line with the inductive study methodology, it then groups these by higher level factors. Secondly, it summarises these higher-level factors in the form of an influence diagram, to reveal how influence flows across and between system levels within this case study.

Table 4-5 summarises the major factor groups that can be seen to influence knowledge utilisation across the levels. The macro-level factors define two separate factor groups: stakeholder analysis and system embeddedness. The segregation between these two facets recognises the different influences that analytical activities and relational activities have on knowledge utilisation. The factor groups at the meso-level are: project management (representing the activities undertaken within the PPP at project level); organisational characteristics; organisation capabilities; resource management; organisational learning; knowledge stocks; and skill sets. The micro-level factors contain two predominant group factors: individual mind-sets and individual characteristics.

FACTOR GROUP	FACTOR	INFLUENCE ON KNOWLEDGE UTILISATION
MACRO-LEVEL		
Stakeholder analysis	Stakeholders identified	Establishes stakeholders needed to meet innovation objectives (wider group); new stakeholders needed for wider impact
	Priority stakeholders	Any prioritised groups may result in greater effort at knowledge utilisation to this group; particularly relevant if financial contributions are made by group
	Stakeholder engagement strategies	'Like-for-like' engagement enables knowledge entrapment within groups; balance engaging wider group with individual needs; identify who to inform (passive), who to influence (action)
System embeddedness	Understanding stakeholder views and motivations	Facilitates understanding of what will be value-adding to stakeholders within their context; determines expectations of knowledge use; aids in developing relevant content and media; stakeholder knowledge needs to be embedded within PPP
	Understanding system context	Understanding the environmental factors of the system, facilitates the identification of potential knowledge barriers and facilitates activity planning
	Stakeholder understanding outputs	Optimises knowledge utilisation opportunities through understanding the value it adds within their own context; promotes value to wider stakeholder group

	Early, iterative and continuous engagements with stakeholders	Relational activities needed to: overcome knowledge boundaries; assist in understanding stakeholder views
	Goal alignment with knowledge users	Identifies organisational knowledge that could be of value to stakeholders within their context; goal alignment maximises knowledge utilisation
MESO-LEVEL		
Project management	Project planning	Determines project success criteria/timeframes and measurements for achieving them (beyond commercialisation); determines stakeholders to be engaged at start; determines type of knowledge utilisation sought (i.e. action or citations); differentiate between knowledge and technology transfer
	Project implementation and control	Monitors, controls and measures both deliverables and impact criteria; makes necessary changes to ensure they are being achieved; concerns creation of short term actions to meet long term goals of PPP
Organisational characteristics	Organisational objectives and mission	Influences the knowledge activities that occur within the organisation; long term organisational vision must be translated to short term goals to achieve short term action; technology focused goals focus on technological deliverables; knowledge utilisation led by support from executive
	Organisational timeframes	Mechanisms need to be developed to ensure knowledge utilisation is continued beyond life of PPP
	Organisational maturity	Increases the knowledge stocks of the organisation and value of knowledge
Organisational capabilities	Technology focus activities	Dominance of engineering mind-set leads to provision of technical evidence and commercial outputs; science driven knowledge utilisation
	Credibility	Establishes rigour and expertise
	Multiple technology view	Lessens barriers between factionalised groups; can be difficult for some stakeholders to see value in this view
Resource management	Time	Extended time needed to undertake relational activities that encourage knowledge utilisation
	Resources	Skills sets needed to undertake relational activities to encourage knowledge utilisation
	Workload	Recognises importance of knowledge utilisation activities as well as project delivery
Organisational learning	Feedback loops	Facilitates the monitoring and measuring of knowledge utilisation; determines any changes that need to be made within the organisation to increase knowledge utilisation; measures the effectiveness of stakeholder engagement strategy
	Organisational training	Determines what knowledge utilisation is in terms of organisational goals and activities; identifies needed skill sets

Knowledge stocks	Technical knowledge	Demonstrates expertise and provides rigour; can be seen as valuable knowledge or not (stakeholder dependent)
	Stakeholder knowledge	Identifies direct and indirect stakeholders and their motivations to use knowledge; adds value to knowledge outputs (aligned with stakeholders)
Skill sets	Communication skills	Produces compelling outputs in line with stakeholder motivations; provides stakeholders with effective content and media; facilitate knowledge accessibility
	Relational skills	Builds relationships and embeds knowledge within innovation system stakeholders according to their needs
MICRO-LEVEL		
Individual mind-sets	Informer logic	Focus on disseminating key messages; emphasis on explicit knowledge (reports etc.); emphasises demonstrating expertise; knowledge-as-an-object
	Influencer logic	Focus on stakeholders implementing knowledge within context; relational based (understand stakeholders needs); knowledge-as-a-process
Individual characteristics	Individual skills	Individual skills contribute to organisational skill set; technical focussed
	Individual preferences	Preference for talking to like-minded people creates narrow knowledge conduits and limits impact; positive preference for engaging with broader stakeholders to achieve wider impact

TABLE 4-5: MULTI-LEVEL FACTORS IDENTIFIED AND INFLUENCE ON KNOWLEDGE UTILISATION

Figure 4-9 displays these factors as components of the system under investigation as revealed by the analysis.

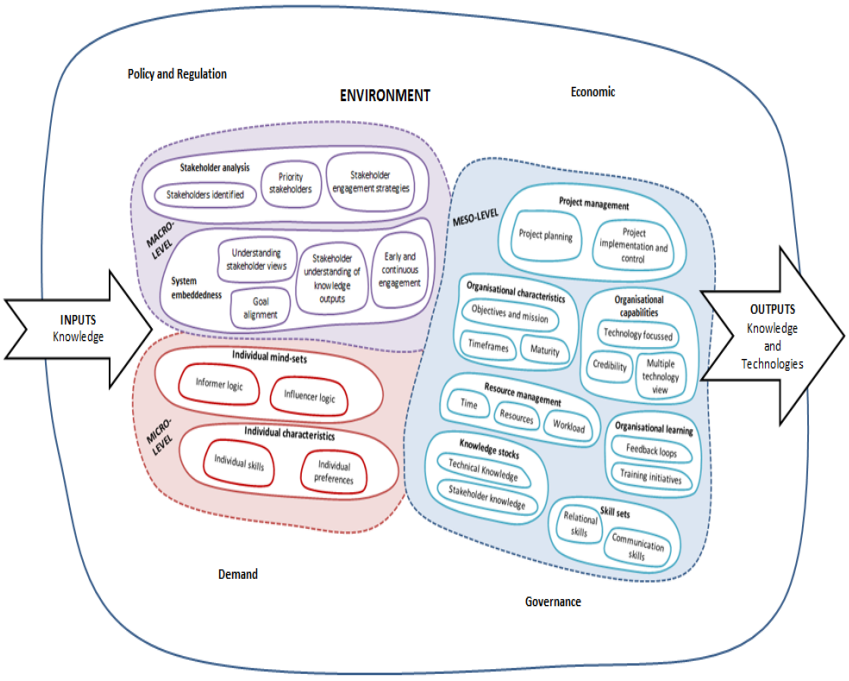


FIGURE 4-9: MULTI-LEVEL FACTORS OF THE INNOVATION SYSTEM

Following on from the groupings that emerged from the data, an influence diagram was drawn to show the *main* influences of knowledge utilisation that were suggested from the analysis over the three levels of analysis and the environmental factors identified (Figure 4-10). In line with the interpretivist nature of this study, these influences, and the strength of each influence, are a representation of how the researcher has interpreted the data. They have not been quantitatively derived.

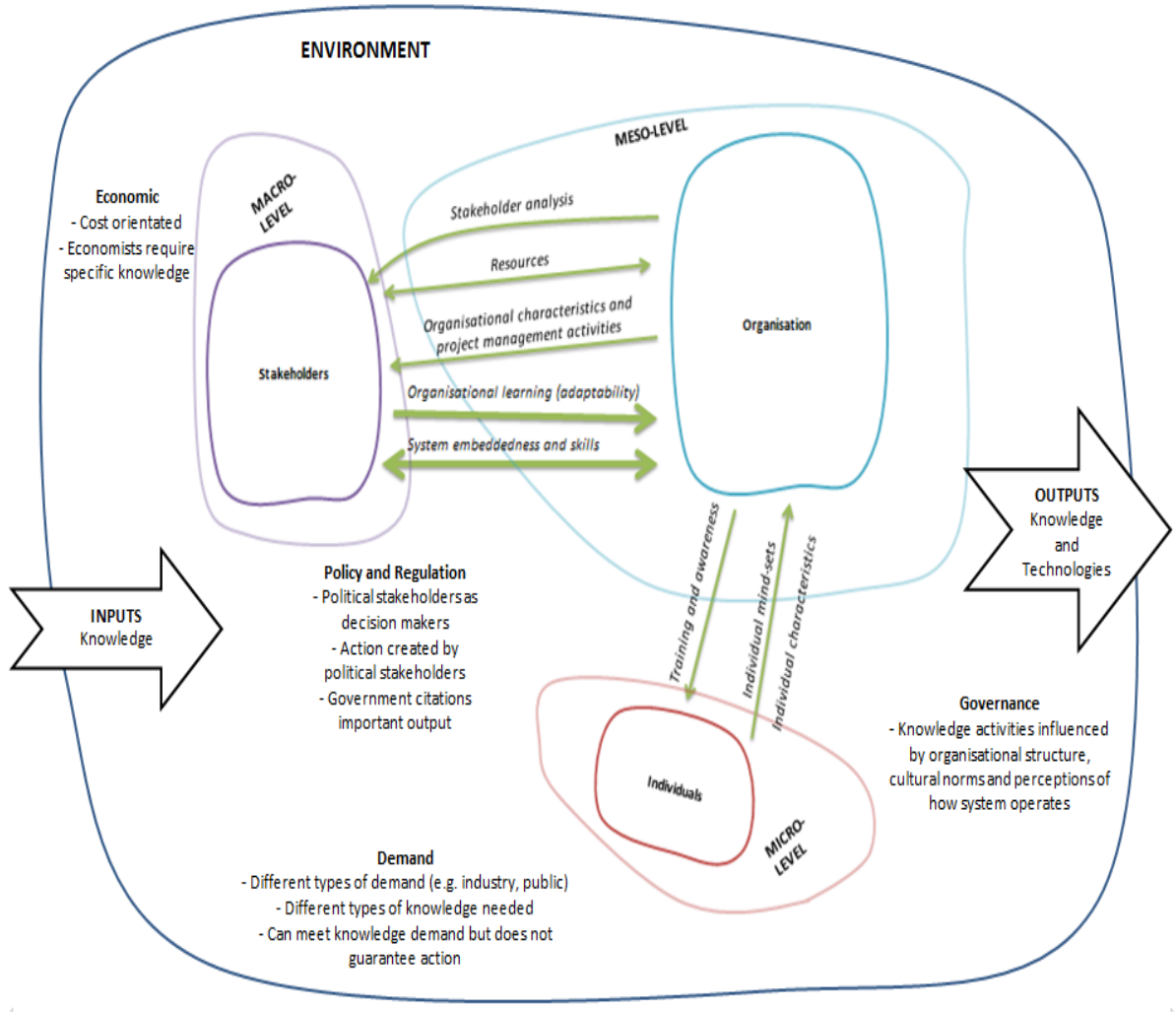


FIGURE 4-10: INFLUENCE DIAGRAM DEPICTING MAIN INFLUENCES BETWEEN SYSTEMS LEVELS

The diagram suggests that a key component of enabling knowledge utilisation was the degree of system embeddedness that the PPP has within the innovation system. This consists of a set of relational activities and skills that aid the PPP in not just identifying stakeholders (stakeholder analysis) but also understanding and responding to their knowledge needs and their individual contexts. Thus, each interaction with stakeholders within the system has a unique context that must be recognised, and knowledge activities adapted to that context. This includes understanding the characteristics of the system (as defined in section 2.2.4) and recognising the system complexity.

The degree of system embeddedness was seen to be strengthened, if the organisation had effective channels for internalising knowledge from the macro environment back into the organisation (organisational learning). This was represented by perceptions of the organisational ability to change and adapt according to what was learnt from stakeholders. The project management capabilities of the PPP, when encompassing the ability to plan, monitor and respond to both deliverables (technology based) and impact (knowledge based), was revealed to be a significant influencer of the degree of systems embeddedness.

4.9. CHAPTER SUMMARY

This chapter presented the analysis and in-depth descriptions for the first case study – the public private partnerships. The chapter initially provided an overview to the case study organisation under investigation, the interview participants and the context to the case study. The PPP is funded by both government and industry members, whilst also acting as funder to various technology development and deployment projects. It is widely established within the PPP that knowledge is a product of the organisation, more so than tangible products and that knowledge needs to be utilised by stakeholders in order that the PPP meets its organisational innovation objectives.

The chapter presented the analysis of the themes and factors that emerged from the inductive analysis. These themes were presented using a three-tier structure, which analysed three levels of the innovation system, namely the system wide factors (macro-level), the organisational factors (meso-level) and the individual factors (micro-level). Lastly it provided a cross-level analysis to synthesise the factors that emerged in the data and illustrate the influences that occur across the systems levels. The within-case analysis for the second case study – the University - will be presented in its own context in the next chapter.

CHAPTER 5: WITHIN-CASE ANALYSIS - UNIVERSITY

5.1. INTRODUCTION

The previous chapter introduced the within-case analysis processes and presented the within-case analysis for the Public Private Partnership case study. This chapter analyses the within-case factors from the second case study, the University. Similar to the preceding chapter the background of the organisation is firstly introduced to present the system under investigation (whilst maintaining organisational confidentiality). The themes that emerged through the analysis are then presented using a three-tier structure (macro-, meso- and micro-level analysis), to provide a holistic view of the influences of knowledge utilisation that occur across the innovation system.

5.2. ORGANISATIONAL BACKGROUND

The University is a UK public research University with a strong history of applied research particularly in engineering and technology. With this foundation, the University has developed expertise and research capabilities within the field of energy research and low carbon innovation. Similar to other academic institutions, the University operates different academic departments across discipline-based schools, supported by various professional support functions. Additionally, the University houses over 40 research institutes dedicated to specific research areas, as well as specialist research centres and groups that focus on specific research interests. The University has identified a number of research priorities; these are significant focus areas of research that have been deemed to require interdisciplinary input in order to successful solve these real world complex problems. A number of engineering subjects are ranked within the Top 10 nationally across several ranking bodies including the recent Research Excellence Framework (REF) in 2014. The University strategy acknowledges the changing landscape for both teaching and research within universities and articulates the growing importance of the role of universities as providers of economic benefits. The University places great emphasis on regional collaborations, particularly within the field of energy, where the research covers both the supply and demand side of energy innovation.

5.2.1. CASE STUDY PARTICIPANTS

The case study participants were representative of a number of disciplines, schools and departments and from both academic and professional roles, but were all involved in low carbon energy research. Different hierarchical levels of both professional and academic roles were also represented and a

total of 14 interviews were undertaken (with 14 participants). Table 5-1 shows the disciplines and hierarchical levels represented by the participants.

Discipline/function (Abbreviation)	Role	Number of Participants
Enterprise function (ENT)	Senior Professional (non-academic)	1
Enterprise function (ENT)	Professional (non-academic)	2
Enterprise function (ENT)	Senior academic	1
Engineering (ENG)	Associate Dean	1
	Professor	3
	Senior lecturer	1
Social Sciences (SS)	Professor	1
	Senior lecturer	2
Science (S)	Professor	1
Other Professional (OP)	Energy research coordination	1
		Total Participants: 14

TABLE 5-1: DISCIPLINE AND HIERARCHICAL COMPOSITION OF THE PARTICIPANTS

Similar to the previous chapter, each function is represented by an abbreviation as shown above in brackets, which appears in participant codes. For example, in participant code B10SS, 'B' stands for the University, '10' is a randomly assigned number and 'SS' refers to the Social Science function.

5.2.2. Other Sources Of Evidence

In addition to the 14 interviews undertaken, a number of other sources of evidence were utilised in line with the presented methodology of the study. This included analysing publicly available documents such as, reports, news articles and observations at industry engagement events regarding low carbon energy matters. Furthermore, there was an opportunity to participate at a one-day training workshop within the University, where detailed observations and notes were taken.

5.2.3. Timing Of Case Study

The interviews for this case study took place over a 6-month period from May to November 2016. During this time a number of low carbon energy related events on the campus were also attended, most of which included attendance by external parties to the University. Participation in a day workshop related to creating impact was also attended in March 2016. Throughout the data collection period, documentary analysis took place using papers, reports and news releases that were concerned with low carbon energy. Figure 5-1 shows the timeframes involved in the data collection for this case study.

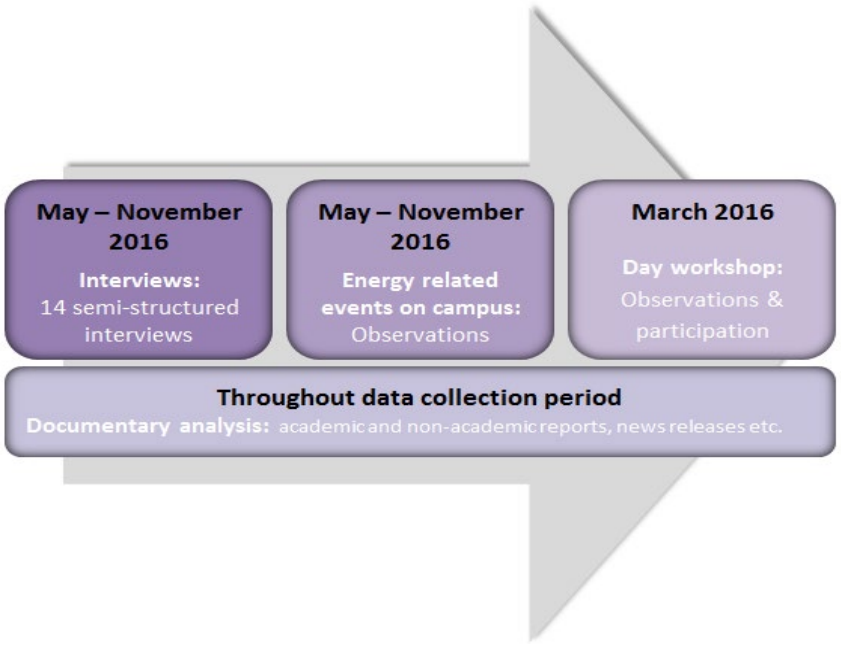


FIGURE 5-1: TIMELINE OF DATA COLLECTION FOR THE PPP CASE STUDY

5.3. MACRO-LEVEL ANALYSIS

This section analyses the macro-level elements; that is the contextual factors that appear at the cross-system level and their influence on knowledge utilisation. The section firstly analyses the perceived stakeholders within the innovation system and how they affect knowledge utilisation. Secondly, it evaluates each stakeholder's needs and reveals how the study participants respond to these needs. Lastly, it reviews the funding mechanisms that operate within the system and suggests how this affects knowledge utilisation.

5.3.1. STAKEHOLDERS

The analysis revealed a number of different stakeholders who engage with the knowledge outputs. These include industry, government, Research Councils, professional bodies, consumer groups, academics and students. Figure 5-2 represents the stakeholders mentioned by participants; the larger the word, the more times that stakeholder was mentioned. The analysis suggests that a wide-range of stakeholder groups influence knowledge activities and utilisation in different ways. The stakeholders can be categorised as direct or indirect stakeholders. Direct stakeholders include those that actively engage on the project with a specific purpose or motivation (i.e. as funders or collaborators). Indirect stakeholders include those that can potentially be affected by knowledge outcomes, but may not directly be involved in individual project processes (i.e. politicians, and industry bodies).

FIGURE 5-2: THE STAKEHOLDERS DISCUSSED BY PARTICIPANTS

In terms of low carbon energy research, the list of stakeholders is extensive, due to the complexity of the challenge of transitioning to a low carbon economy, as Participant B3ENT asserts:

> *"[The stakeholders] are very, very broad! Ultimately you're looking at society as a whole and 'quality of life' type measures that having a successful energy policy contributes to. Because of the fundamental inter-linkage of energy and quality of life, then it's very, very pervasive. The system is very large and very complex".*

However, participant B4OP expressed concern that this vast group of potential knowledge users can not engage with the knowledge that University research generates, in part due to a focus on technology development:

> *"I think what needs to happen in the low carbon and energy innovation space is for people to understand behavioural change. Unless [stakeholders] know what technologies are available, know what research people are doing, I think you end up with a piece of technology and you go, 'so what'? I just don't think this has been answered yet. There's so much information out there with the research, but the impact factor is limited because [the public] don't know how to communicate or publicly engage*

with science…. the technology and the research would benefit from including [the public] on that journey from the beginning".

This suggests that although valuable knowledge is being created, the utilisation of it is limited by the inability of stakeholders to perceive value within their own contexts. Participant B4OP summarises the problem of stakeholders using academic knowledge as one of 'knowledge accessibility':

"Make [knowledge] accessible. At the moment it's just unintelligible unless you're technical…the knowledge that we produce is almost protected…when it comes to commercialising the technology we hope that someone just buys it and that's it. There's a problem there…to improve the impact factor we also need to think about joining people up".

These reflections propose distinctive barriers to knowledge utilisation between universities and external stakeholders including: limited accessibility to created knowledge; inability to understand knowledge (particularly technical knowledge); limited understanding of what motivates groups to use knowledge; and limited understanding of how knowledge will be used.

Participant B4OP suggested that knowledge activities should be customised depending on the needs, motivations and influence of different sets of stakeholders. Categorising stakeholders from level 1 to level 3, the participant suggested important stakeholders would be engaged to facilitate knowledge utilisation, whilst some would only be 'transferred' information:

"I think the stakeholders, level one being the most important, would be those people we're trying to practically engage and trying to shape what we were doing to suit them. At level two we'd be thinking about giving people information about what we were doing. We're still trying to engage these people on a regular basis. Then [at level 3] it would be things like evidence gathering enquiries for Parliament Select Committees".

The list of stakeholders is substantial. Knowledge utilisation needs differ within each group and necessitates different knowledge utilisation strategies for each group of stakeholder, particularly given the ability to realise the value of technical knowledge beyond purely technological innovation and incorporate a more user centric infrastructure to knowledge utilisation. The next section

reviews how different stakeholders influence knowledge utilisation by providing various incentives for knowledge producers.

5.3.2. Responding To Stakeholder Needs And Pressures

The previous section presented the various stakeholders as perceived by the participants of the study. Each stakeholder group was seen to have different knowledge needs, which influence knowledge utilisation. These needs can drive both academic knowledge utilisation (i.e. the utilisation of research through peer review and publication within the academic community) and enterprise knowledge utilisation (i.e. the utilisation of knowledge by stakeholders *beyond* academia). The academic community, as a stakeholder group, was seen to influence how knowledge is utilised via the cultural norms and processes present in academic career development. Knowledge utilisation in this capacity, involved the production of knowledge that was deemed to meet certain disciplinary quality criteria, established through the peer review process and measured through academic citations. It was seen as a fundamental component to those who pursue an academic career as Participant B6SS suggests: "*The academic [outputs] still remain the most important I think, when it comes down to how we are evaluated".* This suggests that the participants prioritised the needs of the academic community of stakeholders, due to the impact they have on career development.

Other stakeholders within the innovation system were seen to influence more enterprise-based forms of knowledge utilisation that aim to create impact beyond academia. Industry stakeholders were seen to need knowledge *and* action that solves specific problems, usually over shorter timeframes, with financial or commercial objectives underpinning these problems. This suggests that knowledge is more likely be utilised, if value adding knowledge outputs, specific to organisational objectives, are provided. This ability to understand individual stakeholder needs and provide 'useful' (beneficial) and relevant (appropriate) knowledge was seen as a key influencer of knowledge utilisation by participant B6SS:

> *"When the research is aligned with the needs of the stakeholders, there is a benefit on both sides. It's about developing knowledge, developing methods, developing ways of addressing problems that industry needs to address in their everyday life. What is required for it to be successful is the ability to dilute the outcome of hard research into something that can be of practical relevance and use".*

Additionally, participant B7ENT advised that early involvement of the end stakeholders was deemed essential in understanding how stakeholders would use knowledge and providing them with valuable knowledge outputs to achieve this form of enterprise-based utilisation:

> *"More and more it's about engagement with stakeholders. You can't say 'right I'm going to do this bit of research and it's going to prove this to a stakeholder, and then I'm going to give it to them to use'…they won't! You may not be solving the problem that they actually had in the first place. So it's about making sure that researchers are aware that whoever their end user group is, they are involved in shaping the research programme at the earliest stage, they're involved in the middle to review it and see…is it still on track for what they were looking at, or do they need to involve someone else"?*

Public funders were seen to be an important stakeholder group who increasingly influence more enterprise-based forms of knowledge utilisation. Chapter 2 discussed the changing role of academia and the increased focus on return on investment (ROI) by public funders, as measured by the amount of positive change or impact created for society from publicly funded research. Subsequently the distribution of public funds is increasingly based on metrics pertaining to this ROI. Participant B1ENT explains how the needs of this stakeholder group have to be met:

> *"If [researchers] apply to any of the Research Councils, part of the application is something called 'pathways to impact' where you have to talk about how your research is going to have an impact. So [researchers] are measured on that from the outset. And it's taking a long time for people to do that properly. But things are now changing. So that's one of the things [Research Councils] look at: what impact has it had or what impact will it have or could it have? And then at the end, well did you manage to do that? So I think it all comes from that government agenda: there's a feeling that if they're funding research you need to show that it's benefitting the UK in some way".*

This focus on 'impact' from the start of a research project and monitoring how knowledge is utilised beyond academia, is therefore seen increasingly to be a necessity for public funders. The effect of funding mechanisms on knowledge utilisation will be discussed further in the following section.
Demonstrating impact was also seen as a cyclic event, in line with the timeframes set for the Research Excellence Framework (REF) system of research assessment. This was seen to affect how

much attention was directed to the creation of and demonstration of impact at any one time, as Participant B6SS states:

> *"[Impact] goes with the REF cycle in a way; at the early stages, as soon as the REF has finished there is a bit more flexibility in what you do. As you come closer to the end there is a bit more pressure, actually delivering concrete examples of impact".*

Government stakeholders were seen to need objective, unbiased evidence on which they could base policy decisions. Participant B5SS gives an example of this:

> *"We did an evidence-based review on a particular topic for [a government department] who wanted to know if there is actually any evidence for what they were looking at, or is it just anecdotes? We can be impartial. So we'd say, 'well this isn't very relevant' and 'this gets talked about a lot but actually it doesn't help us in this particular respect, but here's a really good paper'. And then when [the government department] are policy making they can decide whether they have evidence and therefore they can create a new policy".*

Table 5-2 shows the different types of stakeholder, their needs, success measures and the type of knowledge utilisation realised by each stakeholder, as revealed by the analysis.

Stakeholder	Need	Measure of success	Impact on KU
Academia	Production of new knowledge	Academic rigour, novelty, publishability, reputation	Discipline-specific, academic KU
Industry	Problem specific, financially driven	Cost reduction, efficiency, new technology and practices	Stakeholder-driven, enterprise KU
Government	Evidence	Changes to policy based on impartial evidence	Evidence-driven, enterprise KU
Public Funders	Benefits achieved from public funds	Measurable positive changes in society	Change-driven, enterprise KU

TABLE 5-2: STAKEHOLDER NEEDS AND THEIR INFLUENCE ON KNOWLEDGE UTILISATION

The above measures vary in the complexity and timeframes in which they can be achieved. For example, problem solving activities which have defined goals, tangible or quantitative outputs and

limited influence from external influences may be simpler to achieve (Crawford and Pollack, 2004). However, it may be more difficult to navigate projects that have ambiguous, intangible or qualitative goals and that are subject to multiple stakeholder motivations and relationship building activities. As participant B10SS emphasises:

> *"I think trying to manage a project that's spans both social sciences and engineering and is working in different cultures and is working across academia and other sectors, needs far more time…influencing and interacting with the range of partners that we interact with is massively time intensive".*

Participant B3ENT proposes that considering how to influence people is essential when planning change through knowledge utilisation:

> *"[External engagement] is very much about a two-way dialogue across all disciplines; and universities really seeing that part of their mission is to get the word out there…[Researchers] have to think about what they want: what difference do they want to happen in the world because of their work? Who is it that has to change their behaviours to make that outcome happen? And do they know those people? How are they going to get to know those people? How do they influence those people with what routes to influence"?*

While planning how to influence stakeholders is necessary for knowledge utilisation, there is not always a linear and measurable path between knowledge creation, transfer and utilisation. This is due to the complex and often unseen environmental influences within the larger system (Rich, 1997). This is particularly pervasive in policy environs where external uncontrollable factors and individual motivations can lead to irrational decision-making (Hallsworth et al., 2011). Adaptability to changing environments, therefore, becomes an important facet of knowledge utilisation.

The above section shows that the various stakeholders have different requirements and emit various pressures, influencing how knowledge is utilised (i.e. academic or enterprise knowledge utilisation). It was also revealed that knowledge creation by itself does not automatically lead to knowledge utilisation. Instead, a planned approach was suggested, to achieve change through actively influencing knowledge utilisation, while the systems perspective suggests unforeseen influences can often affect how knowledge is utilised beyond researcher intentions.

5.3.3. Public Funding Mechanisms

Public funding mechanisms were seen to be a major macro-level influence on knowledge utilisation. This was due to researchers needing to access suitable funding streams both to continue their own research agendas and to meet academic career development measures based on income generated. Participants suggested a number of sources of potential funds, with the most common being discipline-specific Research Councils. As discussed in the preceding section, the requirement to demonstrate quantifiable and positive change to the UK, as a measure of research excellence, is increasingly weighted in application processes.

A potential problem with this system is the focus on creating the aforementioned 'pathway to impact' documents in order to access funding, rather than incorporating specifically defined, but ongoing, impact generating activities as part of the project success criteria. Participant B3ENT suggests: "*at the moment (pathways to impact) is seen as something largely that you need to construct to get the grant, rather than a key part of the project".* This indicates a need to monitor impact throughout the lifecycle of the project and possibly beyond any defined end dates to maximise the opportunities for knowledge utilisation. This is particularly important given the nature of impact, particular societal and economic impact in innovation systems, which can occur over extended timeframes.

Research Councils also provide the University with funding specifically targeted to creating impact (as opposed to the funding provided to individual projects). These 'Impact Acceleration Accounts', award block funds to University, who then distribute it to projects where the potential for impact has emerged over the life of the project. Similarly, HEFCE provide block awards in the form of its Higher Education Innovation Fund (HEIF), which aim to: 'support of knowledge exchange activities with all forms of external partners – businesses, public and third sectors, community bodies and the wider public – to achieve the maximum economic and social impact for this country' (HEFCE, 2011:6). These funding mechanisms provide additional incentive to encourage knowledge utilisation through the provision of dedicated funds for this purpose, rather than purely knowledge creation.

This analysis suggests that specific skills are needed by researchers in terms of the application, planning and execution of projects to align with the impact requirements throughout a research project life cycle. This places emphasis on the type of skills needed beyond pure research abilities in order to effectively influence enterprise knowledge utilisation as part of project objectives.

5.4. MESO-LEVEL ANALYSIS

This section analyses the meso-level elements. This analysis represents the factors that appear to occur at an organisational level and their influence on knowledge utilisation. The section firstly analyses the perceived role of the University, before reviewing the role of schools within the University. It then evaluates the influences of promotion and rewards, before analysing the role of research groups. These different factors were seen to influence both academic and enterprise forms of knowledge utilisation.

5.4.1. PERCEPTIONS OF THE UNIVERSITY FUNCTIONS

The analysis indicates that the University provides support to individual researchers and small research groups, each of whom has various goals according to their relevant disciplines. This bottom up culture is different from the private sector setting in the first case study, in which overall organisational objectives are pursued through a clear functional hierarchy. Participant B9ENG illustrates this point: "*The University consists of all these small groups, which make it a big University…we are not strictly an industry, so there is no clear structure".*

The analysis revealed that the University provides specific support functions for enterprise work that influence enterprise knowledge utilisation, with support provided by a team of people who have specific knowledge and experience of funding body criteria. This is also supplemented with optional training for researchers on how to create impact from research, which may maximise the opportunities for achieving impact beyond academia.

The bottom-up culture of the University, the strong effect of academic autonomy and the fact that the support functions offered are not mandatory, mean that, individual academics only engage with these functions if they think it is necessary for their work priorities. Overall, the participants returned to academic autonomy as the overarching influence on whether support for enterprise work is sought as shown by participant B5SS:

> *"There's not really a lot of support…the Enterprise Office, Research Office… really at the end of the day, you've got to decide what your path is, how much you want to do. You can take on more, you can take on less".*

This can greatly influence the character of knowledge utilisation: there has to be a perceived need from individual academics to utilise these enterprise support functions and indeed, to consider if, and how, they will make their work impactful beyond the University.

The University has made energy related research a strategic priority (along with other key areas), subsequently introducing mechanisms that influence knowledge activities within that research area. It was identified that support functions for energy research act as a coordination mechanism between different disciplines. This interdisciplinary approach was seen as crucial in both pursuing funding for projects and for producing valuable outputs and outcomes from the research, which ultimately address the complexity of energy related problems. The support mechanisms enabled the identification of relevant expertise and encouraged collaboration between pools of diverse expertise, which otherwise operate as autonomous subunits across the University. Participant B1ENT comments that the support mechanisms enable "*working beyond the boundaries of the traditional disciplines".* This suggests that prioritising energy research acts as a method to overcome natural silos and knowledge boundaries that operate within University structures. Participant B3ENT illustrates this:

> *"[The energy research support mechanisms] take things from a discipline specific, 'where is this discipline going?' type view of research, to add in that dimension of 'what are the Global challenges within this space'? How can all of the different disciplines work together, support each other, make the sum greater than the parts? We have to collaborate, not only within the University but also external to the University".*

This collaborative approach is vital to holistically tackle large scale problems, such as energy issues. Crucially, it combines both demand (technology) and supply (behavioural) side factors into research outputs. Participant B1ENT proposes that this approach can enable knowledge utilisation:

> *"[Behavioural approaches] bring that wider context and wider understanding to build on the energy research. The energy challenge is very broad. There is a lot around the technology but increasingly there are more of the qualitative, the softer side of things; the people issues. I think it is very clear from research that we can design fantastically from a technological point of view and make the most efficient equipment. But the problem is people don't use it or don't use it in the way you expect them to use it. So*

actually building that understanding enables us to show a more comprehensive approach".

This complex environment in which different disciplines collaborate presents a high degree of knowledge novelty, knowledge difference and knowledge dependency, which Carlile (2002) suggests requires complicated boundary management techniques in order to successfully innovate.

The support mechanisms for energy research were seen as 'developing a community' of energy researchers. Participant B7ENT proposes "*the aims [of prioritising energy research] are to maintain and grow the portfolio through building a community together and also putting energy research on a higher platform".* However, academic autonomy and the nature of disciplinary divides and norms may not facilitate a sustained interaction or develop a shared repertoire of tools for sustained community engagement (Wenger, 2011). Participant B4OP identified some challenges associated with creating these networks or communities of researchers:

"Trying to bring energy researchers together was sometimes fairly challenging. Often we find that people didn't really know where possible collaborations could be made. So people actually in the same building may be unaware of what each other are doing. So, it's about creating those networks between academics to see if that would enhance collaborative research going forward".

This suggests that interdisciplinary work may not arise naturally within the University culture, unless the University introduces mechanisms to overcome natural disciplinary boundaries.

The energy research support mechanisms were seen to *raise the profile* for the University's energy research portfolio, to audiences both within academia and beyond, and thus developing the reputation of the University as a catalyst for energy research. However, some participants suggested that the University as an entity needed to better 'market' the projects and project outcomes to stakeholders beyond the University and encourage knowledge utilisation. Participant B5SS stated:

"I think there are lots of areas of expertise that the [energy research support mechanisms] are trying to identify and promote in a better way, because I think at the

moment, [these areas] are a bit isolated and I think as a University we could better publicise all of them".

This indicates that whilst mechanisms are in place to encourage interdisciplinary knowledge creation, University processes that encourage enterprise knowledge utilisation (through increasing the accessibility of the knowledge beyond the University) are perceived as weak. Participant B3ENT, raised confidentiality as a major barrier to this type of knowledge utilisation:

"It is quite frustrating in that there are big deals that we do that sometimes you can't talk about because there is a commercial sensitivity. Now I'm very proud of some of those, can't talk about them and consequently the University can't talk about them".

This reveals a difficulty in the potential breadth of knowledge utilisation. Whilst a project may have outcomes that are beneficial for more than the main project stakeholders, confidentiality may restrict the flows of knowledge to potential knowledge users, and consequentially, limit knowledge utilisation.

Another perceived challenge was the difficulty in measuring knowledge that is utilised outside of academia. Using the example of industrial researchers, participant B3ENT suggested that there is no standard "*feedback loop*" to ascertain impact beyond academia. Within academia, it was suggested that citation records act as a feedback loop to measure academic impact. This highlights the significance of establishing feedback mechanisms between researchers and stakeholders. The ability to measure impact, therefore, becomes an important part of the knowledge utilisation process.

Although it has been identified that the University provides support to encourage enterprise knowledge utilisation, a perceived barrier was a lack of understanding of what constitutes impact and how this relates to both academic knowledge utilisation and enterprise knowledge utilisation. Participant B7ENT suggested that one way they are distinguished is by who the funder is: public funding (research) or private stakeholder (enterprise), but acknowledges this that distinction is confusing:

"I struggle with the difference when they say, 'oh that's enterprise and that's research'. I'm bringing this company in to pay for research, so why is it research when [a Research

Council] funds it but its enterprise when a company funds it. I'm not sure on that! They're still paying for research".

Participant B2ENG tries to distinguish between the two by highlighting differences in how researchers are supported for both enterprise and research activities:

"The [Associate Dean – Research] is a bit more internal facing, the [Associate Dean – Enterprise] more external facing. [The AD-R] will be working with people on a one-to-one basis, mentoring in terms of paper quality; there will be paper review processes, proposal review processes and things like this to support people. Whereas [the AD-E] will be looking at enterprise clinics… ensure that [staff] are present at key external events and will invite people to come and see us and have tours of the school, so we bring companies in to see what we do and to meet".

This indicates that research support appears to be academic-driven and focuses on the transfer of academic knowledge (i.e. peer-reviewed academic publications). The enterprise support emphasises relational activities that traverse the boundaries of the University (e.g. event attendance and relationship building for future engagement).

The importance of academic knowledge utilisation, measured through citations, was deemed to be important at the organisational level, as Participant B1ENT comments:

"From a University perspective, [citations] are quite important. If we look at international league tables, one of the reasons that [a University] doesn't perform as well on the international league tables is [those tables] take on board citations. Some of it will be on disciplinary mix…engineering is less focussed on citations, I mean its increasing a bit, but more of the pure science, medicine, they're much more citation based".

This indicates that the pursuit of academic knowledge utilisation is, and will remain, important at the University level (as a key factor in the development of reputation), although the potential academic knowledge utilisation itself is generated through individual (or small groups) of academics.

The above section has highlighted a number of University factors that can influence knowledge utilisation. Whilst it was identified that support functions focus on the application processes needed to secure funding, potential barriers included: defining and planning for specific forms of knowledge utilisation; confidentiality issues; the ability to publicise knowledge outcomes effectively beyond academia (at the University level); and the mediating factor of academic autonomy, which influences how much individual academics pursue enterprise knowledge utilisation.

5.4.2. SCHOOL-LEVEL INFLUENCES

This section examines how school level processes affect knowledge utilisation. Each discipline was seen to be built on individual histories of norms and expectations, leading to current research agendas. Additionally, each has its own unique combination of external influences, normative schemas and cultural elements. This leads to specific disciplinary perceptions on knowledge creation and utilisation.

The analysis identifies perceived differences between the schools: engineers were seen as '*problem solvers'* (participant B5SS) who focus on quantitative '*measuring*' (participant B1ENT). Social scientists were viewed as '*theory builders'* (participant B5SS) who often focus on the larger qualitative context or end use of a technology, rather than the technology itself (participant B1ENT). The age of a discipline was also seen to affect how much focus was given to academic knowledge utilisation or enterprise knowledge utilisation, as participant B2ENG explains:

> *"In our sector, citations are a relatively new beast for us. Whereas in the traditional sciences, citations and journals are well established. The execution of those sciences is very long term, it's very well established. The execution of research in [our area] is younger than me…and that of course has an impact on our knowledge practices".*

These different disciplinary views and histories are, therefore, seen to have an impact on knowledge utilisation.

Participants from the Engineering schools indicated differing objectives that either focussed on *reducing costs* for specific technologies or *improving operational practices* for a stakeholder. Participant B11ENG suggested that, in their discipline, the major objective is to: "*reduce cost and you can reduce cost [through] increasing the efficiency of the devices…so everything we do is with that*

aim in mind". Participant B2ENG offered slightly different aims: "*We're doing some materials and product innovation, but typically I've done more management practices research".*

Both of these examples have clearly defined and tangible goals that were represented by the participants, as either cost saving as a percentage or efficiency increases. Both examples also had one principal industry stakeholder with which they were working to deliver these benefits on a project-by-project basis. The 'tangibility' of project outputs was a common theme amongst the engineering schools and affected how the knowledge was utilised by stakeholders; that is, stakeholders were seen to be keen to utilise the knowledge because the benefits were clear, aligned with their objectives and offered some form of financial or commercial return.

Within the social sciences, the objectives of projects occurred over larger (organisational or social level) scales. This often necessitated behavioural change amongst an expansive set of stakeholders. Examples of the objectives from participants within the social sciences include: influencing how global energy access is governed and implemented; exploring how end users interact with energy technologies; influencing energy policy; and contributing to industry practices that facilitates the transition to a low carbon economy. These objectives were often longer term, involved a substantial amount of stakeholders, and had more ambiguous and intangible outcomes. Furthermore, because of goal ambiguity, the steps to achieve goals were often more emergent as research progressed over the longer timeframes. Participant B7ENT commented on the challenges of projects with many stakeholders and the difficulty in measuring enterprise knowledge utilisation:

> *"It was really hard work to follow something back that involved lots of different people, people that have retired, or people I can't remember. So I think, that it's been recognised that you're not going to get a good REF score unless you've got a really strong evidence base and to get a strong evidence base you've got to keep logging [the impact made], you've got to keep following [the impact] through and see how people use the research".*

The above analysis has implications for knowledge utilisation and the ability to measure impact. Table 5-3 illustrates the characteristics of social sciences and engineering projects, which ultimately affect knowledge utilisation. Some research projects were characterised by tangible outputs, one (or a small number of) industry stakeholders who collaborated on projects and clearly defined financial/commercial benefits. However, others encompassed intangible (behavioural change)

outcomes, with a large number of diverse stakeholders, and convoluted benefits. Although these represent the extremes, there was clearly a continuum of project complexity, which encompassed clarity, certainty and stakeholder variability.

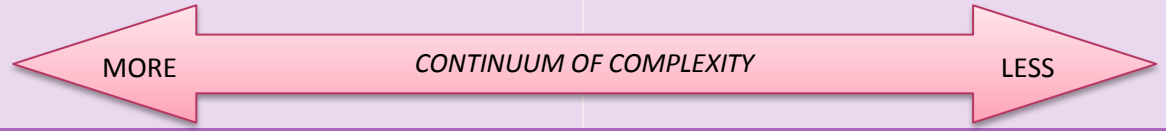
Characteristics of social sciences projects for knowledge utilisation	**Characteristics of science and engineering projects for knowledge utilisation**
Intangible objectives and outputs	Tangible, clearly defined objectives
Large number of stakeholders (different motivations)	Small number of stakeholders (with clearly defined and measurable motivations)
Behavioural change focused	Technology efficiency focused
Longer timeframes	Shorter timeframes
Qualitative focus (context)	Quantitative focus (measure)
Knowledge based on theory building	Knowledge based on problem solving
	

TABLE 5-3: CHARACTERISTICS OF DIFFERENT DISCIPLINARY PROJECTS OF KNOWLEDGE UTILISATION WORK

As project complexity increases, it can be argued that knowledge utilisation becomes harder to manage for two reasons. Firstly, the number of stakeholders that need to change some behaviour, the intensity of that change and the perceived benefit can affect how knowledge is utilised. Secondly, the challenge involved in monitoring and measuring knowledge utilisation to define the impact made becomes increasingly difficult, based on project complexity. Therefore, influencing knowledge utilisation in simple environments may necessitate different skills from complex (human) systems. This continuum of complexity reveals itself across disciplines within the University. Whereas, engineering-based research was seen to be technology-based and working with industry partners to achieve efficiency-based outcomes, the knowledge outputs of the social sciences often (although not always) involved diverse stakeholders with different motivations (including community groups) that would need to achieve some longer term behavioural change in order to meet project objectives.

5.4.3. Workload Allocation Model

Workload allocation models are used by universities to define the plethora of activities that academics undertake and allocate a prescribed amount of time to those activities. The aim of these workload models is to balance and maximise the teaching and research outputs of academics (Graham, 2015). Despite this, there has been limited work on the effectiveness of workload allocation models due to perceptions of workload models being a function of managerialism within

the University sector (Vardi, 2009). This suggests the workload models perform an administrational 'control' role. This may be contradictory to the principle of academic autonomy for individuals in deciding what they spend their time on, as it is the schools that determine the time allocation for each activity.

The analysis suggests that workload models are unable to accurately calculate and consider some activities pertaining to knowledge utilisation and relational work required to encourage knowledge utilisation. Participant B3ENT recognised that any enterprise work that is undertaken towards creating an impact, must get recognised within workload models to provide stimulus for pursuing this impact agenda:

> *"Of course if you do enterprise but you don't get any reduction in your teaching load or allocation for research, as a consequence...there has to be that sense of its given due weighting in calculating people's workload models. Some schools do that better than others."*

A major concern for participants centred on the inability to effectively quantify the social and relational nature of pursuing enterprise knowledge utilisation. This was seen as particularly relevant given the increasing focus on impact work and the amount of interdisciplinary projects being undertaken as a prerequisite to funding body stipulations. Participant B10SS stated: *"I think trying to manage a project that spans social and traditional sciences and engineering…and is working across academia and other sectors, needs far more time than I put into the model".*

This has implications for knowledge utilisation, as extant literature suggests that knowledge utilisation is primarily a social or relational process (Heinsch et al., 2016). Therefore, adequate time is needed to undertake these activities and encourage the utilisation of knowledge amongst stakeholders.

Participants felt that the increase of impact work created unknown timeframes, given the increasing amount of time needed for: administration and application of impact work (participant B13ENG); undertaking and monitoring impact work (participant B7ENT); 'translation' activities between disciplines to ensure work objectives were understood by all (participant B6SS; B10SS); and the relational activities needed to develop and sustain the networks required throughout the cycle of impact work (i.e. from funding through to generating impact) (participant B2ENG). This left some

participants feeling that both the University and school actively encourage and reward the creation of impact beyond academia, in part to facilitate the development of REF impact case studies, but the system of workload allocation models is not in congruence with this espoused aim. Participant B10SS stated: "t*here is talk of the inclusion of impact and enterprise in workload models. But in terms of how that actually works out in workload, I think that's the key thing".*

This highlights one of the challenges of knowledge utilisation. Knowledge utilisation can be viewed as a relational process (Heinsch et al., 2016). This involves undertaking relational activities with a number of actors with varying motivations and objectives. Time is needed during the project to build networks and sustain stakeholder relations, but also may be required post-project completion to engage in relational activities to both encourage and monitor knowledge utilisation with stakeholders. Due to the complex and uncertain nature of interactions within innovation systems, it becomes apparent that the ability to accurately predict and quantify adequate time allocation for such emergent relational activities is difficult.

5.4.4. Promotion And Rewards

The analysis confirmed three major organisational level criteria for career development and promotion as a researcher, which were consistent across the schools: publications and citations; generating impact; and receiving funding. Whilst all three of these criteria were seen to influence career development, any particular emphasis on one of these was seen to be discipline specific. Participant B6SS recognised that, although impact generation beyond academia was an increasingly important part of academic promotion, they perceived the emphasis for their school to be on academic publications: "*I know it's not the same in all disciplines, but within [this] school I would say impact is important but you have to make sure that you've got your publications first".*

This emphasis on academic publications for promotion, therefore, primarily influences academic knowledge utilisation. Additionally, different schools weighted different forms of academic publication above others. Participant B6SS suggests the importance of quality journals in their own school, emphasising the significant timescales needed to produce and publish quality academic work:

> *"For us in [this school], it is actually more difficult to generate publications because we don't give, in general, a lot of importance to conference proceedings or books or official reports or anything like that. So it has to be a paper in a journal that has international reputation. So that transition from having done a successful research project to*

producing good academic work, takes actually quite a lot of time and effort. And I think in other disciplines, the more practical work, maybe that's generated by possibly a large number of authors, is still valued."

In contrast, participant B11ENG suggested conference proceedings were the crucial academic publishing activity: "*we take academic publishing very seriously. So for example, the biggest conference in our field…was held recently in the States. And our team had 9 papers there"!* Also, within the engineering disciplines, publications and citations were seen as a recent phenomenon. As participant B2ENG explains:

"Our journals are high rated journals in our own field, [but] have very low SNIP and citation indices, so we would look to publish outside of those. Now we need to look more at citations indices, but we just don't have that big group of literature that you would have in other sciences. So one has to take that into account, but in order to get the balance between the quality papers and ensuring you have impact [beyond academia] is a genuine challenge for anybody in our discipline right now".

The specific nature of individual disciplines is seen here to affect how (and where) knowledge is utilised within each disciplinary groups (i.e. within specific academic disciplinary communities or beyond). Furthermore, it alludes to the importance of impact beyond academia as an increasingly important facet in career development and promotion. Participant B3ENT agreed with the importance of this type of impact when seeking new positions:

"You need to be able to articulate a position on impact. I'm not sure that the 'I'm not having anything to do with it' will get you a job but it's a position and I do respect that some people hold that view very strongly. Enterprise is in promotion criteria, so [those] people will struggle to get promoted".

The analysis revealed a perceived tension between the publications (academic knowledge utilisation) and impact (enterprise knowledge utilisation) promotion criteria. It was felt that, whilst both feature heavily in career development metrics, there is not enough time to dedicate to both research and impact work: one has to be sacrificed for the other, as participant B6SS suggests:

"Academic recognition is still important and it's a difficult balance to find. Because when you have deadlines in terms of producing reports or delivering to other members of the team so that they can continue, your own academic research takes a step back. And you might find yourself two years down the line not having produced any substantial research".

Participant B10SS further expresses the tensions between different criteria, suggesting that funding may not be recognised as much as high quality papers in their particular school:

"I don't think that [income] is recognised as strongly as the REFable papers that I think we're producing. But I'm not going to be producing the absolute tip-top papers that will be the kind of world leaders at that level. But no one in [this department] is going to get anywhere near the amount of income that I'm bringing in".

This is despite a number of participants suggesting that the University itself uses income as an important measure of its own success.

Participant B2ENG suggested that this 'tension' can be seen as a recent phenomenon as the role of an academic has changed, further expressing the need of researchers in their field to understand the importance of enterprise knowledge utilisation within a contemporary academic career:

"I think [the tension] has grown, it's now become inevitable; one has to resolve it in one's own way. So there is no debate, if you are a fully functioning academic, you must publish in high quality journals and you must have impact [beyond academia] from what you do. Now necessarily, the consequences of that are we've all learned we can't write as many publications that we would wish potentially. And we have to focus in areas that we can attain impact."

The importance of publications, funding and impact work in organisational promotion can be seen to affect knowledge utilisation. Figure 5-3 summarises the promotion criteria and the corresponding influences of knowledge utilisation, as derived from the analysis. Whilst some feel strongly that publications and citations are essential for academic promotion, it was also recognised that schools increasingly espouse the importance of impact for promotion (as distinct from publications). This has led to tensions in managing the two. These two types of criteria can be seen to have two

different stakeholder sets (within academia and beyond) ultimately effecting how knowledge will be utilised.

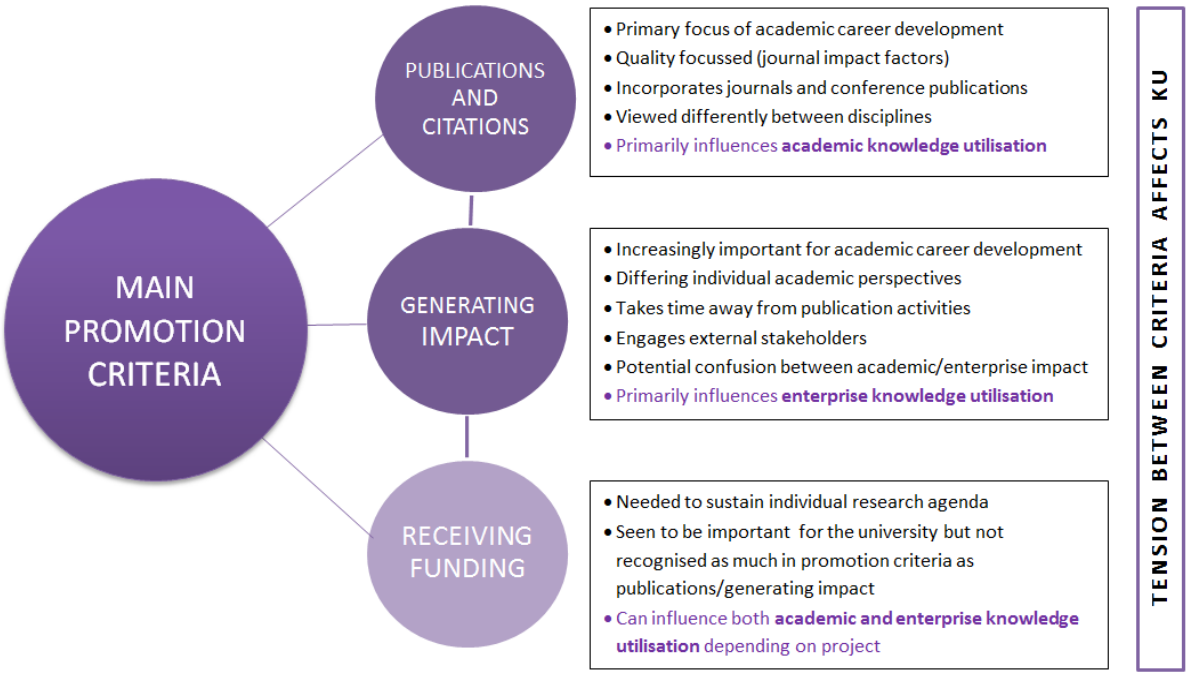


FIGURE 5-3: MAIN SCHOOL LEVEL PROMOTION CRITERIA AND INFLUENCE ON KNOWLEDGE UTILISATION

5.4.5. Research Groups Within Schools

Participants not only discussed the interactions and influence that take place at a school level, they also identified with a number of research centres or research groups within the schools and how these contribute to effective knowledge utilisation. The analysis reveals certain group dynamics that affect the development and utilisation of knowledge. Participants suggested that successful groups are usually small in number. This facilitated awareness and understanding between all group members of the work undertaken by the group. Crucially, this encouraged knowledge utilisation by any member of the group being able to represent the work of the whole group, rather than just individual work portfolios. It was suggested that research groups enabled the development and utilisation of knowledge by facilitating *"shared interests"* (participant B9ENG) and *"developing a sufficient scale (between researchers) in order to make an impact"* (participant B11ENG). Participant B2ENG offered an example of a successful research group, which highlights group size as an enabler/barrier to knowledge utilisation:

> *"In order to have a successful research and knowledge exchange experience, I think [name of research group] have got it absolutely right. A dozen staff maximum, then you have got the researchers, the PhD students, you've got this microcosm. But the*

important thing is they all know each other. If there are too many of us, we find it really hard to work together as a group. If [one person] goes out on their travels [they] simply don't know, even the briefest of what else is going on in the school because there is so much going on in the school. So it's a genuine challenge when you talk about knowledge exchange".

Furthermore, participant B2ENG suggested that it is important that research groups have specific skill sets. Firstly, the ability to undertake research that promotes academic knowledge utilisation and so builds reputation within the academic research field, but also to undertake more '*consultancy*' based work, which is seen to encourage enterprise knowledge utilisation. Secondly, one or more researchers within the group must be motivated and capable of engaging with stakeholders outside of academia to promote the work of the research group and measure any ensuing impact:

"You've got to know where the impact is likely to be, keep tabs on it, keep measuring it, be able to report it, publicise it. At the moment that's the job of the individual academic. [Some academics] don't know how to do [this] evaluation because [they] haven't been trained to do it, don't know what to look for, or how often to look for it".

Figure 5-4 summarises the factors revealed by the analysis that encourage both forms of knowledge utilisation.

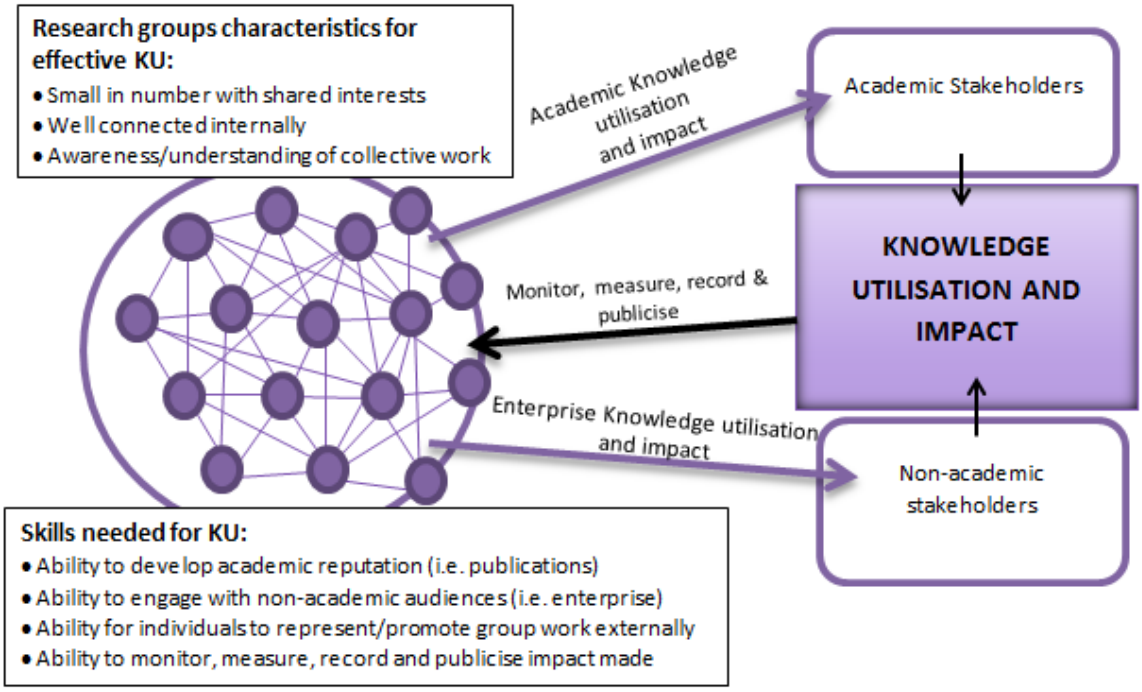


FIGURE 5-4: RESEARCH GROUP CHARACTERISTICS AND SKILLS WHICH INFLUENCE KNOWLEDGE UTILISATION

If research centres or discipline groups become too big, the ability to encourage knowledge utilisation may be impeded due to a lack of understanding of the work that the larger group undertakes. Knowing people and becoming familiar with their work, therefore, appears to be important for knowledge utilisation to occur. Secondly, research groups need to balance the needs of attaining academic impact and enterprise impact, by ensuring that individual academics have both the motivation and the skills to facilitate both of these goals. Thirdly, focus must extend beyond creating impact to recording, measuring, monitoring and publicising the impact made.

5.4.6. Focus On Project Level Objectives

There is a focus on project-level goals and objectives as opposed to overarching high-level goals that were stipulated by the organisation. The objectives of each project are found at the intersection of individual motivation (research interests) and external requirements for funding, and are subject to the identification of suitable expertise. As participant B4OP explains, funding bodies often require different types of expertise:

> *"Research Councils are asking for people to look at multiple energy vectors, multiple technologies perhaps under the umbrella of one funded research centre. So, you need multiple facets of expertise".*

However, the notion of interdisciplinary work varied between participants from different disciplines. Participants from engineering schools often talked of interdisciplinary work in relation to different, but associated, technological facets (e.g. physics and chemists working together to solve a technical problem). Participant B11ENG explained: "*Within our team here we have physicists, chemists, electrical engineers, a geologist and materials scientists - they're all in the team. So, yes very interdisciplinary".*

However, others would perceive interdisciplinary work on a macro-level (e.g. engineers and social scientists working together). This was particularly the case on projects that involved end users of technologies. Participant B10SS suggested:

> *"One of the things I've picked up from working in with engineers and [other stakeholders] was actually to deal with development challenges you need people from a whole range of different disciplinary backgrounds. And I think in the energy space that's particularly important".*

Similarly, participant B6SS proposed a need to look beyond a technological research focus: *"I think from the technology side of things there is a recognition of a need for more qualitative work and also more business-orientated work, which is not only about the specific technologies".*

The engagement of social scientists was defined by one participant as being necessary, due to the complexity and uncertainty involved in human interactions with new technologies and intended outcomes. In this sense, as participant B1ENT alludes to, the value of multi-disciplinary projects was seen as the ability to measure within context:

> *"One of the things we've found working in these multi-disciplinary teams, there is a tendency for engineers to measure everything and then we have so much data that actually it's very difficult to make a lot of sense. So [we] say 'right lets understand what people do in their homes first'. Because otherwise all your getting is this data that says, well these particular people, they [do this] but you don't necessarily understand why".*

The attention on project-level activity focuses the knowledge work within the defined parameters of the project (e.g. timeframes, budget, outputs and outcomes). The success of a project can, therefore, be determined by the fulfilment of project deliverables within these specified conditions. However, participants suggested that project time allocation is particularly difficult, given the emergent and social nature of impact work, where knowledge may be utilised years after the project has officially completed. This requires flexible project frameworks that recognise longer-term, post-project impact (Wood, 2004). Participant B1ENT highlighted this challenge:

> *"Time scale [is a challenge]. The impact can take longer than the research took in the first place, so again, that's really important, that your measures for that aren't very short term. You know, you finished 6 months ago, what impact has the research had, because it could be 5, could be 10, could be 20 years for some types of research before it makes a difference".*

This suggests that knowledge activities need to identify and measure knowledge utilisation as a measure of project success, which can be difficult to achieve within specified project timeframes. It is a challenge to succinctly map any cause and effect relationships between specific knowledge inputs and specific outcomes (Rich, 1997), and emphasises a need to use leading as well as lag indicators.

The nature of knowledge and the challenges associated with mapping cause and effects of knowledge flows have two critical considerations for the measurement of knowledge projects. Firstly, projects that need to demonstrate impact as a measure of success need to be managed to the context in which they are operationalised, not to a defined and unyielding end date. Secondly, rigid metrics, which rely on standard objective units of measurement, may not be effective in measuring impact. This is due to the individual contexts in which the knowledge activities take place. This suggests that any measurement of impact may best be done in more qualitative responses, which acknowledge the subjectivity of individual knowledge activities and the difference in how project objectives can be realised.

5.5. Micro-Level Analysis

This section analyses the micro-level elements, which represents the factors occurring at an individual level and their influence on knowledge utilisation. The section firstly analyses how both explicit and implicit individual influences affect knowledge utilisation, before appraising the importance of undertaking individual networking activities.

5.5.1. Individual Motivations And Preferences

This section analyses the role of individual motivations on knowledge utilisation. It examines how individual preferences effect how knowledge is created and how knolwedge utilisation is perceived and the role of academic automony in relation to these motivators. A number of individual, although not mutually exclusive, motivators were indicated by the analysis. These are represented in Figure 5-5 , with the larger words indiciating a more frequent response from participants.

The analysis showed that the knowledge activities undertaken were highly influenced by both implicit and explicit motivations. Implicit motives can be defined as somewhat stable and unconscious needs that generate internal stimuli to fulfil them; subsequently, individuals feel pleasure when they pursue activities that satisfy these needs (McClelland, 1987). Explicit goals, although conscious, are not as equally stable and are influenced by norms of behaviour and rewards. Although explicit motivations can shape individual behaviours and decisions there is the absence of internal pleasure when they are pursued (McClelland, 1987).

FIGURE 5-5: REPRESENTATION OF THE INDIVIDUAL MOTIVATIONS EXPRESSED BY THE PARTICIPANTS

Examples of implicit motivations revealed in the analysis were: personal research interests; inclination to solve problems; utilising individual skills set; wanting to build relationships; and the disposition to generate new knowledge. Explicit motivations included: criteria that would develop an individual's career (i.e. criteria set by the University, peers or professional norms); and access funding opportunities to carry out further research. As the analysis below suggests, there was recognition that career development criteria influenced both knowledge creation and attempts to ensure knowledge utilisation. However, there was an overarching feeling that academic autonomy and the pursuit of individual goals ultimately dictated how knowledge activities were undertaken and how different types of knowledge were externalised outside of the University.

The analysis indicates that researchers perceived there were two types of researcher: theory driven (pure researcher) or stakeholder driven (applied researcher). Participant B2ENG suggests that implicit motivations such as personal ethos and perceived own abilities, affect where a researcher positions themselves on a pure-applied researcher continuum:

"I only do applied research. I am not a pure theoretician, because I was never trained to be, I never came from that background. So every piece of research I have done has been with an industry partner. And that accords with my own personal ethos that our research should make a difference, it should contribute to wider society".

Similarly, participant B1ENT offered implicit motivations, such as need to engage with stakeholders and making a difference, as the basis for positioning themselves as an applied researcher:

"Personally my research has always been quite applied; I like the fact that by engaging with the stakeholders through the research, you can see it can make a difference. It's addressing a particular problem, and you're looking at solutions and you're taking on board these different stakeholders views".

Both of these participants, therefore, perceive that 'making a difference' is the ability to realise action with wider stakeholder groups and bring positive change to those groups. The University's status as a charitable organisation and its mission to realise public benefit, was also perceived to drive the need to make a difference, as participant B3ENT suggests with:

"It's our role here as a charity to create that public benefit. So as a charity we must be here for public benefit, we're not a company we have different governance structure and so I see this impact piece as part of how we ensure fulfilling that public benefit part of our mission and institution."

This participant clearly aligns their own personal motivations with that of the corporate level mission; however, they were only participant to mention organisational-level goals.

Participant B2ENG also perceived success to be linked to stakeholders, using knowledge to create change. However, they went on to introduce a key concept to creating impact: whilst knowledge may be utilised and impact may be created, the process is achieved only if there is an ability to *measure* any change created. This extends the concept of 'making a difference' to 'making difference that is measurable and measured'. They subsequently linked the ability to measure impact with the REF agenda:

"If there is an impact case study on it, that's a good measure [of success]. More broadly, has somebody from the outside world picked it up? First of all if they've taken notice of it, and then have they done something with it and you can measure the difference it's made to their world. If you can't measure all three of those, then that's not impact".

Participants B1ENT, B2ENG, B3ENT, B5SS, B6SS, B7ENT and B11ENG all discussed the connection between an increased focus of creating impact and the 'REF agenda'. Participant B1ENT suggests that this agenda aligned with the University's focus on enterprise work:

"The REF has been a really usefully thing. Obviously enterprise has been something that has been on the agenda of the University for a long time… [Enterprise] has not always been recognised as a useful way to be spending your time. Whereas if you can say, well I'm doing a REF case study, then again it kind of justifies things much more".

This suggests that the external influence of the REF is a greater motivator than the organisational support mechanisms that support impact generation, primarily because the REF is associated with career development criteria.

Another individual motivation was linked more towards the academic community, with the development of academic reputation being identified as an individual motivation. Participant B5SS suggests that through academic publications and academic knowledge utilisation: *"we get reputation, so we become nationally, internationally world-leading experts".* This aligns with the meso-level analysis pertaining to promotion and the necessity to publish academic papers to create academic impact as a priority.

The analysis revealed motivations to utilise knowledge in certain ways can change over a person's career. Participant B6SS suggests that there had been a move in their career from academic outputs to impact creation as their own reputation had developed and they had built more relationships. This suggests that an academic's career level can influence motivations and consequently, the type of knowledge utilisation that is pursued:

"My main activity has been research work towards papers and research projects. I've seen in my own career really very much of a transformation in the way I work. So increasingly now, I do work with companies because their input is very important and

because they can actually contribute in identifying what key issues need to be addressed. There is also much more of an interest in dissemination of results and presentations to a wider audience, not only academics, but more geared towards the public. But I find that it's been easier to do this now that I'm a bit more established in my career, because I think at the very start it's a bit more of a dangerous route to take. I mean you can't afford to spend all the time that you need to develop these networks of people. And also you have probably less of a reputation of credibility that would allow you to address an audience and basically say this is the knowledge that we have about these things".

This analysis indicates that both explicit and implicit motivations can influence knowledge utilisation, which can change at different stages of an academic career. Importantly, implicit motivations, based on personal objectives and philosophy, can have a bearing on whether researchers position themselves as pure theory-driven or applied researchers. Whilst the applied researchers sought enterprise knowledge utilisation beyond the boundaries of academia, it has been suggested that part of the 'impact agenda' is the ability to be able to measure any impact created.

5.5.2. Individual Perceptions Of Value Creation

The analysis revealed a number of different perceptions pertaining to how knowledge outputs and activities create value. Participants offered various examples of how they engaged with stakeholders to encourage knowledge use, with some referring to more dissemination-based activities. Participants B1ENT, B2ENG, B3ENT, B5SS, B10SS and B9ENG referred to changes in stakeholder practices as a demonstration of impact creation. Participants B5SS, B10SS and B11ENG proposed that non-academic reports are a way to create impact beyond academia. However, participant B1ENT suggests that confusing impact and knowledge dissemination is a barrier to creating impact:

"People think that you can create an impact just by disseminating. So you do your academic papers and you write something for a trade magazine. Doesn't mean it will have an impact. So I think you have to go away from thinking that impact is dissemination. And so dissemination might be part of the plan to create the impact, but you need much more than that. If you're going to write something for a trade magazine, maybe you need to do some follow up event to get people together, and maybe you need to spend time with a company trying to make some changes".

This suggests that support, skills development and a general awareness of what impact is, is needed to avoid confusing impact with dissemination. It also further differentiates between written or explicit knowledge as the primary focus of dissemination and the relational aspects, suggested by the preceding analysis, that are required to encourage knowledge utilisation and create impact.
Participant B14ENG further suggests distinguishing between dissemination of knowledge through workshops and the need for additional activity to create impact:

> *"Impact plans are often around 'we're going to hold a work shop'…it's just about dissemination. Just because you tell somebody doesn't mean they're going to do anything about it. So I think it's about the wider plan to actually get the research out there…maybe you have to build something, so for the technology maybe you have to build a proto-type and a website and get people to come and use it".*

Participant B12ENG thought that a clear distinction between academic publications and non-academic impact was a false dichotomy. When discussing the need to publish *and* create impact beyond academia, they implied that publications can lead to impact beyond academic boundaries:

> *"I think publications are one way of going down the impact stream. It's very crucial for academics to publish, and to publish in journal papers and to publish at conferences and to give key note speeches wherever possible, and that's creating impact on many layers".*

The 'impact on many layers' indicated above would be dependent on the ability for non-academic stakeholders to access and utilise knowledge, which is published in predominantly academic forums, if enterprise knowledge utilisation is sought.

This analysis suggests that there are perceptions that dissemination and transfer of knowledge creates value and leads to impact. However, others suggest dissemination and utilisation of knowledge are distinct concepts that require different activities. Importantly they propose that activities must go beyond the dissemination of knowledge in order to create an impact.

5.5.3. Participation In Network Activities

The analysis revealed a perceived importance of participating in network activities to influence knowledge utilisation. However, participation was seen as occurring at an autonomous individual

level, rather than stipulated by school or University. A number of network activities were identified in the analysis, each driving different types of knowledge utilisation.

A key issue raised by participants was the serendipitous nature of network development for future knowledge activities. That is, the positive, but unplanned, benefits that can arise out of developing network ties and attending network events. Great emphasis was placed on these informal and chance meetings, in particular, from having conversations with people at events about existing knowledge outputs and how they may provide benefit to a stakeholder. Participant B6SS summarises how networks form from these chance meetings:

> *"[Network building] happens when you drink coffee with people! Those networks just form in any direction. You might go to somebody very particular saying 'I'd really like your advice' or 'can you just...?', 'we're doing some work how useful is this?'".*

However, whilst serendipity may play an important role in encouraging different forms of knowledge utilisation, the action of attending the event must occur in the first instance.

Participants revealed that networking was a key factor in the success of maximising chances for knowledge utilisation in a number of ways: sourcing the relevantly skilled academic collaborators (participants B6SS, B10SS); locating stakeholders to work with on problem solving projects (participant B5SS, B6SS); developing shared understanding of problems with stakeholders (participants B2ENG, B6SS); building a research agenda addressing real-life problems (participants B2ENG, B5SS); influencing policy (participants B7ENT, B10SS); disseminating research (participants B6SS, B10SS); develop contemporary ideas for knowledge creation (participant B10SS); develop reputation and chances for future work (participant B7ENT); and the promotion of skills sets (participant B2ENG). Crucially this was done through a variety of network channels and activities, which often involved personal interactions. This was perceived to be critical in creating impact, as participant B12ENG suggests:

> *"To understand all that knowledge that has been accumulated in that discipline, we have to speak to people and work with people together. And I think that's when research actually becomes really interesting and has a high impact".*

Similarly, participant B2ENG suggests that personal interactions: "*heightens people's awareness of who we are, what we do, so that they are more likely to choose to work with us; they are more likely to see us as a partner".*

Analysis of the above-mentioned success factors reveal how networking can enable different forms of knowledge utilisation. Table 5-4 illustrates the different types of knowledge utilisation and the enablers that were suggested above, as well as the characteristics of these enablers.

Knowledge outcomes	Enablers suggested	Characteristics
Enterprise knowledge utilisation	▪ Establish shared understandings of contemporary 'problems' with stakeholders ▪ Develop understanding of potential knowledge use and stakeholder needs ▪ Identify and source necessary interdisciplinary expertise to solve problems ▪ Develop needs-based outputs with benefits to stakeholders	• Relationship-based • Co-creation of knowledge with stakeholders • Knowledge fit for purpose (problem solving or benefit delivery)
Academic knowledge utilisation	▪ Establish contemporary thematic areas for development within discipline ▪ Establish reputation and academic quality (peer review and journal publication) ▪ Promotion of research	• Reputation-based • Focus of explicit knowledge (e.g. publications, reports) • Standard measure and process of academic utilisation (citation indexes)
Knowledge transfer and dissemination	▪ Promotion of research ▪ Promotion of credibility and expertise ▪ Promotion of benefits of new knowledge ▪ Dissemination of materials	• Expertise based (knowledge creator as expert) • Focus on one-way transfer of expert knowledge • Limited stakeholder feedback cycles

TABLE 5-4: THE EFFECTS OF NETWORK ACTIVITIES ON KNOWLEDGE UTILISATION TYPES

The above analysis has highlighted how relational network activities can influence both academic and enterprise knowledge utilisation in different ways. This difference is, in part, due to what change is sought from the utilisation of knowledge in both instances. Crucially, the network diagrams highlight that knowledge transfer is distinct from knowledge utilisation: if knowledge is transferred it will not necessarily be utilised unless value is perceived from stakeholders. The concept of value, and measurement of that value, is different in academia, where disciplinary norms and peer reviews dictate research quality. This is compared to outside of academia, where individual problems necessitate different outputs, according to the context of the problem, and if the stakeholder has the motivation and ability to enforce any changes.

5.6. CROSS-LEVEL ANALYSIS

This section undertakes cross-level analysis in order to explore the interactions that happen across the various levels presented above. As with the previous chapter, it synthesises the factors that have been identified in the analysis as influences of knowledge utilisation, and groups these by the higher-level factors. An influence diagram then illustrates the cross-level flows of influence.

Table 5-5 summarises the major factor groups that can be seen to influence knowledge utilisation for each level. The macro-level factors identify three factor groups: stakeholder analysis and system embeddedness (similar to the previous case study) with the notable addition of academic career development factors. The meso-level factors that emerged are: University culture, University support mechanisms, disciplinary norms, school administration, academic career development measurements, and group skills. The micro level factors in this case study were more extensive, with six predominant groups identified: academic autonomy, individual motivations, perceived career success measures, value creation and networking.

FACTOR GROUP	FACTOR	INFLUENCE ON KNOWLEDGE UTILISATION
MACRO-LEVEL		
Stakeholder analysis	Stakeholders identified	Establishes who needs to use knowledge in order to achieve goals
	Priority stakeholders (e.g. academic and funders)	Prioritised groups may result in greater effort at knowledge utilisation to the requirements of these groups; promotes outputs for either academic utilisation (new disciplinary knowledge) or enterprise utilisation (knowledge leading to required change)
	Inclusion of society as stakeholder group	Increases consideration of behavioural based problems; increases need for interdisciplinary solutions (technology and behavioural change)
	Stakeholder engagement strategies	Influences type of knowledge outputs created; influences how knowledge will get to stakeholders (e.g. dissemination/relationship building); can positively or negatively affect knowledge utilisation
System embeddedness	Understanding stakeholder needs	Influences type of output dependent on perceived need to stakeholder (e.g. academic, government etc.)
	Understanding system context	Understanding the environmental factors of the system, facilitates the identification of potential knowledge barriers and facilitates activity planning

	Knowledge barriers (outside academia)	Reduces opportunities for knowledge utilisation; limits the depth of impact which can be made
	Early, continuous and iterative engagements with stakeholders	Can reduce knowledge barriers; help identify stakeholder needs and motivations for knowledge use
Academic career development	Funding requirements	Influences type of knowledge outputs and knowledge utilisation pursued; determines disciplinary or interdisciplinary focus of knowledge outputs; possible stipulates stakeholders
	Academic peers	Wider academic community affect individual career progression (peer review); strong influence on disciplinary academic knowledge utilisation
	REF cycles	Greater focus on knowledge utilisation around REF cycle; influences promotion criteria and skills set needed
MESO-LEVEL		
University culture	Bottom up culture	Disciplinary (knowledge) silos to be overcome; University promotes (i.e. disseminates) the knowledge when allowed but relationships made at individual level
	Organisational goals	University is support coordination for knowledge utilisation rather than implementer of knowledge utilisation goals; project level goals dominant over organisational level goals
University support mechanisms	Interdisciplinary community	Reduces disciplinary boundaries and 'within discipline' norms; increases interdisciplinary knowledge outputs (suitable for complex energy problems); adds context (qualitative) to measurements (quantitative)
	Raising profile of energy research	Increases knowledge reach; promotes benefits of research; does not necessarily increase utilisation
	Confidentiality requirements	Restricts knowledge access to project stakeholders; reduces breadth of utilisation
Disciplinary norms	Disciplinary perspectives	Focuses on problem solving (action orientated) to theory building (new knowledge); influences outputs and focus on knowledge utilisation
	Project complexity	Influences type and amount of resources/skills needed for knowledge utilisation; influences type of knowledge utilisation needed to achieve goals (e.g. technology uptake or behavioural change)
School administration (resources)	Recognising value of knowledge utilisation work	Influences the allocation of resources for knowledge utilisation; encourages individuals to participate in knowledge utilisation work

	Timeframes allocated for knowledge utilisation work	Difficulties in quantifying knowledge utilisation activities may mean enough time is not allocated to projects; timeframes can go beyond project lifecycle (extended timeframes to achieve impact)
Academic career development measurements	Academic knowledge as promotion criteria	Prominence of academic knowledge as main channel for career development strongly influences academic knowledge utilisation; main criteria for promotion
	Enterprise knowledge as promotion criteria	Enterprise and demonstrating impact is increasingly part of organisational level promotion criteria; influence enterprise knowledge utilisation
Group skills	Small research groups	Facilitates knowledge utilisation through increased group awareness of knowledge that is being created
	Outward looking	Crosses knowledge boundaries; increases the ability to externalise work to stakeholders
	Skill sets for impact	Influences the ability to create knowledge utilisation through relational mechanisms; influences the ability to monitor and measure any impact generated
MICRO-LEVEL		
Academic autonomy	Knowledge utilisation training	Knowledge utilisation skills development is not mandatory; skills needed for knowledge utilisation can be influenced
	Knowledge utilisation activities	Individuals can choose what type of knowledge utilisation to give attention to (academic or enterprise); type of knowledge utilisation activity can be influenced
	Activities undertaken	Individuals can choose what projects to undertake; different projects will have different knowledge utilisation ambitions
Individual motivations	Implicit motivations	Internal stimuli influence the type of knowledge utilisation activities undertaken (pleasure seeking)
	Explicit motivation	External stimuli influence the type of knowledge utilisation activities undertaken (responding to external environment)
Perceived career success measures	Academic outputs and utilisation as measure of success	Academic outputs are prioritised for career development therefore strongly influencing academic knowledge utilisation
	Enterprise knowledge outputs and utilisation as measure of success	Increasingly important for career development, but seen less so than academic outputs; increases focus of enterprise knowledge utilisation
Value creation	Dissemination	Dissemination often confused with impact making activities; increases knowledge transfer

	Influencing	Activities needed to motivate action from stakeholders in line with knowledge utilisation goals
Networking	Serendipity	Can influence future knowledge collaborations; can increase exposure to potential stakeholders
	Relationship building	Can influence knowledge utilisation through development of shared understandings of problems and motivations for knowledge use
	Promotion of research	Can influence knowledge transfer through promotion of research, expertise and reputation; and dissemination of materials; may or may not influence academic knowledge utilisation

TABLE 5-5: MULTI-LEVEL FACTORS IDENTIFIED AND INFLUENCE ON KNOWLEDGE UTILISATION

Following on from the above summary of the major factors, Figure 5-6 was developed to illustrate these factors over the three levels of analysis, in line with the study methodology. This diagram serves as a foundation from which to explore the flows of influence between the different factors.

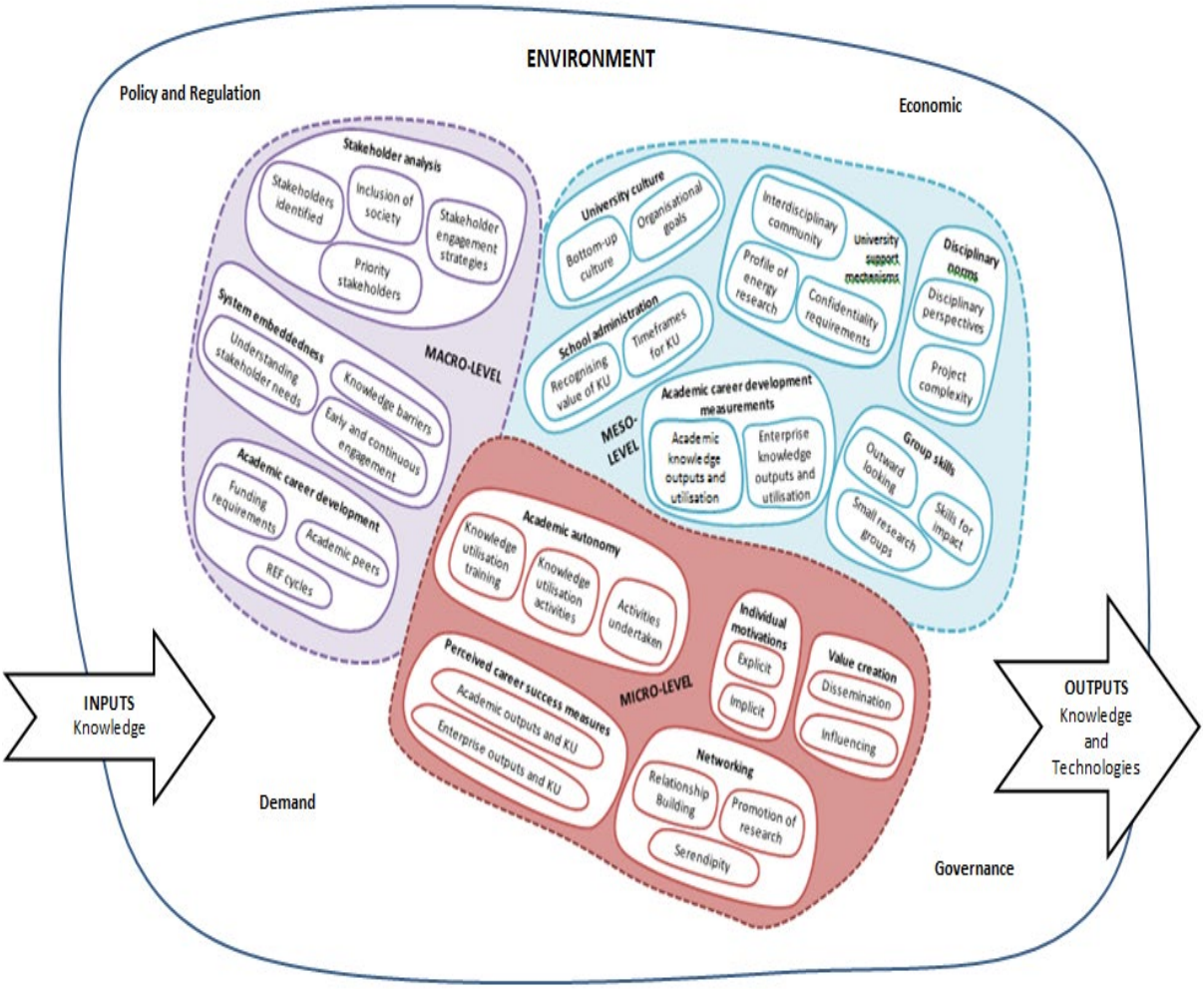


FIGURE 5-6: MULTI-LEVEL FACTORS OF THE INNOVATION SYSTEM THAT EMERGED IN THE ANALYSIS

An influence diagram (Figure 5-7) has been developed which illustrates the influences, between the different levels, to better answer the research questions. As in the last chapter, these influences are representations of the strength of influence, as the researcher interprets them.

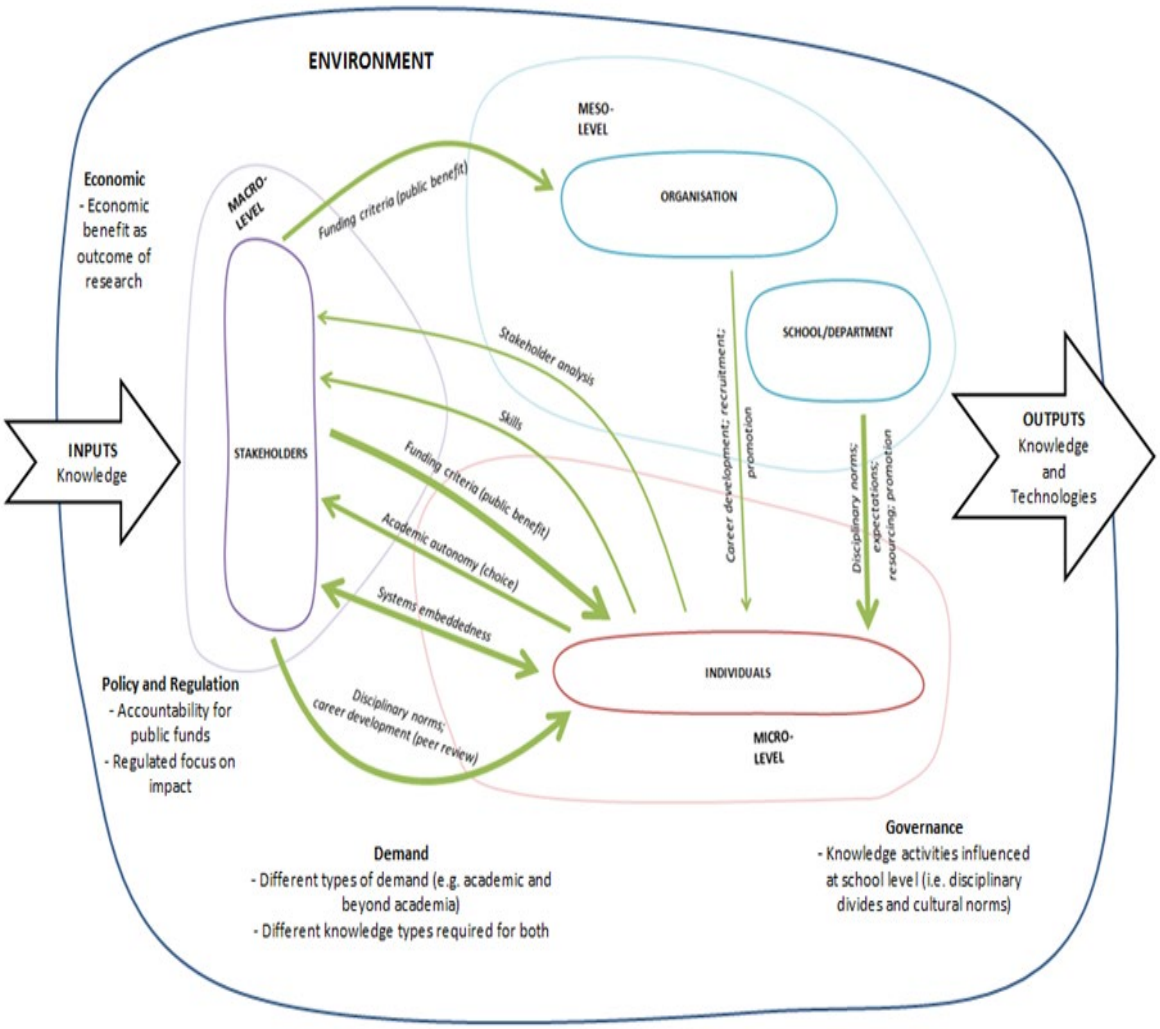


FIGURE 5-7: INFLUENCE DIAGRAM DEPICTING MAIN INFLUENCES BETWEEN SYSTEMS LEVELS

The diagram does not represent any processes or events that occur, rather the influences in operation over the different system levels. It also does not represent all the influences in the system, rather the key factors that were revealed through the analysis. The thicker arrows, which have been labelled, represent the influences that were discussed most often within the analysis.

The influence diagram reveals that the University is subject to many strong influences from the macro-level, which affect knowledge utilisation. In particular, success criteria are often driven from macro-level parties, which predominantly shape the type of knowledge activities and utilisation required. This high level of macro-level influence often interacts with individual-level components,

due to the bottom up culture of the University and the predominance of academic autonomy, suggesting a large degree of independent choice leveraged in relation to knowledge utilisation at the individual level. The need to become socially embedded in the innovation system in order to encourage knowledge utilisation was also revealed. This includes the ability to recognise the system environment, understand individual contexts and plan knowledge activities according to these contexts. In particular, the need to identify and overcome knowledge barriers was seen as crucial, although this was again influenced by the individual choice to engage with activities that fulfil this need. The organisational-level influences were most strongly related to disciplinary norms, with stark differences revealed between the disciplines regarding project complexity, typical knowledge outputs and potential uses for the knowledge created. Overall, the actualisation of knowledge creation and utilisation, primarily takes place at the individual-level, with a high degree of influence from external parties. There is less influence from the meso-level factors, which mediate rather than mandate knowledge utilisation activities and outcomes.

5.7. CHAPTER SUMMARY

This chapter presented the analysis and descriptions for the second case study – the University. The chapter initially presented the system under investigation through the provision of background information and context to the University, as the case study organisation. The University is a research-intensive organisation with significant expertise within the low carbon energy field and therefore, offers an ideal environment for exploring the influences of knowledge utilisation within the UK low carbon innovation system. The chapter presented and discussed themes and factors that emerged through the completion of inductive analysis of the data and aimed to answer the research questions. These themes were presented using a three-tier structure, which analysed three levels of the innovation system, namely the system wide factors (macro-level), the organisational factors (meso-level) and the individual factors (micro-level). Finally, a cross-level analysis was conducted to illustrate the influences of knowledge utilisation across the three levels.

The within-case analysis for both case studies, which has been presented in this and the preceding chapter, has facilitated the investigation of each case independently. It revealed unique factors about each case and the influences of knowledge utilisation with that context; however, no comparisons were made at this stage of the study. Based on the within-case analysis presented, the next chapter analyses the cross-case factors. This aims to explore similarities and differences in the cases using pattern matching logic, in order to provide a more thorough answer to the research questions.

CHAPTER 6: CROSS-CASE ANALYSIS

6.1. INTRODUCTION

The previous two chapters have presented the within-case analysis for two case studies: the Public Private Partnership and the University. The analysis adopted a three-tier framework (macro, meso and micro level) to present the inductively emergent themes and factors. The aim of those chapters was to examine rich details and gain in-depth familiarity with each case study in its own context (Yin, 2009; Miles and Huberman, 1994; Eisenhardt, 1989). The within-case analysis was undertaken before any comparative analysis was conducted. In this chapter the cross-case analysis is presented using the same three-tier structure. The aim of the chapter is to present both the commonalities and differences that were observed across the two organisations. The cross-case analysis aims to build a deeper understanding of the phenomenon, than what can be obtained from studying the cases separately (Miles and Huberman, 1994). In doing so it offers stronger insights to the research questions. Cross-case analysis also allows the opportunity to generate knowledge for broader use (Khan and Van Wynsberghe, 2008), as well as facilitating the provision of explanations as to why any similarities and differences occur (Yin, 2009). The first part of this chapter (sections 6.2 to 6.4) presents the cross-case analysis similar to the previous chapters: at three different levels. Section 6.5 then synthesises the different levels and directly answers the research questions.

6.2. MACRO-LEVEL ANALYSIS

This section investigates the comparative factors that were revealed to influence knowledge utilisation at the macro-level of analysis.

6.2.1. STAKEHOLDERS ANALYSIS

The stakeholder analysis revealed a number of similarities and differences across the two case studies, which contributed to answering the research questions. The analysis suggests that the composition of stakeholders, the perceived stakeholder roles and the perceived stakeholder needs influenced the: type of knowledge activities undertaken; the types of knowledge outputs produced; and influenced how the participants viewed their own roles within the innovation system in regard to optimising knowledge utilisation. Additionally, it facilitated an understanding of how the interaction of the wider stakeholder groups within the system influences knowledge utilisation and the importance of context when considering knowledge utilisation.

Table 6-1 summarises the main elements of the cross-case stakeholder analysis. These are further compared and contrasted in the following sub-sections.

Elements of analysis	PPP	University	Influence on knowledge utilisation		
			Both	PPP only	Uni only
Main stakeholder groups identified	Industry (and industry associations); Government; Academia	Industry (and industry associations); Government; Academia; Acknowledgment of broader society as stakeholder	Potential knowledge users have been identified	n/s	n/a
Prioritisation of any stakeholders?	Members (necessitate return on financial investment including government as funder); Technology focused groups (in line with organisational mission)	Academics (links to career development); Funders (financial resources to enable research projects) Industry (partner/solve their problem)	Knowledge utilisation efforts can be customised to priority of stakeholder; other stakeholders may unintentionally be excluded	n/a	Stronger influence from macro level
Current stakeholder engagement strategies	Provision of evidence: other 'influencers' drive knowledge utilisation and action; Engage wider set of stakeholders to generate greater breadth of knowledge utilisation and action; Predominance of commercial-isation	Creation of new knowledge to drive academic knowledge utilisation; Creation of impact from new knowledge to drive enterprise knowledge utilisation	n/a	Provision of evidence/ new knowledge may not lead to knowledge utilisation (potential users need to see benefits); knowledge needs to be accessible and relevant to stakeholder to optimise knowledge utilisation	Stronger influence from macro level

Identifying and responding to stakeholder needs	Still primarily focused on addressing technology needs; Realisation of different stakeholders needs and motivations (i.e. knowledge outputs need customising for individual stakeholders)	Realisation of different stakeholders needs and motivations; Discipline specific (engineering is technology based; other schools are more end-user centric)	Realising different stakeholder needs can aid in targeted knowledge outputs and encourage knowledge utilisation;	Organisational mission promotes and sustains the dominance of technical knowledge	Disciplinary norms promote and sustain specific types of knowledge (e.g. technical knowledge)
Characteristics of knowledge outputs and outcomes for stakeholder	Explicit knowledge (reports, publications, software, modelling); Technical outputs and outcomes, moving to non-technical reports for wider impact	Explicit knowledge (reports, publications); Academic outputs prioritised for career development, over non-academic outputs; Discipline specific	Potential knowledge users need to understand explicit knowledge outputs and be motivated to use them;	n/a	Lack of wider societal impact due to inadequate public engagement with science

TABLE 6-1: STAKEHOLDER ANALYSIS OF BOTH CASE STUDY ORGANISATIONS

It suggests that although the three main groups of stakeholders identified were similar between the case studies, there were differences in both the way the stakeholders were prioritised and in perceptions of how stakeholders were engaged. Similarly, there were differences in the responses to stakeholder needs and the types of outputs and outcomes pursued. This was, in part, due to the interactions that occurred and the influences felt in, and across, the macro-, meso- and micro- levels of investigation, which will be discussed throughout this chapter.

Stakeholder identification and engagement

The stakeholders identified by participants are similar for both organisations with industry, government and academia being the main stakeholder groups identified. However, the PPP is far narrower in scope than the University as a whole, as defined by its organisational mission and objectives, which focus heavily on technology development and demonstration. This presents a narrower stakeholder environment in which it operates. Accordingly, the University participants also related to society in general as being a stakeholder. The analysis suggests differences in when

stakeholders are identified within the knowledge creation process. Figure 6-1 shows how the stakeholders are represented throughout the knowledge creation process.

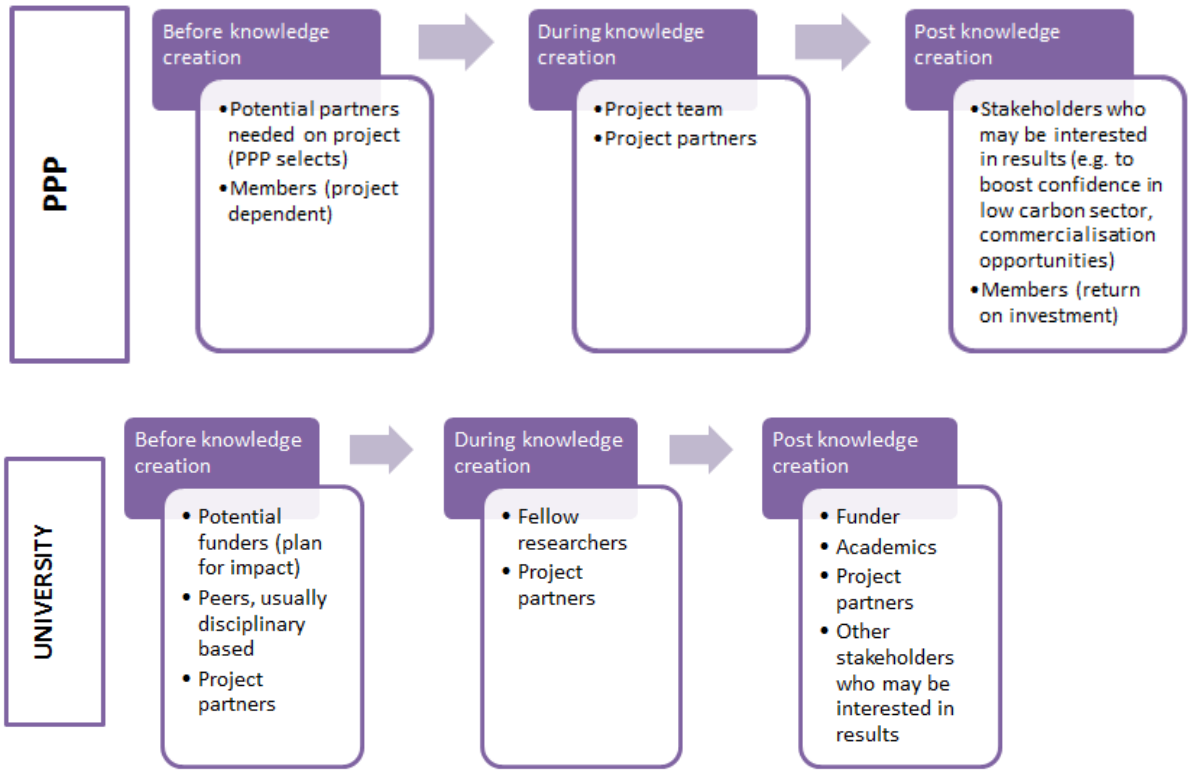


FIGURE 6-1: STAKEHOLDERS AS REPRESENTED THROUGHOUT THE KNOWLEDGE CREATION PROCESS

The PPP participants saw project partners as stakeholders (selected through a competitive bidding process that is controlled by the PPP before project commencement). Members were also seen as important stakeholders due to their financial commitments. Participants at the PPP identified other stakeholders based on who needs to know about, or who would be interested in, the knowledge outputs of the PPP. These stakeholders are seen as the recipients of knowledge *after* the knowledge has been created within a project. The PPP acts as informer to increase the knowledge of these stakeholders, with dissemination remaining an important strategy of the organisation, to raise awareness of the work undertaken amongst a wider stakeholder groups. However, the PPP was identified to be making targeted efforts to identify and understand stakeholders so as to facilitate the application of knowledge depending on stakeholder needs. Participant A1SE states: "*actually we need to be really clear on who our stakeholders are, and, ensure that we're getting outputs of our work delivered to them in a way that they can utilise them*". This requires the identification and understanding of stakeholder motivations to occur before knowledge outputs are created, so as to increase the likelihood of stakeholders using the knowledge.

For the University, the major stakeholders were often involved at the start of a project. This was due to stakeholders mainly being funders or partners at the start of the project; or influential in the career development of the project team (e.g. disciplinary peers). These preliminary external-level institutional influences were seen as stronger at the University, whereas the PPP operates in a more isolated way from the external environment because it has funding secured. The University is subject to external regulative influences from funders, who stipulate the required knowledge outcomes and increasingly require researchers to consider the impact that a project will make. This was primarily seen as requiring the ability to plan for impact before a project starts, rather than a demonstration of impact at the end of the project (although demonstration of impact is becoming increasingly important due to the REF). Similarly, the peer review process for academic outputs is also situated in the macro environment. Here normative and cultural influences are exerted on University researchers to meet disciplinary norms (e.g. what is contemporary and original work for publication). This higher degree of pressure from the macro environment sees knowledge utilisation considered at the pre-knowledge creation stage rather than as an end process. The early interactions with stakeholders also help researchers understand what motivates stakeholders. This comparison suggests that the close links with stakeholders at the start of the knowledge creation process can influence knowledge utilisation in two major ways. Firstly, it establishes what is meant by knowledge utilisation and helps to explicate project goals in relation to knowledge activities. Secondly, understanding stakeholder's motivations allows knowledge creators to create knowledge outputs specifically to align with these motivations. This requires knowledge creators to go beyond stakeholder identification as an analytical task, to actually understanding their needs.

The analysis reveals similarities in the engagement strategies for both organisations. Figure 6-2 illustrates how both organisations are actively aiming to change perceptions of engagement strategies. This includes expanding beyond push forms of communication and adopting relational mechanisms that ascertain stakeholder motivations for knowledge utilisation. The PPP has historically taken the role of informer, focused on generating awareness of the knowledge they produce and increasing stakeholder knowledge through dissemination. This can be seen as a knowledge transfer mind-set, where the knowledge objectives relate to the transfer of explicit forms of knowledge, rather than relational engagement strategies that address the need for stakeholders to *use* knowledge. However, participants felt the PPP is making a concerted effort to take on more relational engagement strategies, through trying to understand stakeholder motivation to use knowledge and expand on the predominance of commercialisation as a main form of knowledge utilisation. This is to facilitate the achievement of organisational goals, which require behavioural

change for many sectors (e.g. industry, policy makers and the supply chain). This sees knowledge as a process, which involves more than the dissemination of explicit knowledge.

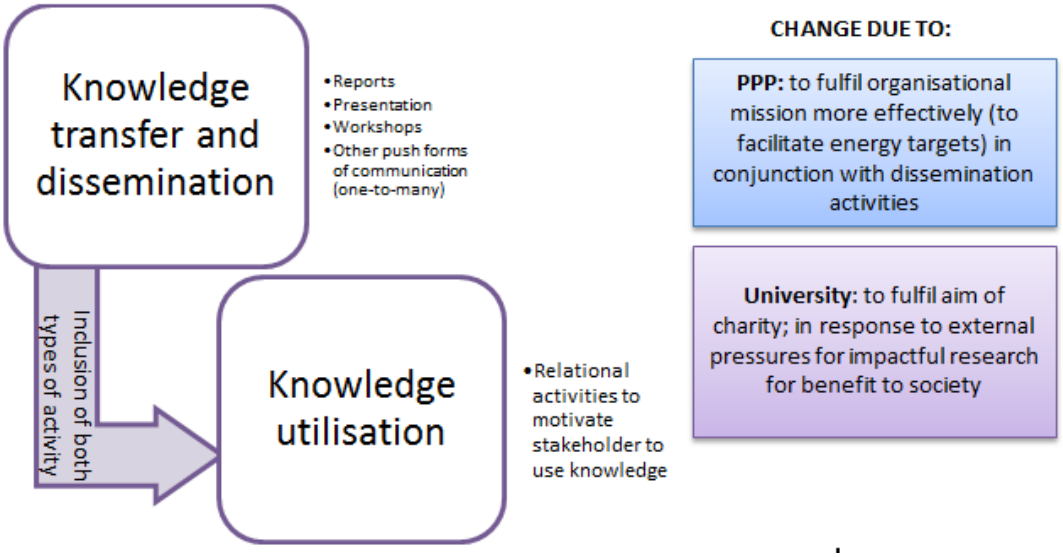


FIGURE 6-2: ILLUSTRATION OF CHANGE OF FOCUS FOR ENGAGEMENT STRATEGIES AT BOTH ORGANISATIONS

Similarly, the University is delivering initiatives to help researchers understand impact through ongoing training sessions that reflect on how research can be impactful (see section 6.3.3 for further discussion on the organisational level support mechanisms for both organisations). However, the analysis suggests that rather than moving from one view to the other (i.e. dissemination to utilisation), dissemination of knowledge remains an important strategy for both organisations. Participant B3ENT realises the importance of dissemination, but separates it from the ability to achieve impact. They suggest dissemination is:

> *"Very much a 'push out into the ether' model rather than a 'this is what this stakeholder needs to know to change their behaviour, how are we going to work with them to do that'. That 'one-to-many' [dissemination] has a place, but it's not what's necessarily going to achieve real impact".*

While the inclusion of more relational engagement strategies is similar for both organisations, the influences behind it are slightly different: for the PPP the move comes to primarily fulfil its own objectives and mission (meso-level influence). Participants from the University also thought that the University's role (meso-level), as a charity, necessitated more impact-related research; however, the influence from the public funders (macro-level) was seen as the major influencer of this.

Characteristics of knowledge outputs

Participants at both organisations discussed explicit knowledge forms as the predominant type of knowledge output. At the PPP, this revolved around completing projects and obtaining project outputs (e.g. new technologies) and then generating reports to disseminate the knowledge created from the project. In line with the need to attract a wider audience, the reports were perceived to be becoming less technical and, therefore, more suitable for a wider audience. Participant A10S at the PPP summaries a typical project output:

> *"We typically write for an informed policy maker, senior industry type person. We're trying to summarise for them, we're trying to focus on key messages, rather than provide all the analysis and all the evidence in a document…the majority are written more at 5 or 6 key headlines".*

Similarly, at the University, participants discussed explicit forms of knowledge as a major knowledge output. However, here the reports or other publications tended to fall into two categories: academic and non-academic. Participant B5SS summaries the knowledge outputs for their role in the University, distinguishing academic and non-academic reports:

> *"So we write academic papers obviously, because that's what we have to write. And that's probably the majority of the outputs. On [a specific project] we wrote a booklet…and this is a bit more digestible. So the whole project is summarised here, an overview. It's probably for industry, this is the sort of output that they might be more interested in. They're not going to read our academic papers, or rarely*."

Similarly, participant A10S at the PPP suggests that explicit knowledge outputs, as typical of a PPP project, can be a method to influence stakeholders *only* if in the correct format that is relevant to a potential stakeholder. This participant distinguished the PPP from the University through the type of knowledge output created:

> *"Very few people read everything that's written in academia, outside of academia. There's just too much of it. And if you want to have influence, you need to get crisper in your messages. Not be publishing 200 pages or essays, or reports which go through all the detail. That's not how you influence. There's absolutely a place for academic*

research and publications but trying then to have impact from them? I think they could be crisper in the way they're messaged".

As Table 6-2 shows, participants from both organisations have suggested reports or other forms of explicit knowledge are a major knowledge output of organisational projects. Participants have also acknowledged that a report needs to be in a suitable format in order to attract stakeholders and help them understand the output. However, the provision of reports does not necessarily result in a stakeholder utilising the knowledge to create action (Green et al., 2009).

PPP	Similar knowledge barriers	University
Focus on explicit knowledge in forms that people can read and understand	**DELIVERY OF EXPLICIT KNOWLEDGE INCREASES STAKEHOLDER AWARENESS OF KNOWLEDGE, BUT ONLY INCREASES KNOWLEDGE, *IF UNDERSTOOD*.** **DOES NOT EQUATE TO KNOWLEDGE UTILISATION**	Focus on explicit knowledge in academic forms for academia
Delivery of short key written messages to try and influence		Focus on explicit knowledge in forms that are suitable for non-academics

TABLE 6-2: FOCUS ON EXPLICIT KNOWLEDGE CREATES POTENTIAL BARRIERS FOR KNOWLEDGE UTILISATION

The macro-level analysis compared additional system-wide barriers that potentially inhibit knowledge utilisation. These appeared to be similar for both organisations. Table 6-3 identifies these potential barriers.

Factor	PPP	University
Knowledge accessibility	**The PPP's mission and objectives are focussed on technology development. Members and technologist were seen as the main stakeholders. The resulting knowledge activities and outputs can limit accessibility.**	**The University produces scientific papers and works with stakeholders on defined projects. However, engagement with the wider society to create action is difficult.**

Supporting quotes	*"Given the kind of knowledge capabilities you gathered here, it seems to me a waste that it only gets used for private sector members or 2 or 3 big government departments of interest… (we're) trying to push forward a bit more what we are doing and also broaden it to a wider market rather than just the niche engineer to engineer kind of market" (A2SE).*	*"How you present [research] to externals is really important…I think you should make the information accessible. I think about 95% of the information that we produce and the IP that we produce here about energy is inaccessible to lay people. I think we don't do enough to communicate our research in terms of perhaps web or inviting people along to see what we're doing in research. There's not a great deal of effort to lift the impact factor in that research by making it accessible to others. And I really do think that is the final piece of the puzzle really is making sure that we can all understand it" (B4OP).*
Fit-for-use (relevance)	**Technical knowledge and technical reports are only suitable for certain audiences. Engaging a wider audience means producing outputs relevant for all audiences and building relationships with the targeted stakeholders.**	**Understanding the context of what is important to people can aid the production of knowledge outputs that are fit-for-use.**
Supporting quotes	*"In terms of the policy makers, if you're going to deliver an impact on policy making, you have to engage, you have to understand those policy makers, you have to engage with them and give them the outputs of the work we've been doing, in a form that is relevant to the work they're doing on policy" (A1SE).*	*"We also do quite a lot of work, really understanding [public energy behaviours] because otherwise you are really making a lot of assumptions about what the energy data is telling you. So we would, go and talk to people and interview them, but also do quite a lot of observation work, videoing, asking them to keep diaries and take photos of certain things; so building up quite a lot of information about energy use. And then from that we would typically look at how we could develop an*

		intervention to change what they're doing" (B1ENT).
Stakeholder motivation to use knowledge	**Participants suggest that the PPP produces knowledge that is valuable to wider stakeholders. Therefore, relational activities with stakeholders must be geared to helping them realise the benefits of the knowledge to increase their motivation to use.**	**Participants suggested that researchers must consider what behavioural change is needed from stakeholders first, and then try to ascertain how they will motivate that behavioural change.**
Supporting quotes	*"(The PPP has) things that are valuable to people who are interested in policy or regulation or legislation or, consumers or whatever it might be beyond people who are interested in, just sort of you know, the engineering or technology development side of things" (A4S).*	*"(Researchers) have to think about what they want: what difference do they want to happen in the world because of their work? Who is it that has to change their behaviours to make that outcome happen? And do they know those people? How are they going to get to know those people? How do they influence those people with what routes to influence"? (B3ENT)*

TABLE 6-3: STAKEHOLDER FACTORS WHICH AFFECT KNOWLEDGE UTILISATION

The barriers presented here are in the context of engagement within the macro-level stakeholder environment. Interestingly these barriers were also seen to operate *between* organisational groups for both organisations (see meso-level analysis for more discussion) and on an individual level (see individual level analysis for more discussion). These barriers have to be overcome in order to increase the possibilities for stakeholders to utilise knowledge. The above analysis on the characteristics of knowledge outputs suggests different outcomes from producing explicit knowledge: raising the awareness of the knowledge through dissemination; and increasing the knowledge of the recipient, if knowledge barriers are overcome (i.e. knowledge is understood).

6.2.2. Stakeholder Roles And Responsibilities Within The System

The cross-case analysis reveals that perceptions of defined stakeholder responsibilities within the innovation system can affect the nature of knowledge activities that are undertaken. Subsequently, these perceptions can also influence how knowledge is utilised. Table 6-4 shows, for each organisation, the perceived role of the external stakeholders; the perceived role of the organisation

in relation to those stakeholders; and the knowledge activities undertaken to fulfil those perceived roles.

Group	Factors	PPP	University (discipline specific)
Role of main external stakeholders within system	Members	Financial investors	n/a
	Academics	Research partners	Linked to career development and academic utilisation; collaborators
	Government	Financial investors (members); decision makers; Influencers; create action/impact	Project funders; partners; collaborators
	Industry	Financial investors (members); project partners; commercialisation agents; create action/impact	Project funders; partners; provide real-life problems to solve; sources of knowledge application
	Society	Rarely mentioned (outside of scope of operations)	Provide real-life problems to solve (end-user focus); sources of knowledge application; recipients of public benefit
	Research Councils	Financial investors (members)	Project funders; set criteria for projects and project outcomes
Role of case study organisation relative to other system stakeholders	Knowledge scope	Develop and deploy technologies; facilitate 2050 energy targets	Create new knowledge; provide public benefit (as charity); application of knowledge to real life situations
	Knowledge creation	Provide evidence; demonstrate expertise; build credibility; technical knowledge; other forms of knowledge	Create original knowledge; demonstrate expertise; build individual reputation; disciplinary knowledge; interdisciplinary knowledge
	Knowledge utilisation	Lack of power to create action; increasingly to encourage others to utilise knowledge; commercialisation	Add to academic/disciplinary knowledge stocks for academic use (citation); create public benefit/impact; commercialisation

Knowledge activities dictated by perceived roles	Activities	Inform; facilitate 'informed decisions'; disseminate; increasingly to influence and create impact	Discipline specific; publications for academic/non-academic use; problem solving; theory building; hard and soft aspects (technology development to social change); achieve impact for social and economic benefit ('REF returnable')
	Mediums	Technical reports, non-technical reports; presentations; events to highlight work/build relationships	Academic reports; non-academic reports; presentations; conferences; events; board memberships
OVERALL INFLUENCE ON KNOWLEDGE UTILISATION		**PPP:** Perceived role of informer; explicit knowledge outputs; knowledge as object to be delivered (changing to influencer through interaction with stakeholders)	**Uni**: Discipline specific; knowledge outputs geared towards academia (for promotion); increasingly demonstration of impact from knowledge outputs

TABLE 6-4: MAIN STAKEHOLDER ROLES AND SUBSEQUENT KNOWLEDGE ACTIVITIES

The University has a wide variety of major stakeholders who fund projects and, therefore, provide the context in which knowledge creation and utilisation will occur. Each project is then managed according to this context. As noted in the previous chapter, the nature of the projects within the University varies greatly in scope and complexity; they are subject to the influence of disciplinary norms. The analysis suggests that working together with stakeholders on projects allows the University participants to solve project problems, which can incorporate technological advancements and/or behaviour change. The defining of knowledge utilisation criteria and subsequent processes to encourage knowledge utilisation were, therefore, seen to be driven externally, although mediated by academic autonomy. Participants at the University also discussed the public/society, suggesting that the University has a role, as a charity, to provide public benefit. The University participants tended to view government as partners or project funders, with each individual interaction dictating what forms of knowledge would be produced and defined utilisation criteria at the start of a project.

The PPP participants differentiated more between the role of government stakeholders and industry. They indicated that industry partners were pro-actively sought, with commercialisation of technology as the main source of project outcome. However, the organisation was also seeking to make an impact in industry by increasing confidence of industry members. Knowledge utilisation was predominantly seen as the commercialisation of products, despite this schema changing to encompass additional forms of knowledge utilisation. However, unlike the University participants, the PPP participants distinctly segregated the roles of informer (the PPP) and action creator (government).

The macro-level cross-case analysis has suggested that both organisations have made efforts to identify stakeholders, with each organisation giving priority to certain groups, either due to the perceived role of the organisation (the PPP) or the influences from the external environment (the University). The perceived roles of others within the innovation system also affected both organisations, though in different ways: the PPP had historically taken the role of informer, while others in the innovation system were seen to be the influencers; at the University, the role of funders and other peers were both key influencers of knowledge utilisation. There is an emphasis on explicit knowledge output due to: the perceived role of the PPP; and the cultural norms associated with academia (i.e. increasing knowledge through academic publications). Participants of both organisations recognised the need to produce documents in relevant forms for the potential knowledge user. However, even with the correct mediums, there were a number of barriers that existed for both organisations: knowledge accessibility; fit-for-use; stakeholder motivation; and stakeholder ability.

6.2.3. Funding Mechanisms

The cross-case analysis has revealed that the funding mechanisms that affect the type of knowledge activities undertaken and importantly, how knowledge utilisation is influenced within the innovation system. Table 6-5 summarises a comparative analysis of the funding factors that affect both of the organisations knowledge activities and influences knowledge utilisation. Although the University has additional funding mechanisms for teaching activities, the comparison focusses on research activities discussed in the interviews. The University relies heavily on external stakeholders for funding research projects. However, the PPP's receipt of funding is more secure, having been pledged at the establishment of the operation, despite the PPP only being a temporary organisation. This would suggest that the University is more susceptible to influences and demands from funders regarding knowledge utilisation: if external funders have the legitimate power to determine criteria as to how

knowledge will be utilised, the knowledge creators are more inclined to use that criteria as a basis for establishing what successful knowledge utilisation is.

	PPP	University	Similarities	Differences
Main funding mechanisms	Funds already secured at establishment of PPP (public and private investors/ members); PPP also acts as funder to individual projects	Individual researchers enter ongoing competitive processes for funds based on funder stipulations Funds received on project by project basis Specialist funding pool to create impact	n/a	Funds already secured in PPP and distributed Funds ongoing (competitively) applied for in University
Knowledge utilisation criteria	Knowledge utilisation criteria set at meso-level by organisation Knowledge utilisation expectations are revealed through organisational culture and norms; some influence from member organisations	Knowledge utilisation criteria set at macro-level by external funders Current focus is at planning stage of project (i.e. funding distribution subject to demonstration of planning for impact) Focus can be on academic or non-academic utilisation depending on funder requirements	Both organisations recognise the importance of knowledge utilisation criteria	University has greater degree of influence from external environment as to what impact is and how to demonstrate. Impact is related to funding at the University

TABLE 6-5: COMPARATIVE FUNDING FACTORS FOR BOTH ORGANISATIONS

In the case of the University, this can mean outputs targeted towards academic knowledge utilisation or enterprise knowledge utilisation. Public funders, such as Research Councils, increasingly require a demonstration of how impact, defined as some kind of public benefit, will be created, in order to receive the financial resources to commence the project. Subsequently, this may necessitate collaboration between disciplines in order to effectively create the desired impact. The knowledge activities at the University are, therefore, directly influenced by the macro regulatory environment. Knowledge utilisation at the PPP is less influenced by external funding mechanisms, and rather is embedded in the organisational mission and goals. Although this mission was influenced by initial funders, participants perceived this as an organisational influence.

6.3. MESO-LEVEL ANALYSIS

This section investigates the factors that were revealed to influence knowledge utilisation at the meso-level of analysis. The following section compares and contrasts the organisational structure, organisational level goals and the organisational support of knowledge utilisation.

6.3.1. ORGANISATIONAL STRUCTURE AND CULTURE

The organisational structures of both organisations were extremely different. The analysis suggests this difference results in diverse influences being exerted on knowledge activities and knowledge utilisation efforts. Table 6-6 illustrates the comparative characteristics of the organisational structure and culture of both case study organisations.

Aspect of organisation structure/culture	**PPP**	**University**	**Similarities**	**Differences**
Culture characteristics	Top down (mission driven)	Bottom up (school level driven)	Cultural norms influence staff perceptions	University has greater macro level cultural influence
Knowledge goals	Derived from organisational mission and goals	Discipline based; set at individual, school and external level	Knowledge goals linked to low carbon energy innovation	Greater macro level influence at University; meso level at PPP
Knowledge creation structure	Various programmes that segregated by technology with focus on cross-technical approach	Individuals working in research groups; strong disciplinary divides brought together by University (optional participation)	Segregated by background and discipline	Harder to coordinate across disciplinary divides in University
Interdisciplinary characteristics	Micro level interdisciplinary work (i.e. different technologies working together)	Macro level interdisciplinary work (i.e. different sciences working together); University support mechanisms encourage interdisciplinary 'energy' community (includes social sciences)	Focus on interdisciplinary work	University encompasses greater diversity of worldviews (i.e. technical and social work)

Structure	Different teams for project management (delivery of outputs) and exploitation (strategic outcomes)	Individuals and project teams responsible for delivering outputs and impacts	Projectised environments	University may not have a specific resource dedicated to impact generation
Promotion	Not tied to knowledge outputs	Tied to achievement of knowledge outputs	None	Opposite for both organisations

TABLE 6-6: COMPARATIVE CHARACTERISTICS OF THE ORGANISATIONAL STRUCTURES AND CULTURES

The University was seen to have a unique bottom-up culture: individual researchers worked within research groups, within disciplinary-based schools. Together these groups collectively become the University. Although the University has its own mission and goals, the cultural norms were seen to be strongest at the school level: Participants B1ENT, B2ENG, B5SS, B6SS, B9ENG, B10SS, B11ENG, B12ENG and B13ENG all illustrated a scenario that they deemed specific to that school. The University as a whole was, therefore, seen to act as a support mechanism to influence some kind of cohesion amongst the schools for knowledge creation projects (participant B3ENT suggested the University was the "glue" that holds the school together). However, this was not seen as a naturally occurring phenomenon, with there being strong disciplinary silos, characterised by different norms, cultures, administrative procedures and structures. These norms affected individual perceptions of knowledge utilisation, which were conceptualised quite differently within each school. Academic knowledge utilisation was particularly influenced by the school level norms, partly due to the peer review process, disciplinary norms and school level promotion criteria influencing academic career development. Non-academic knowledge utilisation was influenced from outside the University, with the University subsequently trying to permeate these ideas of non-academic knowledge utilisation throughout the schools via awareness initiatives and promotion criteria.

The nature of academic autonomy meant that individual researchers can ultimately choose to participate in any impact initiatives. However, the importance of impact was seen to permeate via memetic mechanisms: there has been a subtle shift in the cultural norms associated with the role of an academic, which increases the importance of achieving impact. Figure 6-3 is a depiction of the University structure and highlights where the pockets of influence of meso-level knowledge utilisation are (where 'I' relates to individuals). The PPP was characterised by a top-down culture, underpinned by holistic organisational goals and an overriding mission. The conceptualisations of knowledge utilisation were grounded in achievement of this overriding mission, with participants frequently referring to the mission as a purpose for carrying out knowledge activities. Despite this hierarchical, top-down structure, the organisation was seen to be divided at a programme/ project

level with varying objectives and also by individuals who were seen to possess different ideas of knowledge utilisation. Overall, the PPP has more meso-level influences on knowledge utilisation and less external influences than the University.

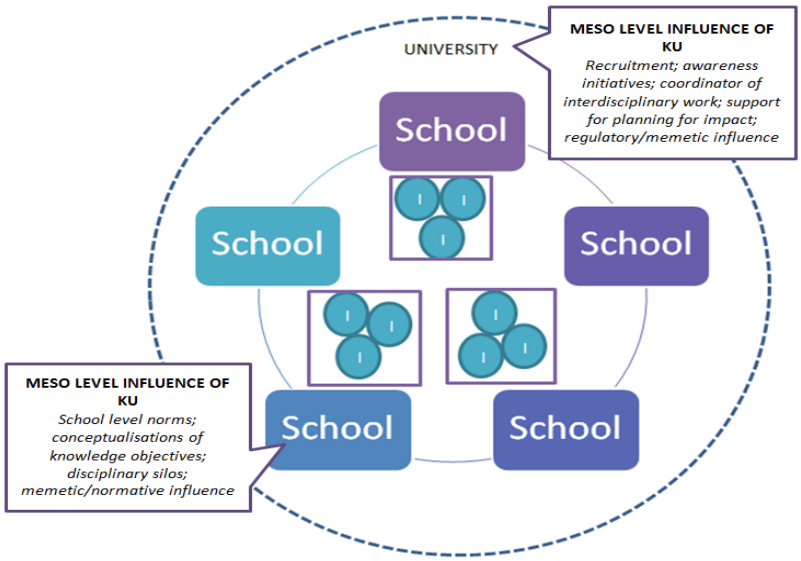


FIGURE 6-3: DEPICTION OF UNIVERSITY CULTURE WITH MESO LEVEL INFLUENCES OF KNOWLEDGE UTILISATION

Figure 6-4 is a depiction of the PPP structure, again with the meso-level influences of knowledge utilisation identified.

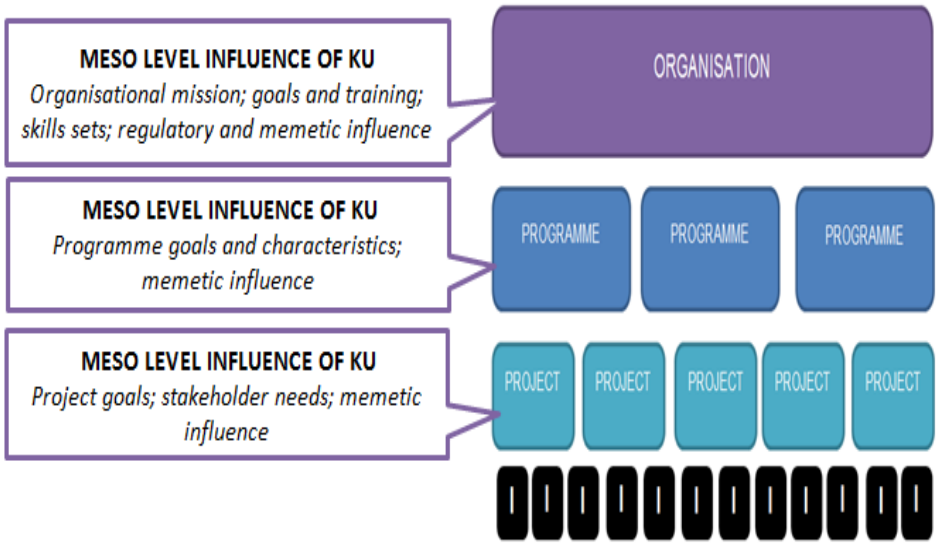


FIGURE 6-4: DEPICTION OF PPP CULTURE WITH MESO LEVEL INFLUENCES OF KNOWLEDGE UTILISATION

The different structures have been seen to lead to different perceptions of knowledge transfer and utilisation: the University is more substantially influenced from the external macro environment, whereas the PPP is more heavily influenced from within the organisation.

6.3.2. Organisation Goals And Activities

The goals of each case study organisation were operationalised at different levels, due to the different organisational structures, as mentioned above. This was seen to have different effects on knowledge utilisation. Table 6-7 summarises the key comparable factors relating to knowledge activities and goals.

Factor	PPP Influences	University Influences	Similarities	Differences
Overall goals and objectives	Organisation provides overall objectives to be pursued (top down)	Personal motivations and interests, school/research group objectives (bottom up)	All goals are low carbon energy related	Different structures mean goals are set/influenced by different levels
Nature of goals	Technology focused (develop and deploy techs); facilitation of national energy targets	Discipline specific; technology focused problem solving (e.g. engineers); social and behavioural change (e.g. social scientists)	Technology features heavily in both goal sets	University encompasses more social and behavioural change goals and greater consideration of context
Timeframes	Focus on long- term goals (e.g. mission statement) attained through the fulfilment of short term goals	Focus on project level goals	Timeframes around project goals	Long-term goals often neglect short-term actions; project goals neglect long-term monitoring of impact
Knowledge activities to fulfil goals	Provide credible evidence as a driver of knowledge utilisation	Academic or non-academic knowledge outputs	Focus on provision of explicit outputs	University has specific drivers for non-academic outputs (e.g. REF)
Perceptions of knowledge utilisations activities	Emphasis on 'exploitation plans' rather than operationalisation of exploitation plans	Emphasis on planning for impact to obtain funding; increasingly on implementation and measuring impact for REF	Emphasis on planning for utilisation/ impact (moving to implementing and measuring);	Macro level interactions (e.g. funding applications) influence university focus on planning
	Growing consideration of how relationship building can create action; understanding who needs to change behaviours to create action	Increasing recognition of importance of networks to create action/ influence; increasing recognition of need to measure impact	Growing realisation of importance of relationships (knowledge as a process)	Growing realisation of importance of relationships seen more comprehensively at the University

TABLE 6-7: COMPARABLE FACTORS RELATING TO KNOWLEDGE ACTIVITIES AND GOALS

The PPP, in line with its top-down hierarchical structure, was seen to have two overarching organisational goals to which all participants related. This included technology development and, subsequently, facilitating the attainment of national energy objectives in the form of reduced emission targets. These goals were seen to be long-term, with action needed in the short-term in order to successfully achieve the longer-term goals. The pursuit of these shorter-term goals was achieved at the programme and project level, with each project/programme devising plans on how the knowledge they produced would be exploited.

A great emphasis was put on the planning phase, but the workshops revealed a greater need to actualise the plans. However, this was seen as difficult, due to the complex system in which the PPP operated and the varied and changing motivations of stakeholders within that system. The culture of the PPP was witnessed to be changing through the series of workshops, which aimed at generating an understanding of the complexity of knowledge utilisation. In particular, it aimed to create shorter term *actions* to facilitate the attainment of longer term goals.

The main focus for specific knowledge activities was found in the role of an academic rather than that of the University as an entity. The role of the academic was enacted through individual interests the social norms of the individual disciplines and subject to influence from the external environment. Each discipline displayed different goal characteristics, which were fulfilled through a series of projects. Individual projects were seen to be the focus for goals, partly due to the individualised nature of project funding. Goals ranged from more tangible, problem-solving type goal (e.g. technology development, efficiency related goals or process improvements); to the more intangible, longer term goals (e.g. trying to achieve some kind of social change). These goals could also be seen to range from more theory testing (in relation to technology development) to more theory building (e.g. social sciences). This diversity presented many different activities and conceptualisations of knowledge utilisation.

The analysis suggests that both organisations have a tendency to focus on the planning stage for knowledge utilisation. However, within the PPP workshops, participant A8D questioned "*how do we link project plans with impact*?". There were calls for a 'model' that would aid successful knowledge utilisation. This perhaps indicated a perception of knowledge utilisation being a replicable, context-free process, where a single model would work for all situations. Participant A10S suggested they needed to review exploitation plans and "*throw rocks at [them] and challenge [them] to make sure [they're] working*", indicating a needs for adaptability, should the plans not work. While B3ENT from

the University stated "*At the moment [impact] is seen as something largely that you need to construct to get the grant, rather than a key part of the project, which is part of the problem*". Participants at both organisations felt that the emphasis on planning for knowledge utilisation and impact was largely due to challenges with implementing it in a complex environment. Participant A10S suggests that a challenge of delivering impact was the organisational tendency to focus on deliverable outputs that were less risky, rather than high impact outcomes that were risky and less controllable.

Both organisations were also similar in recognising the importance of relationships to create impact and encourage knowledge utilisation. However, at the University, more emphasis was placed on this aspect. Participants B1ENT, B2ENG, B3ENT, B4OP, B5SS, B6SS, B7ENT, B10SS and B12ENG all explicitly expressed how relationship building is an integral part of their knowledge utilisation activities and emphasised the need to understand stakeholder needs to create impact. At the PPP all participants identified networking as a key activity, but the context was networking to deliver messages to people. However, during the workshops, participants actively began to discuss who they would need to influence and how they would need to influence them in order to create opportunities for knowledge utilisation.

6.3.3. Organisational Support Of Knowledge Utilisation

The organisational support of both organisations was different due to the organisational structures, in particular the top-down versus bottom-up cultures. However, there were also similarities, as detailed in Table 6-8. The PPP has training initiatives that focus on the complexity of the innovation system and the need to understand stakeholder needs to try and motivate stakeholders to use knowledge (in line with organisational goals). Similarly, the University holds workshops that look generically at impact across research disciplines, but also specific to fields (including energy research). These convey: many types of impact that can be made with research work (e.g. Reed, 2016), the need for stakeholder analysis to try and understand stakeholder needs and to try and highlight the difference between project outputs and outcomes. Essentially, the realisation of the importance of context in knowledge interactions was observed in both sets of training. However, the University also focuses on the importance of monitoring and measuring impact, primarily to account for impact in the REF. Both the PPP and the University have challenges with resourcing knowledge utilisation and impact work. At the PPP, this was explicated by participant A11D:

"I think the exec team have realised that doing the project is not the end of the journey, and they've wanted us to focus on exploitation. At times, to be honest, we struggle to resource that. There hasn't necessarily been recognition about the workload associated with that".

Factor	PPP Influences	University Influences	Similarities	Differences
Training	Development workshops to highlight relational aspects of knowledge utilisation	Development workshops to improve engagement/social practice skills; skills needed to generate, measure and monitor impact	Emphasis on relational aspects/stakeholder needs as key to influencing knowledge utilisation	University more focused on measuring (for REF)
Resource planning	Difficult to resource exploitation due to time frames for relational activities; takes time away from delivering project outputs	School workload models favour research/teaching – difficult to quantify 'impact' work, particularly interdisciplinary; takes time away from writing papers	Difficulties in resourcing exploitation/impact work due to extended timeframes required; both have competing objectives (i.e. project delivery and academic writing)	University tries to quantify the time needed to fulfill impact work
Support functions	Organisational wide initiatives with executive support aimed at highlighting knowledge exploitation	Dedicated team which reviews 'pathways to impact' proposals; University as coordinator of interdisciplinary energy research	Executive and senior staff members support impact work	Top down v bottom up approach to support; normative/ cultural support at university instead of regulated

TABLE 6-8: COMPARABLE FACTORS RELATING TO ORGANISATIONAL SUPPORT OF KNOWLEDGE UTILISATION

Similarly, at the University participant B10SS suggested that the workload model does not adequately represent the time interdisciplinary, impact-driven projects take. Participant B6SS also suggested it takes a significant amount of time to network in order to make considerable impact with your research. The participants in both organisations suggested that knowledge utilisation and impact work takes significant time and is subject to the ability to build effective relationships (i.e. relational skills). In the PPP, this time is taken away from delivering other project outputs, whereas in academia, the time investment compromised the ability to write academic papers. Therefore, the

timeframes associated with relational models of knowledge utilisation, which view knowledge as a process, were difficult to plan for and manage, particularly relative to other work that has more tangible aspects (such as technology deliverables or papers), which can be completed over shorter time frames. Additionally, participant B3ENT suggested that specific skills training for impact was a necessity at the University:

> *"You've got to know where the impact is likely to be, keep tabs on it, keep measuring on it, be able to report it, publicise it. At the moment that's the job of the individual academic… [They] don't know how to do an evaluation because they haven't been trained to do it. They don't know what to look for, how often to look for it. So this is again something else we have to train people to do".*

Although both organisations had support functions for knowledge utilisation work, these were enacted in different ways, in part due to the cultural differences. The PPP offered support for knowledge exploitation work by having initiatives (with executive support) that emphasised the value of knowledge and knowledge exploitation within the organisation. This included delivering internal workshops to help develop skills for exploitation work. The University was seen to provide support in two main ways. Firstly, it offered dedicated support with applications for funding where 'pathway to impact' criteria were a stipulation to receiving funding. Secondly, the University helped interdisciplinary researchers join together through coordinating energy-related opportunities. However, the latter of these was seen as optional rather than through top-down regulated means. Both of these types of support were seen to help emphasise the importance of creating impact through stakeholder's utilisation of knowledge.

The meso-level cross-case analysis has illustrated how the differing cultures and structures of the organisations influence knowledge utilisation. At the PPP, the top-down structure influences knowledge activities through espousing the organisational mission and cultural/normative functions of the organisation. The delivery of project outputs (technology-based) and outcomes (action-based) is hard to combine under project goals. There are also no explicit promotional components tied to knowledge utilisation, unlike the University. Due to the nature of the University structure, academic autonomy and project-by-project funding, there were greater influences on knowledge utilisation as an inherent part of projects, mediated by disciplinary norms. The nature of the organisational goals and activities revealed both similarities and differences for the organisations. While at the PPP the focus was on long-term goals with a focus on technology, the University operated on wider

technological and social levels, with emphasis on project timeframes. Despite these differences, there were similarities in emphasis on planning for knowledge utilisation as opposed to implementing and measuring knowledge utilisation or impact. Both organisations espoused difficulties with resourcing relational work and suggested that the delivery of associated tangible outputs was somewhat easier to achieve. Training at both organisations was focused on relational aspects of knowledge utilisation, which views knowledge as a process instead of a transferable object. The next section analyses the comparative factors at the micro level.

6.4. Micro-Level Analysis

This section investigates the factors that were revealed to influence knowledge utilisation at the micro-level of analysis. The following section compares and contrasts the individual level motivations of participants and the individual perceptions of how value is created in each organisation in relation to the knowledge activities.

6.4.1. Implicit And Explicit Motivations

The analysis revealed similarities and differences between the two case study organisations. While academic autonomy was applicable only to the University, similarities were reflected in the willingness to engage with stakeholders.

The amount of individual autonomy held by staff to participate in knowledge utilisation activities was larger at the University, due to the organisational culture and academic norms. This meant that staff were encouraged, although not required, to attend training on enterprise and impact activities. Additionally, the career path of an academic was more individually defined depending on motivations.

There were similarities between the two organisations regarding engaging with stakeholders. At both organisations the analysis suggests that silos are created by disciplines/background. At the University, these were seen as disciplinary silos, with the University taking an active role as a cohesive agent, to bring together these disciplinary units. Challenges in interdisciplinary work were discussed, due to differing worldviews between disciplines, which sometimes affected project outputs. Similarly, at the PPP, participants reflected on how different backgrounds affected knowledge activities (e.g. engineers were seen to prefer engaging with other engineers). The analysis of both organisations suggests that individuals are motivated to engage with stakeholders who have similar experiences: being from different backgrounds or disciplines can act as a barrier to

knowledge utilisation. However, the pursuit of innovation goals can require engagement with a wide variety of dissimilar stakeholders, in order to motivate them to use knowledge. Therefore, skills sets to facilitate the engagement are important facets of encouraging knowledge utilisation for both organisations.

6.4.2. Individual Perceptions Of Value Creation

The analysis revealed similarities and differences between individual perceptions of value creation. Table 6-9 highlights the main factors from the analysis.

Factor	PPP	University
Disseminating knowledge and increasing awareness of knowledge creates value	Knowledge activities centre on dissemination of expert information, in line with perceived role to generate awareness; one way 'knowledge transfer' mind-set; focus on explicit knowledge in the form of publications and reports	Knowledge activities centre on dissemination of expert information; focus on explicit knowledge in the form of publications and reports
Increasing knowledge of stakeholders creates value (subject to stakeholders understanding knowledge)	Awareness that stakeholders have to understand the content of explicit knowledge (greater focus on providing context to facilitate understanding)	Awareness that stakeholders have to understand content of explicit knowledge (focus on providing academic and more digestible forms of explicit knowledge)
Stakeholders *using* knowledge creates value (action orientated)	Growing recognition of action needed by stakeholders to meet objectives (from organisational level); Growing recognition that networking and relationships building is an essential part of encouraging knowledge utilisation (from organisational level)	Value creation and impact can be cyclic (in accordance with REF submission dates); individual self-concept (e.g. associates with being an applied researcher).

TABLE 6-9: SIMILARITIES AND DIFFERENCES BETWEEN INDIVIDUAL PERCEPTIONS OF VALUE CREATION

Participants in both organisation indicated value is created through two main mechanisms: disseminating knowledge and stakeholders using knowledge. These two factors demonstrate differences in where the value can be found, which ultimately affect knowledge objectives. Disseminating knowledge has value in either increasing the stakeholder awareness of the knowledge or through the act of increasing stakeholder knowledge. However, the knowledge of stakeholders will only be increased if the previously identified knowledge barriers are managed and overcome. The second value creating mechanism identified in the analysis is increasing stakeholder holder usage of knowledge.

Literature suggests that even if knowledge is used by stakeholders, it may not be used as intended by the knowledge creator (e.g. Green et al., 2009). This suggests three value creating mechanisms: generating awareness of knowledge, increasing stakeholder knowledge, stakeholders using

knowledge and stakeholders using knowledge as intended by the knowledge creator. These are represented in the figure 6-5.

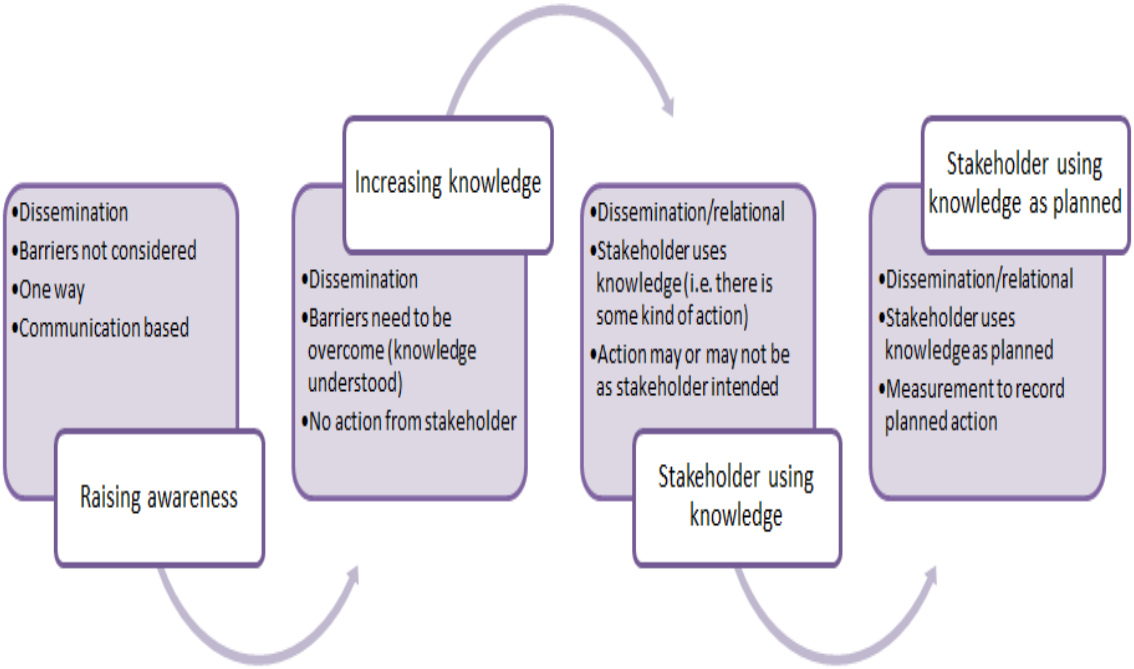


FIGURE 6-5: VALUE CREATING MECHANISMS DERIVED FROM ANALYSIS

The micro-level cross-case analysis has suggested how individual motivations and individual perceptions of value creation influence knowledge utilisation. The individualistic, bottom-up culture of the University makes these influences stronger. At the PPP, the organisational structure (i.e. projects are performed by organisational teams that all pursue the same goal) lessens the influence. While academic autonomy was absent from the PPP, a major similarity was the different world views held by participants and how this resulted in participants wanting to communicate and engage with those who held the same or similar worldviews. In the PPP this was based on people's backgrounds (e.g. engineers) and with the University the segregation occurred at discipline level. Lastly, individual perceptions of value creation were found to span two broad categories at both organisations: disseminating to increase knowledge (or awareness of knowledge); and stakeholders using knowledge to achieve action.

6.5. Synthesis Of Levels

This section aims to synthesise the factors that have been presented in the preceding sections of this chapter, providing an overview of the comparative analysis in order to better answer the research questions. Table 6-10 summarises the themes that emerged in the analysis in relation to the

research questions. The factors in italics represent aspects that were unique to that organisation. These factors are discussed in detail in the next chapter.

	PPP	UNIVERSITY
How is knowledge transfer perceived?	• Transfer of knowledge to raise awareness (inform) and/or increase recipient knowledge; commercialisation; knowledge as an object • Increasingly to create action through exploitation of knowledge; knowledge as a process	• Transfer of knowledge to raise awareness and/or increase recipient knowledge (both academic and non-academic); *knowledge* as an object • *Create action through citations (academic)* • Generate impact (enterprise); knowledge as a process
What types of knowledge activities are undertaken to realise knowledge related goals?	• Projects aiming to deliver outputs • Exploiting knowledge beyond project for wider stakeholders • Reports; presentations; awareness events; workshops	• Interdisciplinary knowledge creation to solve complex social problems • Projects aiming to deliver academic outputs, tangible outputs and increasingly creating impact (discipline specific) • Publications; dissemination of reports; presentations; workshops
What are the systems influences of knowledge transfer?	**Macro-level** • *Perceptions of stakeholder roles within the innovation system (e.g. who takes action within the system)* • Ability to identify stakeholders • When stakeholders are identified and engaged • Ability to establish stakeholder needs (what will motivate them to use knowledge)? • Ability to identify and overcome barriers through knowledge activities • Ability to differentiate between generating and awareness of knowledge; increasing stakeholder knowledge; and motivating stakeholders to use knowledge utilisation (and creating knowledge activities around these)	**Macro-level** • *Strong influences from macro-level* • *Criteria set by funders or project partners about knowledge goals on project-by-project basis* • *Academic peers* • *Perceptions of own role in system* • Ability to identify stakeholders • When stakeholders are identified and engaged • Ability to establish stakeholder needs (what will motivate them to use knowledge)? • Ability to identify and overcome barriers through knowledge activities • Ability to differentiate between generating and awareness of knowledge; increasing stakeholder knowledge; and motivating stakeholders to use knowledge utilisation (and creating knowledge activities around these)

	Meso-level • *Organisational structure – greater influence from meso-level* • *Organisational goals and mission (long term)* • Organisational training and support • Ability to plan and implement knowledge related activities • Skills sets • Adequate resources: *management of tension between what is deliverable and what is impactful* • Activities undertaken (importance of relational activities)	**Meso-level** • Organisational culture • *Recruitment and promotion criteria* • *School level norms* • *Individual project goals and objectives (project complexity)* • Organisational training and support *(optional)* • Ability to plan and implement knowledge related activities • Adequate resources: *management of tension between academic and non-academic outputs* • Activities undertaken (importance of relational activities)
	Micro-level • Ability and motivations of individuals to engage with a wide range of stakeholders (engaging with different world views) • Individual understanding of how value is created (through increasing knowledge or encouraging use of knowledge)	**Micro-level** • *Academic autonomy* • *Pursuit of individual career goals* • Ability and motivations of individuals to engage with a wide range of stakeholders (engaging with different world views) • Additional skill sets for monitoring and measuring impact

TABLE 6-10: SUMMARY OF THE FINDINGS IN RELATION TO THE RESEARCH QUESTIONS

Figure 6-6 shows the main institutional influences on knowledge utilisation for both organisations. The blue lines are the University influences and the orange lines the PPP influences. These have been grouped into regulatory, normative and cultural-cognitive influences (Scott, 2001). The figure highlights the greater influence and interaction from the external environment that the University experiences. These influences shape perceptions of knowledge utilisation and the subsequent activities undertaken to achieve knowledge related goals. However, the PPP is not subject to the same influences (particularly at the pre-project stage). Instead the perceptions of knowledge utilisation were built on the organisation's goal and mission, and how individuals saw their role in relation to other stakeholders. Concurrently, the meso-level to micro-level interactions at the University were seen to be founded in school level norms and expectations, with increasing influence from the University in the form of recruitment and promotion criteria being more heavily geared towards the ability to demonstrate impact and enterprise related work.

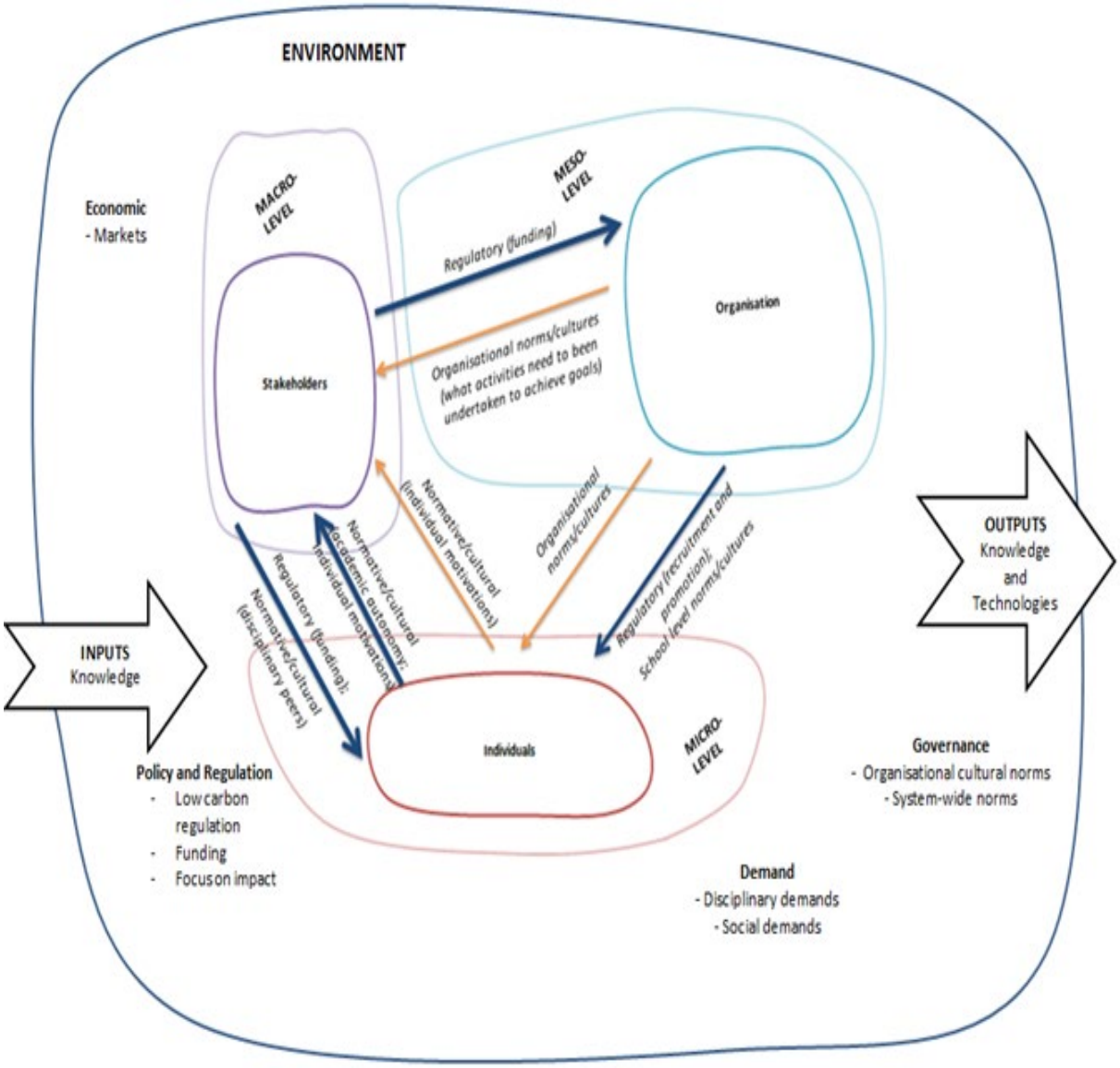


FIGURE 6-6: THE MAIN COMPARATIVE INFLUENCES OF KNOWLEDGE UTILISATION FOR BOTH ORGANISATIONS

6.6. CHAPTER SUMMARY

This chapter presented the cross-case analysis, comparing the similarities and differences between the organisations to offer insights for the research questions posed. The findings suggest that, although the stakeholders of both case study organisations were similar, a number of factors influenced how knowledge utilisation was perceived when considering these stakeholders. The culture and structure of both organisations influenced the types of knowledge activities undertaken and result in differences in the types of influence on knowledge utilisation. The University was more exposed to influences within the external environment, with funders and peers heavily influencing the individual researchers towards academic or non-academic knowledge utilisation, through regulatory or normative/cultural mechanisms. However, the PPP was shown to be less influenced by

the macro environment. Instead, perceptions of knowledge utilisation were seen to be grounded in meso-level organisational mission and goals. Similarities between the organisations occurred in the emphasis on explicit knowledge and dissemination activities. Additionally, both organisations experienced the same knowledge barriers. This was seen in part to be a result of individual preferences to engage with those of the same world-view (i.e. same disciplinary cohort or background). The next chapter incorporates the literature review, the analysis and new literature to produce a discussion of the themes and factors that emerged during the study.

CHAPTER 7: DISCUSSION

7.1. INTRODUCTION

This study has utilised two case studies to explore the influences of knowledge transfer within a defined innovation system. It has adopted an innovation systems approach to address gaps in extant literature and to facilitate answering the following research questions:

- What knowledge activities are undertaken to realise knowledge-related goals?
- How is knowledge transfer perceived by those creating knowledge?
- What are the system wide influences on knowledge transfer?

It has explored and analysed the complex nature of interactions occurring at and between the various system levels, to reveal the influences on knowledge utilisation.

The purpose of this chapter is to discuss the main findings from the study, incorporating the literature review (Chapter 2), the analysis (chapters 4-6) and introduce new literature which addresses the themes and factors which have emerged throughout the study. This chapter aims to contribute to a better understanding of how knowledge transfer is perceived and explore the influences of knowledge transfer that occur within and between the levels of the innovation system. Ultimately, a greater understanding of these influences can contribute to effective practices that recognise and respond to system complexity, and maximise the opportunities for knowledge utilisation to occur, in line with the established aims and objectives of this study.

This chapter commences with a discussion on the terminology and conceptualisation of knowledge utilisation that were perceived by study participants (section 7.2). It explicitly distinguishes between knowing and using in an attempt to clarify these concepts in order to reduce confusion for knowledge workers. It then investigates the innovation system influences that were perceived and analyses how they affect knowledge utilisation (section 7.3). It then reviews the different views of knowledge (as-an-object and as-a-process) that were revealed by the study and how they affect knowledge utilisation (section 7.4). The chapter concludes by developing guiding principles which consider how to maximise the opportunities for knowledge utilisation, by distinguishing it from knowledge transfer (section 7.5).

7.2. Clarifying Concepts And Terminology Associated With Knowledge Utilisation

The literature review highlighted that there is a plethora of terms utilised in both theory and practice, which represent either the whole process of turning knowledge into action or specific components of this process. Similarly, Reed (2016:9) suggests there are many terms that are used to describe how "impacts occur through processes of knowledge exchange and the co-production of knowledge". Throughout the analysis the exact language that was used by participants within each organisation has been presented to remain true to what each participant perceived (in line with the research questions). This included many terms, such as knowledge exchange, knowledge exploitation, knowledge utilisation and impact. Graham et al. (2006) suggest that the vast catalogue of terms can create confusion amongst academics, practitioners, policy makers and the public, contributing to ineffective mechanisms for overcoming the knowledge to action gap. The analysis found this to be particularly important within the academic sector, where terms such as 'impact' and the related impact objectives were seen to be founded within the wider macro environment (i.e. established by funders such as Research Councils external to the University). Importantly, the ability to secure funding was seen to be subject to understanding and demonstrating the potential to meet these externally set objectives. Graham et al. (2006:22) further state that "consensus on terms and definitions is essential if knowledge producers and implementers and users are to effectively and meaningfully communicate with each other". This need for consensus can be applied to both case study organisations as knowledge produces and their stakeholders as implementers. This section aims to elucidate some of the terms used in the literature and provide greater clarity and synthesis for the many stakeholder groups who use the terms. The increased clarification of terms can facilitate the defining and pursuing of knowledge utilisation goals, within the bounds of any wider organisational and project objectives. This section firstly draws a useful distinction between knowing (increasing knowledge) and using (utilisation of knowledge) through the review of existing conceptualisations and the data analysis within this study. It then evaluates the relationship between knowledge utilisation and impact before discussing the differences between planning for knowledge utilisation and implementing knowledge utilisation; both key activities in motivating stakeholders to utilise knowledge.

7.2.1. From 'Knowing To Using'

Rich (1997:15) proposes four widely cited conceptualisations of knowledge utilisation (see Figure 7-1).

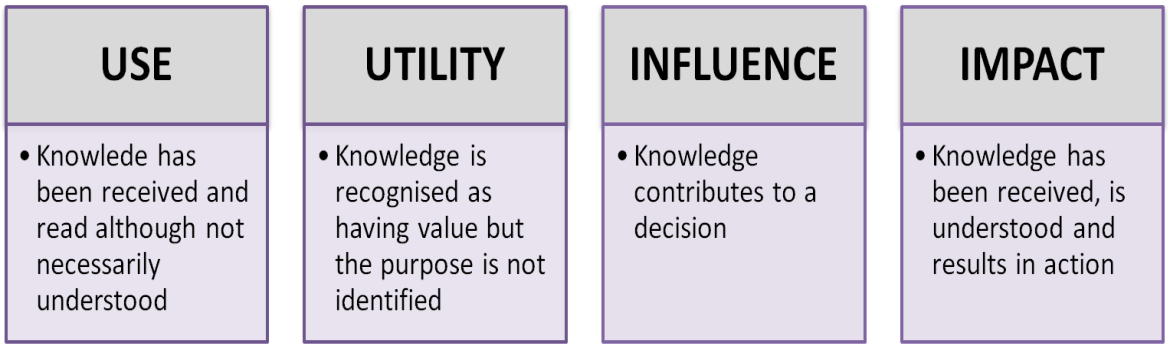


FIGURE 7-1: FOUR CONCEPTUALISATIONS OF KNOWLEDGE UTILISATION (RICH, 1997:15)

Rich (1997:15) does suggest that there is no widely accepted definition of what 'use' is, but does distinguish between the use of knowledge and the dissemination of knowledge (with dissemination being seen as purely a "channel of transmission"). However, this study suggests that all of these categories may not equate to knowledge utilisation and may not facilitate the achievement of all organisational or project knowledge related goals. Three important factors were revealed through the analysis. Firstly, and in line with Rich's comment above, dissemination activities or the transfer of knowledge from one place to another does not guarantee knowledge utilisation. These activities may increase the knowledge of those who receive it, if they are able to understand it, or have adequate absorptive capacity (Tortoriello, 2015; Bishop et al., 2011; Zahra and George, 2002). However, projects tied to goals within socio-technical innovation systems, may require behavioural change or action by the stakeholders in order to meet established goals. This leads to the second factor: technical and social objectives may need differing knowledge utilisation goals and activities. Whilst technically focussed projects may require that technologies are developed, the implementation and use of such technologies requires greater and more complex levels of knowledge utilisation, potentially involving a large number of stakeholders. The clarification of any objectives (both short- and long-term) is, therefore, vital to establish what knowledge utilisation activities and measures of success are required by the research project participants. Thirdly, in order for knowledge utilisation to be successful, it is necessary to measure the outcomes of knowledge utilisation *against organisational or project goals*. With these three factors in mind, it is useful to map the continuum of 'knowing to using' onto Rich's model in order to clarify what knowledge utilisation encompasses, as suggested by the data. The distinction between increasing knowledge (knowing) and motivating others to apply knowledge (using) can facilitate any organisation or project goals, as can the distinction between the knowledge utilisation process and the outcomes of knowledge utilisation. Figure 7-2 illustrates how each conceptualisation of Rich's model can be viewed as 'knowing or using'. It also introduces the third category 'know-of' that was present in the analysis, which indicates an awareness of information although not necessarily an increase in

knowing. This category distinguishes between information and knowledge, suggesting that the delivery of information does not necessarily lead to knowledge utilisation, depending on recipient characteristics.

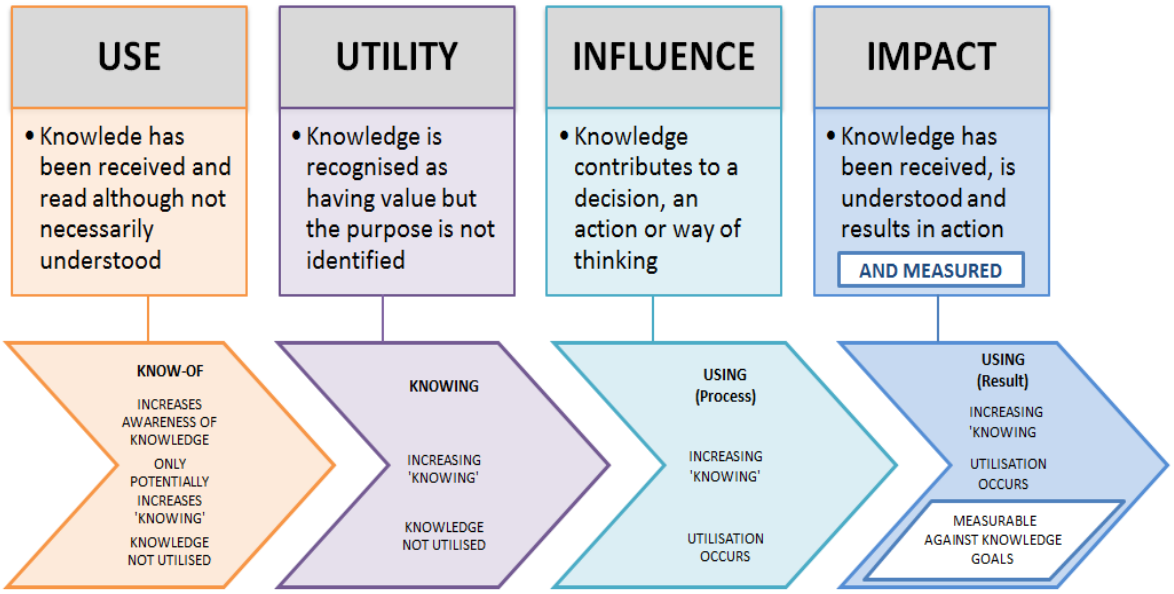


FIGURE 7-2: ADAPTED FOUR CONCEPTUALISATIONS OF KNOWLEDGE UTILISATION (ADAPTED FROM RICH, 1997:15)

These can be applied to Rich's model as follows:

- Use (know-of): the information has been received although not necessarily understood (and therefore arguably not knowledge). Stakeholders awareness of relevant information is increased, although increasing 'knowing' is only a potential based on both creator and recipient characteristics (e.g. has the knowledge been transferred with relevant medium and content? Does the knowledge recipient have adequate absorptive capacity to increase their own 'knowing')?
- Utility (increasing 'knowing'): the knowledge has been received, although its purpose is unidentified. Whilst 'knowing' may be increased, the inability to understand how to apply the knowledge to capture value for the recipient inhibits knowledge utilisation.
- Influence (increasing 'using'): the process of increasing knowledge and motivating utilisation. A decision or an action is undertaken by the recipient; however, this outcome is not measured.
- Impact (increasing 'using'): the result of knowledge utilisation; an action is undertaken by the recipient. Impact is proactively pursued by the creator and is measured against knowledge creator goals.

Dividing these conceptualisations, theoretically, illustrates the differences between awareness of information (know-of), knowing and using. Practically, this distinction can aid knowledge creators in determining relevant knowledge goals and activities, in line with their own organisational objectives. It highlights the difference in outcomes between increasing knowing and motivating others to use knowledge. It further suggests that knowledge can be utilised in ways that create and capture value, in alignment with Wood (2004), who suggests that in order for innovation to be successful value must be created and captured. It elucidates that the achievement of organisational knowledge-related goals can be facilitated through the monitoring and measurement of knowledge utilisation.

The next section will explore the concept of creating impact, particularly in relation to academic activities, and relate these conceptualisations to knowledge utilisation.

7.2.2. Clarifying The Concept Of Impact In Relation To Knowledge Utilisation

This section aims to draw distinctions between the conceptualisations of impact and knowledge utilisation based on the study analysis. Again, this theoretical clarification can facilitate knowledge creators with establishing (and subsequently measuring) knowledge goals and activities that facilitate the achievement of overall organisational goals.

Impact can be defined in a number of different ways. The Research Councils UK, who were identified in the study as a major funder for academics, define impact as *"the demonstrable contribution that excellent research makes to society and the economy"* (Research Councils UK, 2014) and suggest that impact can be academic or societal and economic. The London School of Economics (LSE) define impact as: *"a recorded or otherwise auditable occasion of influence from academic research on another actor or organization*" (LSE Public Policy Group, 2011:11). They further state that impact can be defined as academic: "*when the influence is upon another researcher, academic author or University*" or external when "*influence is achieved upon a non-academic organization or actor in a sector outside the University sector itself*" (LSE Public Policy Group, 2011:11-12). This study has suggested that due to the intensity of macro-level influences in academic career development, there is a perceived need (particularly for early career researchers) to primarily focus on delivering academic impact in order to develop reputation. However, both the literature review and the data from the study suggest that impact is becoming: an increasingly important component of academic career development; an indicator of research quality; and a mechanism to distribute funds at both an organisational level and individual/project level (e.g. Hicks, 2012; Smith et al., 2011). This is particularly visible through the attention that academic participants

gave to the REF. For the purposes of the REF, impact is defined *as "any effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia"* (REF, 2011). Within each impact case study that must be submitted for the REF, both the reach (the spread or breadth of influence or effect on the relevant constituencies) and the significance (the intensity or the influence or effect) are used as measurement criteria. All of the above definitions indicate that some change, influence or benefit needs to happen in order for impact to occur, and the change should be verifiable, not just an assumed outcome from the research.

Reed (2016:10) propose five types of impact (see Figure 7-3), suggesting that some types of impact may be more tangible that other (i.e. instrumental impacts are the most tangible). This, as well as the perception that instrumental impacts are more highly scored in the REF, is leading to academics focussing on these types of impact, whilst undervaluing the other forms (Reed, 2016).

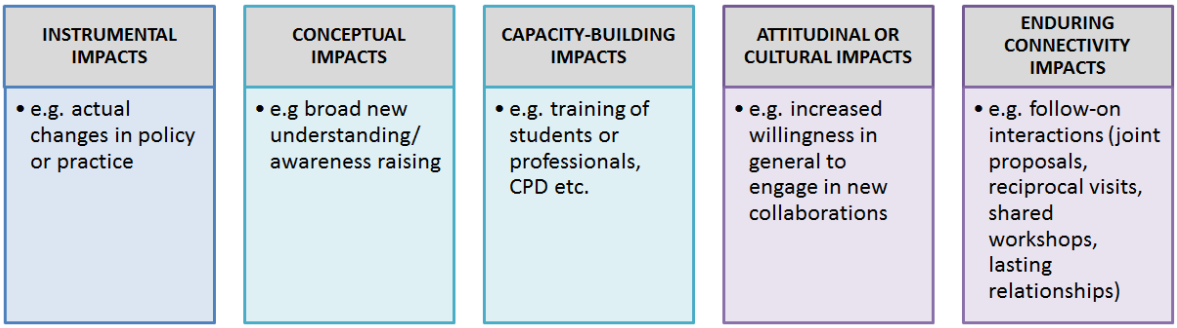


FIGURE 7-3: FIVE CONCEPTUALISATIONS OF IMPACT (REED, 2016:10)

Both the definitions of impact provided above, and the analysis, suggest that impact is a measurable change. Knowledge utilisation, therefore, can be considered a process by which to achieve that change. Figure 7-4 demonstrates how the different impacts proposed by Reed (2016) can be considered in relation to knowledge utilisation. Importantly, all of these types of impact do influence some kind of change, whether that is a change in relationships (enduring connectivity) or actual changes (instrumental). Underpinning these different types of impact is the ability to link the impact outcome to any established impact goals (i.e. to increase awareness, knowing or using). This study has suggested that impact goals for academic research are largely determined by external bodies and the ability of the academic sector and individual researchers to understand what is meant by impact. From the definitions above, the definitions of impact by external stakeholders, often encompasses actual (instrumental) changes. Therefore, the goals of any project need to be aligned with what impact is sought by funders or other project stakeholders, and defined against

Reed's (2016) different types of impact. The discussion so far has also revealed that impact and knowledge utilisation can be conceptualised differently: knowledge utilisation may include the ability to create an impact; however, creating an impact does not necessarily entail the utilisation of knowledge.

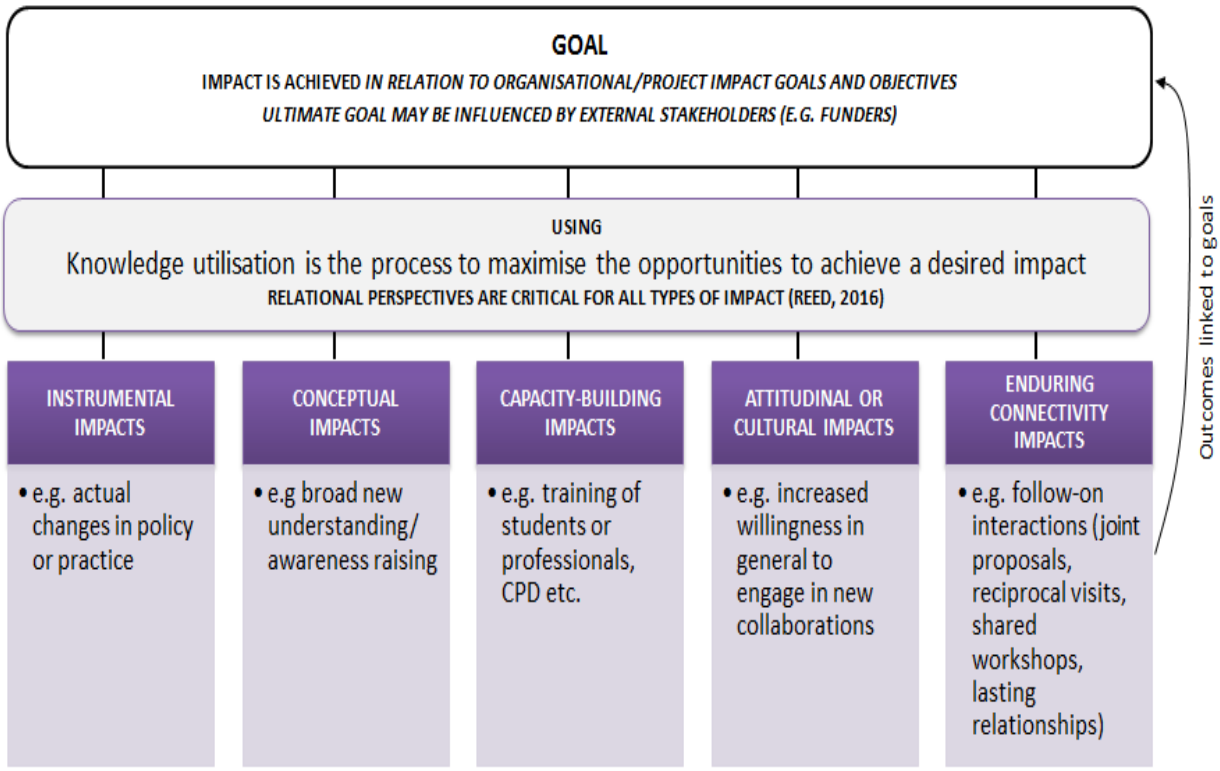


FIGURE 7-4: FIVE CONCEPTUALISATIONS OF IMPACT AND THEIR RELATIONSHIP TO KNOWLEDGE UTILISATION (ADAPTED FROM REED, 2016:10)

Based on the above theory, and the aforementioned proposed differences between knowledge utilisation and impact, new definitions are offered here, which clarify the two terms. Knowledge utilisation is a value creating *process* that encompasses the ability to motivate knowledge recipients to use knowledge in a way which contributes to predetermined objectives. In line with the study findings, this definition: raises the importance of motivating users as a key factor in achieving knowledge utilisation; emphasises the relational aspects of knowledge utilisation that this study has found to be important; and explicates the necessity of the eventual knowledge use being in line with goals. Impact is the *measurable change* achieved through knowledge activities that facilitates the achievement of predetermined objectives. This definition suggests that impact is a broader change, which is dependent on the ability to build relationships.

This section has built on existing theory to offer clarification of what knowledge utilisation and impact are. It has further offered new definitions of both of these terms. The next section clarifies two components of knowledge utilisation: planning knowledge utilisation and implementing it.

7.2.3. Differentiating Between Planning And Implementing Knowledge Utilisation

A key finding of the study is the importance of distinguishing between planning and implementing knowledge utilisation, with the study proposing that these two components require different activities and skills. In both case studies, it was found that *planning* for both knowledge utilisation and impact creation was well developed. The University provided support mechanisms for individual researchers and project groups to meet impact requirements set by public funders at the application stage. This involved understanding what funders wanted from 'pathways to impact' statements so as to optimise the probability for obtaining funding. The PPP was seen also seen to develop knowledge exploitation plans as part of the planning stage, albeit with a focus on commercialisation as the main form of intended knowledge utilisation (i.e. technology focused goals). In essence, the planning stage for both case studies was a static phase, where plans were made in somewhat isolation from the real-life influences that affect actual knowledge utilisation. The study finds that *implementing* these plans was a more difficult task, due to: the long time frames involved in reaching innovation objectives; the relational processes needed; the complex and dynamic nature associated with a system; and the differing skills needed to implement plans. The difference between planning and implementation was apparent at the University: whilst impact plans have to be completed as part of a competitive bid for public funds, there is a need to fully incorporate the impact goals into the implementation of the research project. Due to this, knowledge utilisation is mainly perceived as a planning process. It was noted that this is liable to change due to public funders becoming more stringent on ensuring public benefit is actually achieved. However, the potentially long-time frames involved in realising knowledge utilisation mean that some aspects of it, may happen after predetermined project completion dates. Similarly, the PPP case study illustrates that planning for knowledge exploitation has resulted in a number of plans being drawn up, but the implementation of these plans was seen to be secondary to delivering the physical outputs of the projects (i.e. new technologies or reports instead of measuring against actual knowledge utilisation).

Another difficulty in implementing the plans appears similar for both organisations, with suggestions that it is difficult to measure knowledge utilisation in a systems environment that is characterised by multiple influences. The study supports work that finds that the dynamic nature of the flow of knowledge (Rich, 1997) combined with complex and often irrational systems influences (e.g. Dunlop,

2014; Gredig and Sommerfeld, 2008; Head, 2010; Jordan and Russel, 2014; Wood, 2004) mean that implementing knowledge utilisation activities as planned is a challenging task. A complex system requires actors in an innovation system to create a shared institutional logic so that systems goals can be achieved (e.g. Hogstrom and Tronvoll, 2012; Weick, 1995). The study goes further to suggest that knowledge creators need to be embedded in the innovation system, not only to create this shared logic, but also to amend these shared logics in response to ongoing systems changes.

The study finds that different skills and activities are needed for planning (a static process) and implementation (a dynamic process). The necessary skills for knowledge utilisation are discussed further in section 8.3.3.4. It further supports theoretical work that advocates knowledge utilisation as a relational task (Heinsch et al., 2016), emphasises the importance of relational ties (Dhanaraj et al., 2004; Fang et al., 2013; Jiang, et al., 2013) and that value in systems is created in a social context (Hogstrom and Tronvoll, 2012). The following section goes onto to discuss the nature of the innovation system and the perceived systems influences.

7.3. INNOVATION SYSTEMS

The comparative study revealed that there were both similarities and differences pertaining to how innovation systems influence knowledge utilisation between the two case study organisations. As presented in the literature review, Edquist (1997) suggests that all innovation systems are subject to the institutional influences and that actors within the systems operate interdependently. Additionally, the Triple Helix model (Etzkowitz and Leydesdorff, 1998; 2000) suggests that the two case study organisations are part of a triadic arrangement, which helps build knowledge infrastructures within the innovation system.

This section analyses the institutional influences of knowledge utilisation and the need to be embedded in the innovation system. It appraises the skills needed in order to maximise the opportunity for knowledge utilisation before critiquing hard and soft aspects of the innovation system. Lastly, it evaluates the Triple Helix model of innovation, suggesting that effective knowledge infrastructures are not automatically formed, and knowledge boundaries still exist.

7.3.1. INSTITUTIONAL INFLUENCES OF KNOWLEDGE UTILISATION

The literature review has discussed the importance of innovation systems approaches where it was noted that there is a gap, particularly within the low carbon innovation literature, as to empirical investigations that consider a wider system perspective (e.g. Bale et al., 2015; ICCEPT, 2003).

Therefore, this study has aimed to contribute to the knowledge in that area by exploring the wider systems influences of knowledge utilisation. This section evaluates the nature of the systems influences that were shown in the analysis and how they affect knowledge utilisation.

Edquist and Johnson (1997) suggest that all innovation systems have certain characteristics, including: innovation and learning; holistic and interdisciplinary; interdependence and non-linearity; conceptually diffuse; and subject to institutional influences. The study has empirically revealed the presence of these characteristics and this discussion suggests how they influence knowledge utilisation. Building on this, the study finds that these systems characteristics make it imperative for knowledge creators to respond to these influences by becoming embedded in the innovation system. That is, to proactively understand the needs of potential knowledge users within the system in order to maximise the likelihood for knowledge utilisation to occur as planned.

When considering institutional influences and how they affect knowledge utilisation, it is useful to use Scott's (2001) three pillars of institution influence to explore the different types of influence and determine which influences are stronger. Scott (2001) suggests three types of influence that can affect how systems operate: regulative; normative; and cultural-cognitive, which provides a useful framework for discussing the different types of influence of knowledge utilisation (see section 2.2.1). Within the University, the analysis indicated that normative and cultural factors, such as academic career development norms, disciplinary norms and academic autonomy heavily influenced a perceived need to pursue academic knowledge utilisation as a priority. The study suggests that regulative mechanisms have given more prominence to non-academic knowledge utilisation through the need to generate impact plans and measures as part of a competitive funding bid. Despite the growth of this impact agenda, the study proposes that the larger influence still remains that of academic promotion as achieved through reputation, publications and the academic peer review process.

While the impact agenda seems to be a growing influence on the knowledge activities undertaken, the nature of academic promotion and academic autonomy mediates how strong this influence can be. It was also found that normative influences (in the form of disciplinary norms) affected the balance between academic and non-academic utilisation. This was enacted at school level, suggesting that disciplinary norms were a more predominant influencer of knowledge utilisation, rather than the University as a whole. The University (as an organisation) was shown to slightly influence knowledge utilisation through the provision of support mechanisms. However, this is

again subject to the counter-influence of academic autonomy (i.e. individuals can choose whether to engage with the support mechanisms depending on the individuals perceived needs). Therefore, the study suggests that cultural-cognitive and normative influences are a strong counter to any regulatory mechanisms that are adopted. The study also highlights the uniqueness of academic culture and the continuing dominance of Mertonian norms (e.g. Nowotny et al., 2003; Schoonmaker and Carayannis, 2012; Slaughter and Rhoades, 2004). That is, whilst a researcher may work at a particular University, regulatory, normative and cultural influences are set and regulated from outside of the University. Extant literature suggests an eroding of academic autonomy (Slaughter and Rhoades, 2004) which affects the types of knowledge task undertaken and the subsequent knowledge utilisation that is achieved (Hicks, 2012; Smith et al., 2011; Zalewska-Kurek, 2016). The study suggests that normative and cultural influences restrict this proposed erosion slightly. Instead of the erosion of academic autonomy as presented in the literature, the perceived role of an academic has become a dual one, which encompasses both academic and non-academic knowledge utilisation: the one role does not necessarily erode the other. Indeed, the normative influences, such as career development and peer review were seen to be the stronger influence, in general, on the academic role and heavily influenced researchers towards academic knowledge utilisation through publications.

The normative and regulative requirement to pursue impact or non-academic utilisation was seen to work on paper (i.e. workload models) but in practice was difficult to achieve due to complexity and resource constraint. There was also perceived to be only limited recognition for this type of work. This discussion leads to a number of considerations for public funders, universities and researchers. When considering the introduction of more regulative based mechanisms in order to increase non-academic knowledge utilisation, the strength of normative and cultural influences need to be deliberated. The study finds that the cultural influences remain very powerful and difficult to change, with the nature of the academic role making academic knowledge utilisation imperative for a successful career. Additionally, methods need to be established to practically measure and manage time allocation for impact activities. This work supports work (e.g. Graham, 2015) that suggest that although workload management can be evaluated as a functional process, there are socio-institutional consequences from these models that need to be assessed. Such consequences include how they affect both the academic role and the knowledge outputs of researchers. In the University case, the study suggested that there was incongruence between the functionality of being tasked with impact work, practical implications of undertaking the work and the recognition for actually completing it.

Interestingly, knowledge utilisation within the PPP was also governed by normative and cultural influence, despite being a top-down hierarchical organisation. The norms associated with certain professions or backgrounds within the PPP, dictated the type of knowledge activities undertaken. For example, it was suggested that engineers liked to talk to other engineers due to similar contextual languages and thematic cohesion, where individuals had interests in the same specific technologies. This supports the work of Dawes et al.'s (2012) on contextual distances, where it is proposed that the smaller the contextual distances the easier the knowledge flows. In this instance, the smaller the cultural, relational, language, knowledge and technical distances, the more easily knowledge flowed between these people. However, Dawes et al. (2012) study does not consider the need for knowledge to be utilised, rather it only explores knowledge flows between actors. This study highlights that in this complex socio-technical innovation system, there is a need for knowledge to be received and utilised by a wide-range of dissimilar people (therefore, in circumstances where there is a larger contextual distance). It has been discussed that within the University there were different perceptions as to what the role of an academic encompasses (i.e. pursuit of academic or non-academic utilisation). Within the PPP there were also individual perceptions and beliefs about what the role of the PPP was, which affected how knowledge utilisation was perceived. Participants talked about the role the PPP played as an informer to other actors within the innovation system. This widely held belief led to knowledge activities that consisted of disseminating information to others, rather than explicitly trying to influence them to achieve impact. The PPP was managing this common belief through the provision of training to clarify what knowledge exploitation actually entailed. As with the University, the cultural influences (common beliefs) proved a powerful influence on how knowledge utilisation was perceived and enacted.

The use of institutional perspectives to define the types of influences within the innovation system, begins to address recent calls to improve the understanding of the institutional attributes of innovation systems (e.g. Andrews-Speed, 2016). Furthermore, it extends the understanding of the influences of the innovation process, expanding beyond the predominant techno-economic analysis.

7.3.2. Context: The Need To Achieve System Embeddedness

A key finding of the study is the importance of context and understanding the wider environmental influences when pursuing knowledge utilisation goals. The systems perspective this study has adopted has revealed a high degree of complexity within a system and multiple influences of knowledge utilisation occur and illustrates the presence of the proposed characteristics of

knowledge flows (i.e. non-linear, irrational), as presented in the literature review. This study, therefore, explicates that 'knowledge utilisation' is not a replicable process: there is not a single model that can be followed in order to guarantee knowledge utilisation occurs as planned: the system is too complex. Returning to the definition of knowledge utilisation offered in section 7.2.2., it was suggested that knowledge utilisation involves the ability to motivate others. This in itself is a contextual process that necessitates understanding what those motivations are. The study finds that there is a need for researchers to become embedded within the innovation system in order to maximise opportunities for knowledge utilisation. This particularly applies to becoming embedded in the innovation system, beyond academic boundaries. This relational perspective supports Reed's (2016:6) proposition that "build[ing] the kind of two-way, long-term, trusting relationships…can enable people to learn about and apply your research". The notion of social embeddedness, as related to economic theory, can be traced back to Granovetter (1985) with subsequent authors presenting both theoretical and empirical research on the concept (e.g. Dacin et al., 1999; Kenney and Goe, 2004). The theory of social embeddedness proposes that economic activity does not occur in a rational vacuum, but rather is heavily embedded in social processes and structures. When applying this in the context of knowledge utilisation within an innovation system, this study suggests that the likelihood of knowledge utilisation occurring in line with established objectives, is partly influenced by how embedded knowledge producers are in the innovation system. Crucially, the study has suggested that this involves going beyond analytical aspects of stakeholder management (such as the identification and prioritisation of stakeholders), to include the understanding of stakeholder needs, to better meet these requirements with the knowledge that is being produced. In this sense, the stakeholders themselves and their own needs and influences are treated as separate. In particular, the study suggested a number of components relating to social processes and structures that maximise the potential for knowledge utilisation to occur, namely: understanding stakeholder views and motivations; facilitating stakeholder understanding of any knowledge outputs; early, continuous and iterative engagements with stakeholders; identifying and understanding any knowledge barriers which may hinder knowledge utilisation; and aligning goals with potential knowledge users. This empirically builds on more theoretical work which emphasises the importance of viewing knowledge utilisation as an interactive and relational process (Fitzgerald and Harvey, 2015; Heinsch et al., 2016).

7.3.3. Skills For Knowledge Utilisation Within The System

The study has built on prior work that suggests a catalogue of skills is needed for actors involved with innovation processes. The core competencies of an organisation are imperative, given how the

study has emphasised the importance of relational models of knowledge utilisation and a need to be embedded within a system. System embeddedness was seen to facilitate: the understanding of motivations for knowledge use amongst stakeholders; the ability to adapt to and learn from the wider system influences to optimise opportunities for knowledge utilisation; and identifying not only knowledge boundaries (knowing), but utilisation boundaries too (using). This section reviews the skills that the study suggests are required for knowledge utilisation.

7.3.3.1. TECHNICAL, COMMUNICATION AND RELATIONAL SKILLS

Donofrio et al. (2010) developed a model of skills needed within modern, knowledge intensive innovation systems that are characterised by a high degree of collaboration. Presented as a range of 'professional shapes' (see section 2.5.7), the model is based on a continuum between in depth technical knowledge to wider general knowledge and greater communication skills.

This study builds on this portfolio of skills, firstly by acknowledging the presence of the two sets of skills (i.e. technical and communication) but also through arguing the existence of relational skills *in addition* to communication skills. While technical and communication skills may increase stakeholders knowledge ('know-of' and 'knowing'), relational skills may increase the opportunities for stakeholders to utilise knowledge ('using'). Additionally, it has emphasised skills specific to knowledge utilisation, such as the ability to monitor and measure it. Communication skills were seen in this study to encompass the generation of relevant and compelling messages, content and formats that emphasise the benefits of knowledge to stakeholders. The ability to develop convincing messages in the form of reports was seen to go some way to addressing a wider audience groups through the delivery of generic information. This aligns with a knowledge transfer mind set (e.g. Liyanage et al., 2009), rather than explicitly facilitating knowledge utilisation, where messages are sent from knowledge creator to potential recipients. It also reveals an over-emphasis on explicit knowledge, which needs to be addressed when knowledge utilisation is an objective. Furthermore, whilst reports can be used as a means to engage wide-ranging audiences, organisations also need address individual stakeholder needs within specific contexts. This indicates an *additional* requirement for relational skills, which the analysis suggests are imperative to enhance the opportunities for knowledge utilisation to occur. Relational skills embody the notion of system embeddedness as discussed in the previous section. This skill set includes strengthening networks, understanding stakeholder knowledge requirements, adapting existing knowledge or creating new knowledge to fulfil these needs and motivating stakeholders to use knowledge in order to meet both organisational and stakeholder objectives. These skills, when utilised from the start of a project, were seen to allow the knowledge creator to ascertain any potential knowledge needs and identify

utilisation barriers that may be occur during a project, through understanding stakeholder requirements and the influences at play in a system. These skills could also aid researchers in making better use of serendipitous encounters with stakeholders, to optimise knowledge utilisation opportunities. Therefore, specific attention to the development of relational skills would add value to the case study organisations and increase the possibilities of knowledge being used by stakeholders ('using'). This suggests that studies from business and marketing, which propose the development of relational skills is a value-adding mechanism for organisations (e.g. De Beer, 2014; Zerfass and Viertmann, 2017), can facilitate effective knowledge utilisation.

The study suggests that the possession of technical, communication and relational skills would aid both case study organisations in their knowledge utilisation objectives. However, as suggested in section 8.3.1 above, normative and cultural influences between different disciplines (the University) and different backgrounds (the PPP) result in knowledge barriers, due to greater contextual distances between different cohorts of people. Additionally, Donofrio et al. (2010) suggest it is less common for one person to possess both specialist and general communication skills. Therefore, the study finds that organisations need to consider how to incorporate these skills into existing organisational structures in order to maximise opportunities for knowledge utilisation. This study also supports recent work that suggests the ability to manage to context is important in knowledge transfer work (e.g. Krylova, 2016). It suggests that adapting to different contexts and stakeholders is vital, when operating in dynamic environments, to meet the needs of various stakeholders and overcome different knowledge barriers.

7.3.3.2. INTERDISCIPLINARY SKILLS

The analysis showed that interdisciplinary skills were increasingly important in the academic context. The growth of interdisciplinary work brought both opportunities and challenges. Firstly, specific skills and mind-sets were linked to individual disciplines. Each of these disciplinary cohorts brought different perceptions of what needed to be accomplished on a project: this was seen as a strength, enabling holistic solutions to complex problems (such as energy related issues). These perceptions occurred on a spectrum between theory building to problem solving. The latter of these was seen to be driven by data, the measurement of data, testing, experimenting and replicability. The prior of these was seen to add context to any measurements, hence, providing more holistic outcomes to projects. However, the varying disciplinary skills bases also were seen to bring challenges when trying to overcome these natural ways of disciplinary thinking. The study suggests that the ability to synthesise expectations, perceived project outcomes and even terminology used on projects is an important skill for realising knowledge utilisation goals.

7.3.3.3. Relational Skill Sets Within Organisations

In addition to the relational skills needed to understand stakeholder motivations, the study also illustrates the importance of relational skills and activities *within* a knowledge producing organisation. It was suggested in the University case study that certain characteristics of research groups enhance the opportunity for knowledge utilisation. This included being well connected within a group that was small in number (to better understand what work was being carried out by all group members) and have the ability to represent the collective work when engaging with a range of external stakeholders. This would potentially maximise the opportunities for the groups knowledge to be utilised by stakeholders (Krykova, 2016). Additionally, it could facilitate feedback loops into the research group regarding understanding what stakeholders needed from the group. However, these skills do not automatically lead to increased knowledge utilisation: this is mediated by academic autonomy (do individuals want to engage with external stakeholders and do they want to discuss the work of others)? Within the PPP the functional structure of the organisation meant that different portfolio of technologies were managed by different teams (i.e. a thematically segregated structure). However, the ability to present a systems model which incorporates a number of different technologies was seen as key to establishing organisational credibility. In line with the above discussion, the study suggests that the ability for a person, or persons, to represent the breadth of work undertaken by the organisation to various stakeholders would facilitate knowledge exploitation. This study has, therefore supports the importance of a wide skills base *within* research groups encompassing technical, communication and relational skills (e.g. Donofrio et al., 2010; De Beer, 2014; Zerfass and Viertmann, 2017).

7.3.3.4. Different Skills For Academic And Non-Academic Utilisation

The analysis did indicate that there are different skills sets to promote academic knowledge utilisation and non-academic utilisation. Whereas academic knowledge utilisation was primarily about explicit forms of knowledge (i.e. publications), it is suggested that the non-academic utilisation relied more heavily on relational skills. This encompasses the ability to relate to non-academic audiences through personal means rather than through papers.

The study revealed a need for organisational skill sets to encompass the ability measure when and how knowledge is utilised in line with any objectives. The measurement of academic knowledge utilisation was seen to be a rather quantitative task, which was measured on the number of citations of academic knowledge (publications). However, the measurement of non-academic utilisation was seen to be rather more interactive, involving maintaining relationships with potential knowledge users in order to ascertain if, and how, they have used knowledge. Therefore, to increase impact

(particularly given the REF's definition of impact as something that is demonstrable) processes, training and tools need to be in place that facilitate the monitoring and measurement of impact.

7.3.4. Hard And Soft Dimensions Of Knowledge Utilisation

The analysis has presented the various knowledge goals which are being pursued in each of the case study organisations, and explored the differences between these goals. It was suggested the University has project and individual level goals which pivot around impact – either academic or external. These goals are heavily influenced by the macro-level environment, either through external funders who set impact related criteria or the wider academic community who have a high degree of influence (through peer review) over career development. However, the PPP has organisation level goals with less influence from the macro environment. The PPP has dual level goals: technology development and deployment (technical level); and carbon emission reduction (social level). The study implies that there is a need to understand the difference in knowledge activities required to achieve these goals: the prior requires a focus on the more tangible side of technology development and transfer; the latter requires a degree of behavioural change achieved through the utilisation of knowledge by recognised stakeholders. Hence, the study suggests that the PPP must successfully adopt the role of both a technology developer and a change agent (through knowledge utilisation), to motivate others to use knowledge and subsequently achieve this latter social level goal.

In line with the project management literature on soft and hard projects (e.g. Atkinson et al., 2006; Crawford and Pollack, 2004; Daniel and Daniel, 2018), the study found that some project goals may be more difficult to achieve than others due to project complexity. Crawford and Pollack (2004:651) suggest projects can be considered to be positioned on a scale of hard and soft which require different management approaches. They provide a framework of seven dimensions of project hardness and softness (see Table 7-1) which "leads to enhanced recognition of [project] complexity and legitimises questioning the standard application of the more readily accepted hard approaches to project management". The framework highlights crucial project components that require different management approaches to achieve soft (social and behavioural) goals that were found in the analysis. Indeed, extant literature suggests that although predominantly hard project management techniques are utilised in projectised organisations, they are only successful in simple environments, (Pollack, 2006; 2007). In line with this framework, this study has illustrated how engineering and social sciences projects can be mapped across this hard and soft continuum and has suggested that knowledge utilisation within 'soft' projects can be more difficult to achieve and

measure (see section 5.4.2 for illustration). In addition to the dimensions presented above by Crawford and Pollack (2004), this study suggests that 'softer' projects tend to encompass longer time frames, usually due to a requirement of some degree of behavioural change.

Hard and Soft Dimensions of Project Management		
Hard	←	Soft
Goals/objectives clearly defined	**Goal clarity**	Goals/objectives highly ambiguously defined
Physical artefact	**Goal tangibility**	Abstract concept
Quantitative measures	**Success measures**	Qualitative measures
Limited external influences	**Project permeability**	Extensive external influences
Refinement of single solution	**Number of solutions**	Exploration of alternative solutions
No stakeholder participation	**Participation and practitioner role**	High stakeholder involvement
Values technical performance	**Stakeholder expectations**	Values relationships

TABLE 7-1: HARD AND SOFT DIMENSIONS OF PROJECT MANAGEMENT (CRAWFORD AND POLLACK, 2004:650)

The high degree of intangibility in 'softer' projects also means that knowledge utilisation may be harder to measure. Therefore, 'softer' projects and the complexity associated with them, require project management techniques that consider knowledge utilisation within complex environments.

The different characteristics between hard and soft project, also mean that it is imperative to clearly define what success is for each project, in relation to knowledge utilisation. The literature review established that there are many definitions of what successful knowledge utilisation is, but these were shown to be mainly higher-level goals and predominantly involved assessing organisational changes within the recipient organisation. A suggested gap in the literature was the ability to understand how knowledge creators defined success. This study has empirically explored how knowledge creators perceive success and what outcomes they seek from generating knowledge. The study has found that successful knowledge utilisation is highly contextual and individual; it has high dependency on individuals' own disciplinary background and interests. Within the academic environment, there were a variety of success measures that related to both academic and non-academic knowledge utilisation. In line with the discussion on hard and soft projects above, those from engineering disciplines often suggested tangible outputs such as cost effectiveness or efficiency measures. Others who are involved in more of the social sciences cited increased understanding of

behaviours and subsequent behavioural change as key outcomes of their knowledge work. The study found that there was conflict between these goals when working on interdisciplinary projects, with too much attention being given to cost effective technologies but not necessarily considering the context within which they would have to be adopted. Similarly, with the PPP, success was seen to focus on generating knowledge on low carbon technologies. To many participants, commercialisation of technology was the main form of knowledge utilisation. However, others suggested the need to create change within the low carbon innovation system. Both of these success measures were seen to be in line with the organisational mission, although both require different activities. It is therefore vital to gain a consensus within projects and organisations on what success looks like. The study has also found that it is important to understand how knowledge generated within a specific project can be used outside of that project (subject to confidentiality and other commercial considerations). This involves taking the lessons learned from projects and using them to motivate others to use knowledge.

7.3.5. Innovation Models And The Creation Of Effective Knowledge Infrastructures

The literature review critiqued a number of different innovation models concurrently in existence. These included Mode 1, Mode 2 and the Triple Helix model (see section 2.2.1), which relate to academic knowledge and adaptation of innovation models in line with changing social paradigms and the co-evolution of science and society. In particular, the Triple Helix model suggests that "transcending sectoral or technology boundaries, Triple Helix systems emphasize boundary permeability among the institutional spheres" (Ranga and Etzkowitz, 2013:238). This study has supported arguments that these different types of innovation system are present concurrently, albeit with some tension between them. Mode 1 notions were witnessed in the analysis of the pursuit of academic impact which were found to be: based on Mertonian norms of academic autonomy; discipline based and deeply ingrained in the peer review process. The study suggests that the generation of original knowledge and publication through peer review is still seen as the essential process of supporting academic career development and promotion. Similarly, Mode 2 concepts were supported with: greater emphasis on interdisciplinary work; engagement with government, society and industry; increased focused on application of knowledge; and increased quality controls. This type of innovation system has notably forced changes on academia and introduced new languages, knowledge creation processes and quality indicators for academia.

The Triple Helix model suggests that balanced and triadic relationships between government, academia and industry aims to produce a knowledge infrastructure, in which boundary permeability is increased between the participating organisations. This in turn, facilitates the generation, diffusion *and* utilisation of knowledge. However, this study suggests that a number of barriers still exist between organisations within the triad and also between the organisations and society in general (see Figure 7-5).

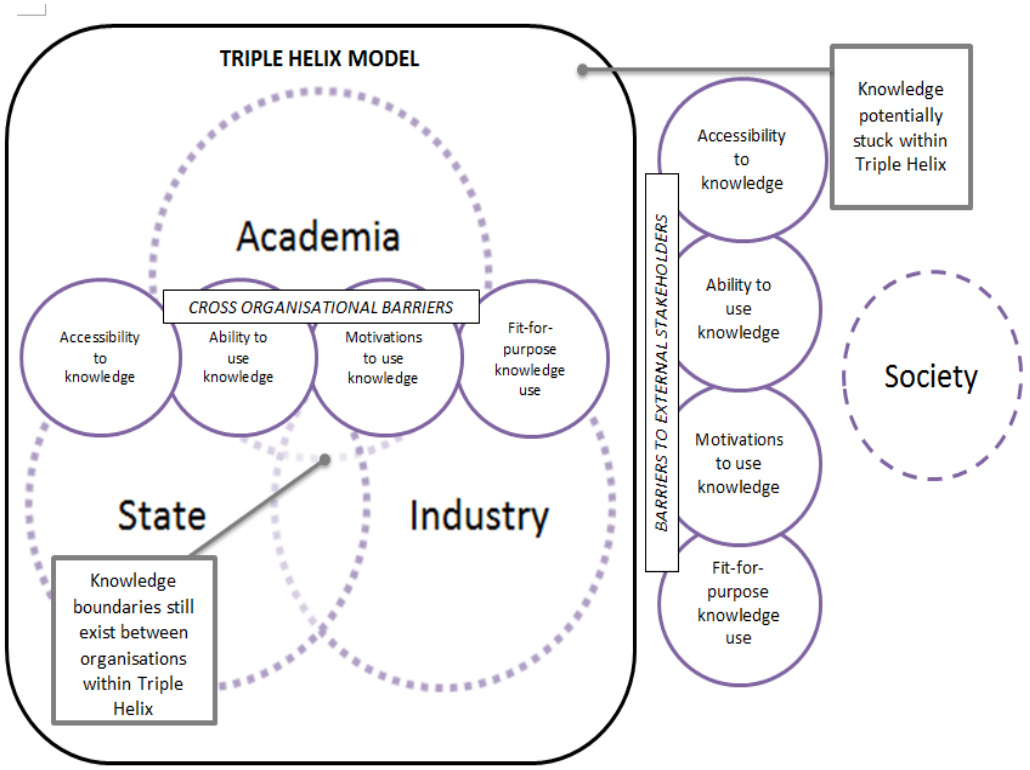


FIGURE 7-5: SUGGESTED BARRIERS TO KNOWLEDGE UTILISATION

This results in knowledge getting 'stuck' in one or more of the organisations represented *within* the Triple Helix model and *between* Triple Helix organisations and external stakeholders. The four main barriers indicated in the study are: accessibility to knowledge; ability for stakeholders to use knowledge; motivation for stakeholders to use knowledge and producing knowledge that is fit-for-purpose. This was caused by a number of interdependent reasons, namely: focussing on knowledge forms which are unsuitable for all stakeholders, a focus on delivery of explicit knowledge (either academic or non-academic publications), knowledge creators' preference to talk to like-minded stakeholders, a focus on technical knowledge, possessing a knowledge transfer mind-set (e.g. linear and one-way) and a lack of relational tools and processes which help embed knowledge creators within the innovation system.

Overall, the study suggests that there is a need to develop more user centric knowledge infrastructures to overcome the identified barriers. Pandey and Dutta (2013) suggest a knowledge infrastructure consists of: cultural capabilities (e.g. visions, values and attitudes towards knowledge transfer goals); structural capabilities (e.g. command and operational structures that support knowledge transfer goals); and technological capabilities (e.g. the information technology hardware and software within an organisation that facilitates knowledge transfer goals). In addition to these three cited capabilities, this study finds that relational capabilities (e.g. the ability to understand and adapt to stakeholder knowledge requirements *as an antecedent* to knowledge creation), are important in overcoming the above-mentioned knowledge barriers. In this sense, the knowledge infrastructure was found to need to be more user-centric to overcome the knowledge barriers. This supports work on the Quadruple Helix model (e.g. Afonso et al., 2012; Carayannis and Campbell, 2009) which introduce a need for social embedding processes as part of models of innovation.

7.4. KNOWLEDGE-AS-AN-OBJECT AND KNOWLEDGE-AS-A-PROCESS

Knowledge has been defined as both an object and as a process (e.g. Cook and Brown, 1999; Newell et al., 2009). This section analyses how these different viewpoints have been perceived in the study and how they affect knowledge utilisation.

The study indicates a large focus on the generation and distribution of reports and other codified material within the case study organisations. The focus on knowledge as an object (e.g. reports) lends itself to a knowledge transfer mentality, where knowledge can be moved from one person or place to another in a package. This transfer mentality is predominantly one-way and linear and may not result in knowledge utilisation within a system context (Heinsch et al., 2016). It can also be argued that the mass distribution of reports may not constitute knowledge transfer, but rather information delivery, if codified knowledge is considered information and not knowledge (e.g. Rowley, 2007). The delivery of reports and a knowledge transfer mind-set also means that stakeholders predominantly engage with the reports (or codified knowledge), rather than with people. This limits the ability for knowledge utilisation as there is an assumption that the stakeholders will have access to the reports, be motivated to use the reports and that they have the ability to use the reports. This also supports Nonanka and Takeuchi (1995) who suggest that there is an overreliance on explicit knowledge forms within Western organisations.

The study suggests that when knowledge is considered a process, particularly a relational process, the stakeholder's needs come first, with either existing or new knowledge being tailored to

stakeholder requirements. This leads to two predominant ways to conceptualise knowledge utilisation: expert driven or stakeholder driven (see Figure 7-6).

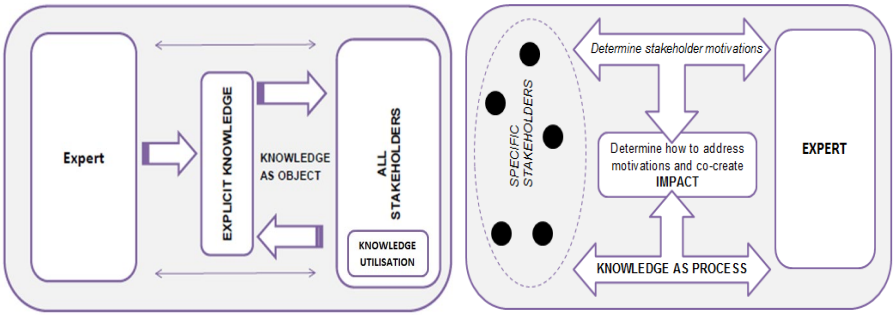


FIGURE 7-6: DEPICTION OF KNOWLEDGE-AS-OBJECT AND KNOWLEDGE-AS-PROCESS AND THEIR RELATIONSHIP TO KNOWLEDGE UTILISATION

The expert driven model aligns with the knowledge-as-object view of knowledge, where an expert (person or organisation) produces reports. Stakeholders and potential knowledge users then access these reports and may or may not utilise them depending on their motivations, abilities and needs. However, the stakeholder model views knowledge-as-process, where the needs and motivations of the stakeholder are established first and knowledge is built around this to best encourage utilisation. This model focuses more on the relationship between expert and stakeholder.

However, if a relational process model is adopted and stakeholder needs are a *priori* for knowledge generation and utilisation, the accurate establishment of stakeholder needs becomes a critical process in itself. This may be an easier process within the different 'hard and soft' project paradigms (see section 8.3.4). Within smaller projects with defined stakeholders, there may be a well-defined problem statement pertaining to what stakeholder needs are. In the study, this was particularly relevant for technology development where financial or efficiency measures were pursued by a small number of stakeholders. However, some projects had a large number of diverse and widely dispersed stakeholder groups. Where this is the case, it may be difficult to determine or synergise the various needs through the stakeholder population. In addition to this, stakeholders may not genuinely know what their needs are. In a well cited historical innovation example, it is suggested that Henry Ford said of automobile innovation "If I had asked people what they wanted, they would have said faster horses." Furthermore, the mission of the PPP is to contribute towards national targets on low-carbon energy use and decarbonisation. However, for this to be realised, a large number of stakeholders (both industrial and consumer) need the motivation to change their entrenched energy use behaviours. Whilst the PPP can facilitate these through the development of cost effective and efficient technologies, the motivation for stakeholders to change their behaviours

will ultimately be part of a far more complex set of motivators involving parties beyond the PPP (i.e. regulation, financial incentives and ongoing shifting societal norms over a longer time frame).

The two models of knowledge-as-an-object and knowledge-as-a-process can be related to certain knowledge creation mechanisms as conceptualised in Nonaka and Takeuchi's (1995) SECI model. Where knowledge is viewed as an object that can be transferred, the emphasis lies within a process of externalisation: that is transforming the tacit knowledge held with the organisation into codified forms. Throughout this study, a focus on the knowledge object itself (e.g. a report) has led to a knowledge transfer mind-set which somewhat overlooks the utilisation of knowledge. When viewed as a process, the importance of the socialisation mechanism (tacit-to-tacit knowledge conversion) is revealed. The socialisation process suggests the knowledge creator personally engages on an individual level with potential knowledge recipients in a two-way knowledge exchange. This would allow for common understandings to be generated and would allow the knowledge creator to gain valuable insight into if and how the knowledge will be used. The need to consider knowledge as a process in order to maximise opportunities for knowledge utilisation to occur, therefore has been a key finding from this study. With this in mind, the next section of the chapter provides a more practical application of these key findings for academics and practitioners alike.

7.5. GUIDING PRINCIPLES: PLANNING-KNOWING-USING

The discussion so far has centred on the academic implications from the study, including revising and building on existing theory. This section of the discussion aims to provide a more practical application of the analysis and, as such, develops guiding principles that incorporate a practical commentary for maximising the opportunities for knowledge utilisation. These principles have not been written as a conclusion from the previous discussion, instead they represent the practical implications of the analysis. They are also not intended to be 'an answer' as to how to ensure knowledge is utilised because this study indicates that knowledge utilisation is contextual and subjective. In this sense, there is no single solution to ensure it is achieved as planned. On the contrary, the innovation systems view adopted in this study suggests that complex systems, irrationality, human behaviour and the non-linear flow of knowledge mean that knowledge utilisation as a process, is far from replicable in any given situation. In this sense, the principles cannot be validated, as such. Therefore, rather than being rigid and linear, the principles encompass a set of beliefs derived from the data, which suggest a number of activities and process which will facilitate, knowledge utilisation to occur.

7.5.1. Overview

The Planning-Knowing-Using principles (see Figure 7-7) do not reflect a set linear process. Instead, in line with the study analysis, they are to be viewed in the context of organisational or project goals, which may or may not require knowledge to be utilised in a specific way. These principles have been developed from the themes presented in the analysis and from existing knowledge utilisation literature. They are presented as five higher level functions: knowledge planning, knowledge creation, knowledge transfer, knowledge utilisation, knowledge internalisation. These are divided into eight values: planning, systems engagement, knowledge creation, stakeholder awareness, stakeholder 'knowing', stakeholder 'using', measuring and learning.

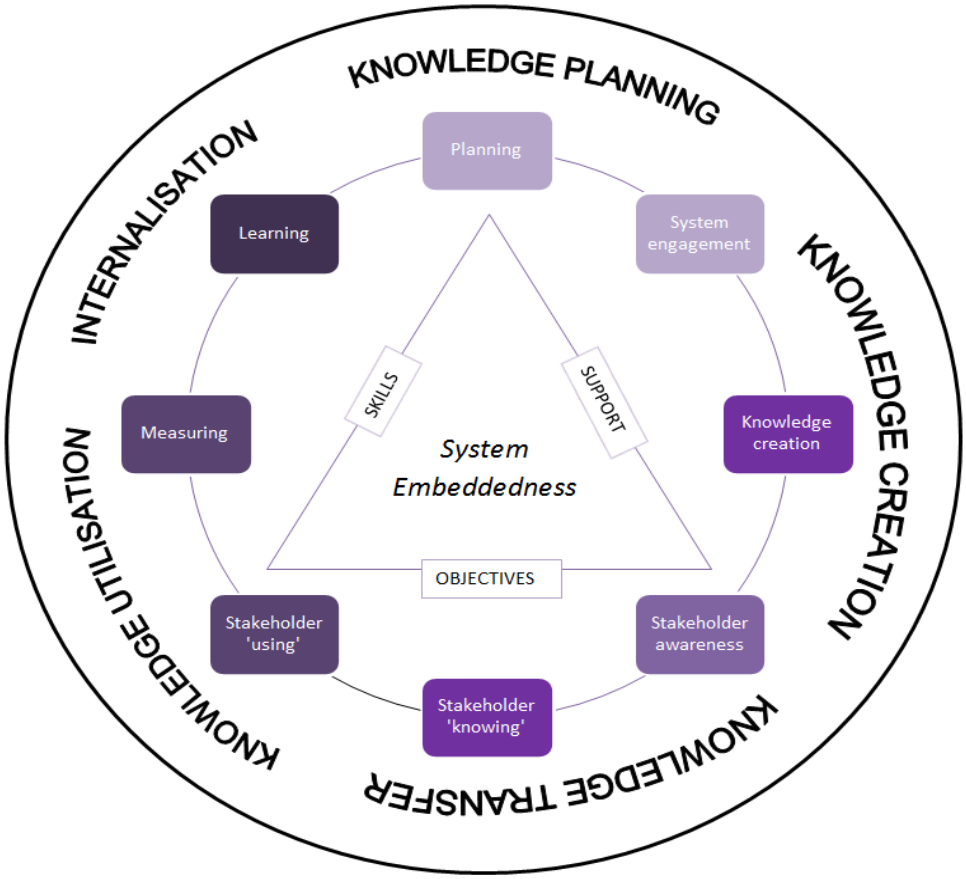


FIGURE 7-7: THE PLANNING-KNOWING-USING PRINCIPLES

7.5.2. Support Mechanisms

The principles are underpinned by three crucial support mechanisms: clear objectives (do organisational/professional objectives support knowledge utilisation?); skills (does the organisation have sufficient skills to enable knowledge utilisation?); and support (are there adequate resources, rewards and recognition for knowledge utilisation work?).

7.5.3. Framework Values

This section develops the eight framework values and highlights the importance of each value (as suggested by the analysis).

Planning

Importance: Sets direction in line with knowledge objectives. Facilitates differentiation between planning and implementation tasks.

The study has found a difference between planning for knowledge utilisation in a static environment and implementing it in a dynamic and changeable situation. The planning activities represent the more analytical activities illustrated in the analysis. They should remain flexible in line with the dynamic systems environment, being amended where necessary as the project progresses. The analysis suggests a number of key tasks for this activity including:

- **Stakeholder identification** – who are the stakeholders?
- **Prioritising stakeholders** – do stakeholders need informing only or do they need to take an active role in knowledge creation to encourage utilisation?
- **Identify expertise that is needed** – technical knowledge, stakeholder knowledge, communication skills and relational skills
- **Establish goals** - knowledge transfer or utilisation (is the utilisation of knowledge vital to achieving goals, if so does this need to occur in a certain way?)
- **Synchronise terms/objectives**– where different disciplines are working together ensure terms and objectives are understood
- **Define engagement strategy** – how will stakeholders be engaged?
- **Resource and skills allocation** – ensure adequate resource and skills availability

System Engagement

Importance: Emphasises the importance of early relational activities with other systems actors according to the context. Evaluates system characteristics and facilitates system embeddedness.

The analysis revealed that understanding engagement strategies for complex environments is an essential component of knowledge utilisation. The ability to apply context to any given situation was seen to enhance possibilities for knowledge utilisation to occur. A key influencer of knowledge utilisation was the ability to ensure early and continuous engagement with stakeholders. These activities are therefore presented partly as a planning task (although separated here from planning

due to their relation nature) and partly as a component of the knowledge creation function. The importance to go beyond identifying stakeholders, to understanding their *needs* was deemed a large influencer of knowledge utilisation.

- **Identify skills and resources** – what and who are needed to understand system influences?
- **Understand stakeholder needs, motivations and views** – what will motivate them to use the knowledge?
- **Align goals with stakeholders** – to maximise opportunity for knowledge utilisation.
- **Determine utilisation barriers** – ensure knowledge is accessible and can be used as intended.

KNOWLEDGE CREATION

Importance: Creates knowledge that is fit for purpose and that aligns with organisational goals

Although this study has not primarily been concerned with knowledge creation processes, it has recognised that consideration of knowledge utilisation *at the creation stage* can help to achieve it. The study has also suggested that knowledge created with stakeholder involvement may increase the chances for it to be utilised. The key tasks involved with this principle include:

- **Interdisciplinary** – Is an interdisciplinary cohort required for complex problems (depending on project/organisational goal)? If a project is interdisciplinary have all terms and expectations been synergised between different cohorts?
- **Stakeholder orientated** – keep the stakeholder needs central to the knowledge creation process in order to maximise chances for knowledge utilisation.
- **Stakeholder engagement** – continue engagement with stakeholders throughout the creation process. Be adaptable to changing needs.

STAKEHOLDER AWARENESS

Importance: Helps the stakeholder to access the knowledge created

The study has illustrated the difference between knowing and using (see section 8.2.1). Increasing stakeholder awareness of knowledge created requires dissemination activities and is aligned with a knowledge transfer mind-set. However, the study has suggested that although knowledge may be disseminated, the stakeholders who receive it do not necessarily understand it. As such, this activity only increases awareness of knowledge through receipt of information.

- **Communication skills** – Produce knowledge and information in relevant forms (content and medium).

- **Knowledge access** – ensure knowledge and information are accessible to stakeholders.
- **Establish organisational/researcher credibility** - can make new knowledge more attractive to stakeholders
- **Dissemination activities** - Explicit knowledge/ information, workshops, promotions and other forms of dissemination activities may increase stakeholder access to knowledge

STAKEHOLDER KNOWING

Importance: Helps increase the stakeholder's knowledge, but doesn't necessarily result in action

Stakeholder knowing encompasses many of the same components as the previous activity. However, here the focus is on assessing whether the knowledge recipient has increased their knowledge.

- **Knowledge access** – Have stakeholders been able to access knowledge
- **Communication skills** - Assess if the knowledge produced is relevant to stakeholders
- **Measuring increases in knowledge** – have stakeholders increased their knowledge as a result of the knowledge created?

STAKEHOLDER USING

Importance: Maximises opportunities for knowledge utilisation to occur

The study has suggested that relational models of knowledge utilisation are preferential when seeking to achieve knowledge utilisation, particularly in a systems environment. However, knowledge utilisation is not guaranteed or a linear process: it is the ability to motivate stakeholders to utilise knowledge in line with goals and objectives.

- **Resource allocation** - communication and relational skills are required. Realistic timeframes need to be established (often longer term, post project)
- **Recognising value** - organisations and individuals need to recognise the value of knowledge utilisation and be rewarded for achieving it
- **Relational activities** – relevant relational activities need to be adopted in line with stakeholder needs in order to motivate stakeholders to use knowledge.

MEASURING

Importance: Ascertains if knowledge utilisation efforts have been successful and to what degree

The study indicates that successful knowledge utilisation encompasses the ability to measure it, despite the fact that knowledge utilisation within innovation systems may occur over long timeframes beyond project completion.

- **Resources** – are there adequate resources to assess ongoing knowledge utilisation?
- **Skills** – does the organisational skills profile include skills that facilitate the measurement of utilisation activities (e.g. evaluation and auditing skills are needed to measure against objectives)?

LEARNING

Importance: Establishes what knowledge utilisation is; enables adaptation to the system environment

The learning activity represents two forms of organisational learning. Firstly, in line with study findings it is important to determine what success is in terms of knowledge utilisation, to facilitate goals. Therefore, internal organisational training can clarify goals and ensure the organisation has the relevant skills for knowledge utilisation work. Secondly, organisations need to internalise knowledge obtained within the system. This allows them to adapt to the changes that are occurring within the system and increase organisational knowledge stocks. These learnings can then be incorporated into future projects.

- **Establish feedback loops** – incorporate new knowledge back into knowledge stocks and enable adaptation to environment.
- **Organisational training** - assist in understanding what knowledge utilisation is and to incorporate feedback to project teams and individuals. Develops the skills needed (e.g. technical skills, communication skills, monitoring and evaluation skills).

7.6. CHAPTER SUMMARY

This aim of this chapter was to facilitate a better understanding of how knowledge utilisation is perceived and explore the influences of knowledge utilisation within a defined innovation system. The chapter has discussed the main findings, synthesising the themes that were developed in the analysis. It has suggested that both knowledge and knowledge utilisation is perceived in many ways, resulting in a plethora of terminology pertaining to the use of knowledge. It has attempted to clarify these terms and provided new definitions for key terms. It has discussed the nature of influences within the innovation system and how these affect knowledge utilisation. It has also presented guiding principles as a method to provide a more practical application of the analysis. The next chapter concludes the study by presenting the overall research findings, the contributions to theory and practice, the limitations of the study and the directions for future research.

CHAPTER 8: CONCLUSIONS

8.1. INTRODUCTION

This thesis commenced by recognising the need to explore how knowledge utilisation is perceived within the context of the UK low carbon innovation system. Subsequently, the literature review in Chapter 2 revealed a predominance of positivist work in the area, which focuses mainly on technology development and transfer. Gaps were identified pertaining specifically to creating action from knowledge that is produced and the more intangible aspects of the innovation system. Therefore, this study has aimed to move away from the predominant positivist stances of low carbon innovation, which concentrate on techno-economic factors of the innovation system. It has provided a holistic view of the soft-side of innovation, namely in-depth exploration of how knowledge moves within the UK low carbon innovation eco-system, how impact is generated from knowledge activities and the system wide influences of this. It does this by being exclusively positioned from interpretivist philosophical underpinnings. Accordingly, the study adopted the inductive methodologies presented in Chapter 3, to uncover the perceived nature of knowledge utilisation within two different organisational contexts. Two types of analysis were presented: within case analysis (Chapters 4 and 5), which aimed to provide in-depth understanding of the context within each case, and Cross Case analysis (Chapter 6), which aimed to compare the two organisations presenting the similarities and differences. The analysis presented inductively derived themes which aimed to answer the research questions and fulfil the study objectives. Chapter 7 then provided discussions incorporating the literature review, analysis and newly introduced literature to further provide answers to the research questions. This included both academically positioned discussion and the provision of a framework which, in line with the study objectives, identified key factors for those undertaking practical work within the field of knowledge utilisation.

The study found that knowledge transfer is often perceived as the dissemination of explicit forms of knowledge, which depict knowledge as an object. However, the need to undertake relational activities in order to maximise opportunities for knowledge utilisation was somewhat overlooked. The main forms of knowledge utilisation perceived were commercialisation and the development of technologies. Contrary to extant literature, barriers to stakeholders utilising knowledge were found to include: accessibility to knowledge; fit-for-purpose knowledge; stakeholder motivation/ability to use the knowledge; and viewing knowledge as an object. In particular, knowledge activities and the ability to encourage utilisation is bound by individual and organisational worldviews. The planning of how knowledge will be utilised was seen to occur in static environments. However, challenges

arose with the implementation, monitoring and measuring of knowledge utilisation due to the dynamic, non-linear nature of the environment that was characterised by complex influences. This requires that organisations and individuals are embedded within the system so as to understand and respond to stakeholder needs.

This final chapter provides an overview of the research and summarises the key findings of the study. It identifies the main contributions to both theory and practice before discussing the study limitations and providing potential directions for future research.

8.2. Research Overview And Key Findings

This study aimed to explicitly adopt an interpretivist position to explore how knowledge transfer is perceived within the UK low carbon innovation system and better understand the influences of knowledge transfer within the system. The study suggests that knowledge transfer is often perceived as the dissemination of information via explicit forms of knowledge. This is often aimed at increasing stakeholder knowledge rather than motivating potential knowledge users to apply the knowledge in a way that facilitates organisational objectives. The study proposes that existing models of knowledge utilisation also focus on expanding knowledge rather than creating actions from it. Additionally, it suggests that there is a tendency to concentrate knowledge utilisation efforts on the planning stage, rather than engaging in relational implementation activities that encourage knowledge utilisation within individual, dynamic contexts. Barriers to knowledge utilisation were seen to exist, despite the Triple Helix innovation model (Etzkowitz and Leydesdorff, 2000), suggesting that more permeable knowledge boundaries were emerging within this model. Based on this work the study presented new definitions for both knowledge utilisation and impact as well as developing a set of guiding principles to guide more effective knowledge utilisation.

8.2.1. Nature Of Research Results

This study adopted a qualitative, two case study approach utilising embedded units of analysis to explore knowledge transfer within and across different levels of the innovation system. This approach was appropriate for the identified interpretivist philosophical underpinnings of the research and best suited to answer the proposed research question. Additionally, this approach was well positioned to fill identified gaps in the literature regarding the need to investigate the soft side of innovation. It, therefore, begins to address the imbalance towards existing positivist, techno-economic stances of knowledge utilisation within innovation systems. It was noted in the literature review, that both the recent body of knowledge utilisation literature (e.g. Heinsch et al., 2016) and

innovation literature (e.g. Meuer et al., 2015) called for more empirical research to counterbalance the atheoreticism present in extant literature. This study has, therefore, adopted a case study approach to answer these concerns.

The literature review presented a number of different models of innovation system that each provides analysis of the given system from a different level. The literature review suggested the need to consider systems approaches to innovation and in particular the institutional influences that are present within these systems (e.g. Edquist, 1997). Far from being linear and rational, the literature review suggests that innovation systems are complex, characterised by interacting components and crucially are context dependent. This study, therefore, integrated an innovation systems view, aiming to look at system wide influences of knowledge utilisation, whilst maintaining the knowledge producing organisation as the main level of analysis (Yin, 2009). This view aimed to address the complexity when exploring knowledge mechanisms operating within the system, while acknowledging that the system itself is distinct from human representations, where interpretation is unique to any individual within the system (Checkland and Poulter, 2010). Given this distinction between the system itself and the individualities of a perceived system, the findings are researcher interpretations of a perceived system.

8.2.2. Key Findings In Relation To The Research Aim And Questions

The overall aim of this research was to achieve a better understanding of the influences of knowledge transfer through the perceptions of the participants. The perceptions of knowledge transfer and utilisation were wide ranging, encompassing a number of different terminologies, activities, processes and goals. The different case study organisations employed terminology including impact, knowledge utilisation, knowledge exploitation, knowledge exchange and knowledge transfer. These terms were often used interchangeably. This supports the prior work of Graham et al., (2006) who suggest that the various terms are vague and often used interchangeably despite various terms being associated with differing goals. This can lead to confusion and ineffective communication between knowledge producers and implementers. As such, this study has offered definitions which help to differentiate and clarify some of the terminology used within the two case study organisations.

The study indicates that knowledge activities within the given contexts are often perceived from a knowledge transfer mind-set, which views knowledge as an object which can be moved. The activities undertaken within this schema frequently rely on explicit forms of codified knowledge

(further proposing that this can be seen to constitute information delivery if codified knowledge and information are viewed as the same thing). This included explicit knowledge forms in specific forms such as academics papers for an academic audience (the University), or reports aimed at a wider audience (the PPP and the University). There was also an emphasis on more tangible activities pertaining to knowledge utilisation such as the commercialisation of technologies (the PPP) or the development of more efficient technologies (the PPP and the University). In this sense, knowledge was seen as an object, rather than as a process. The predominance of explicit knowledge and associated dissemination activities may increase stakeholder knowledge, but does not guarantee that the knowledge will be utilised in a way that achieves innovation objectives. There were clear distinctions between planning activities and implementation activities, with emphasis given to the former, which was undertaken in a static environment. However, the implementation and measuring of knowledge utilisation was seen to occur in a dynamic, changing environment which necessitated greater relational activities with stakeholders, more resources (including uncertain time requirements) and a specific skills set.

The study indicates that there are many influences of knowledge transfer. The two organisations had both similar and different influences. The organisations were both influenced by individuals and cohort perceptions of knowledge transfer. These different world views influence the activities undertaken and the perceptions of success. There was a clear divide between hard and soft aspects of the various projects. At the University the hard aspects included engineering projects, geared towards problem solving, measurement and more tangible objectives of innovation. The soft aspects included projects which encompassed social and behavioural change where many stakeholders were involved. At the PPP, the organisational mission, combined with a staff base consisting of mainly technology focussed cohorts, meant that knowledge transfer was often seen as commercialisation. Both organisations were seen to need to overcome similar knowledge barriers due to differing worldviews (either at an individual or group level). These barriers included accessibility to knowledge, fit-for-purpose knowledge, stakeholder motivation/ability to use the knowledge and viewing knowledge as an object. This is contrary to propositions that the Triple Helix model of innovation (Etzkowitz and Leydesdorff, 2000) creates knowledge infrastructures with more permeable knowledge boundaries. Overall, the PPP was seen to be more isolated from external influences than the University and instead more influenced from the meso-level via organisational norms, missions and structures. However, the University was subject to strong influences from the macro-level. The growing impact agenda and necessity to demonstrate impact as a pre-requisite to funding has strongly influenced academic researchers and focussed efforts on the demonstration of

impact, as well as the creation of new knowledge. Despite propositions in academia that this is eroding traditional academic activities, the study suggests the role of academia is expanding to include both traditional academic outputs and more impact related outcomes. The study does suggest that the external influence of academic peers in the form of peer review and publication, still results in academic outputs being the main focus of the academic role. This is also supported by meso-level norms such as recruitment and promotion criteria, as well as individual level academic autonomy in pursuing what is important to individual researchers. Therefore, the cultural/normative influences of being an academic, counter the regulatory influences of the impact agenda.

Overall the study suggests that knowledge transfer and utilisation are context specific, with each project influenced by a unique combination of macro-, meso- and micro-level factors, which constantly change. Therefore, the ability to manage to context rather than an end goal is crucial for both organisations. This includes the ability to monitor and adapt to changing influences, as well as the capability to measure knowledge utilisation efforts against organisational or project objectives. The systems influences are complex, meaning that knowledge utilisation is never guaranteed and not a replicable process.

8.3. Main Contributions

The findings from this study make a number of contributions to both theory and practice. This section firstly details the theoretical contributions before presenting the practical ones.

8.3.1. Contributions To Theory

This section reviews the study's main contributions to theory. Overall, the study has answered calls in the knowledge utilisation literature for more empirical work to address the imbalance of atheoreticism in current literature (Heinsch et al., 2016). It has also contributed to exploring the soft side of innovation (Byrne et al., 2012**;** Ockwell and Mallett, 2012), including the exploration of the human influences of innovation (Crichton-Sumners et al., 2013; Rutten and Boekema, 2007). Methodologically, the study has also addressed the dominance of positivist, techno-economic research of the innovation system. Specifically, it has contributed in the ways detailed below.

Innovation systems approaches

The innovation systems approach undertaken in this research adds to the knowledge utilisation literature and establishes a need to become embedded in the system in which action or change is

required. This gives further merit to relational approaches to knowledge utilisation (Heinsch et al., 2016). It has enhanced the extant literature by moving away from the dominant investigations of a one or a small number of variables (detailed in section 2.6), to provide a holistic view to the influences within and between the three levels of analysis. The complexity found within the systems approach to innovation, has also supported current literature which suggests that the ability to manage to context as a dynamic phenomenon, rather than managing to an end fixed state (e.g. Robertson and Jacobson, 2011; Wood, 2004) is critical for successful business models which capture any created value. The study has shown that knowledge utilisation within this context is neither rational nor linear; instead revealing a complex environment where knowledge utilisation is never guaranteed. This study has applied systems approaches of innovation to the theoretically important context of the UK low carbon innovation system. As such, it better reflects the relational nature of actors within the system and the interactions between the different actors.

The conceptualisation of knowledge utilisation

Rich (1997) offered a widely cited model of knowledge utilisation consisting of four concepts for what constitutes knowledge use. This study has proposed that certain concepts within this model and other similar scale or ladder type models (e.g. Knott and Wildavsky, 1980; Landry et al., 2001a; 2001b; 2003; Landry and Amara, 2012), do not constitute knowledge utilisation, and explicitly distinguishes between the 'knowing' and 'using' components of knowledge utilisation. Through this distinction, the study has shown that the ability to increase stakeholder knowledge and the ability to optimise stakeholder utilisation of knowledge necessitates different activities, skills and objectives. Thus, the study has enriched the body of knowledge utilisation literature by evaluating what constitutes knowledge use.

Revising and clarifying the terminology

The study has contributed to the clarification and differentiation between concepts and terminology presented in the literature (e.g. Graham et al., 2006; Greenhalgh and Wieringa, 2011; Liyanage et al., 2009), through examination of the terms used by study participants. It offers new definitions for two terms that were used somewhat interchangeably: knowledge utilisation and impact. It specifically proposes that knowledge utilisation is a motivational process that necessitates relational models in order to maximise the opportunity for knowledge utilisation to occur. Through these definitions, the study has answered calls to clarify the terminology in order to minimise confusion (e.g. Graham et al., 2006) and supports work advocating that knowledge utilisation is best achieved when viewed as a relational process (Heinsch et al., 2016).

Differentiating between knowledge transfer and utilisation, and technology transfer

This research has enriched the knowledge transfer and knowledge utilisation literature (e.g. Graham et al., 2006; Gredig and Sommerfield, 2007; Green et al., 2014; Heinsch et al., 2016; Jacobson, 2007; Knott and Wildavsky, 1980; Liyanage et al., 2009; Landry et al., 2001a; 2001b; 2003; Landry and Amara, 2012; Rich 1997), suggesting that knowledge transfer and knowledge utilisation are related, but differing concepts. It has done this by explicitly differentiating between activities that increase stakeholder knowledge, and those that try to motivate stakeholders to use knowledge. It has also distinguished between technology transfer and knowledge transfer. The nature of the varying projects that were undertaken by the case study organisations, supports existing literature that explicitly distinguishes between technology and knowledge transfer (e.g. Crichton-Sumners et al., 2013; Davenport, 2013; Gopalakrishnan and Santoro, 2004) and hard and soft approaches to projects (e.g. Atkinson et al., 2006; Crawford and Pollack, 2004; Daniel and Daniel, 2018), by providing empirical evidence that these concepts often involve different activities with knowledge creators seeking different outcomes which vary in complexity (i.e. technology development to social change).

Barriers within the triple helix model of innovation

The study builds on innovation literature by suggesting that barriers are still present in some innovation models. This is contradictory to the Triple Helix model of innovation (Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2003; Ranga and Etzkowitz, 2013), which suggests knowledge boundaries become more permeable through the establishments of organisations such as public private partnerships. Instead, there were a number of identified barriers in existence that were seen at both the PPP and the University, which require boundary spanning objects to reduce the barriers (e.g. Akkerman and Bakker, 2011; Carlile, 2002; 2004; Kimble et al., 2010). These barriers include: accessibility to knowledge, fit-for-purpose knowledge, stakeholder motivation/ability to use the knowledge and viewing knowledge as an object. As such, this study suggests that there needs to be a more user orientated knowledge infrastructure in place, which incorporates potential knowledge users into innovation models.

8.3.2. Contributions To Practice

The study has provided a set of principles that guide more effective utilisation of knowledge and promote more impact research outcomes. The principles do this in a number of ways, which are presented below.

Linking organisational objectives to knowledge activities

The principles strengthen the link between knowledge activities and organisational objectives through differentiating between knowledge transfer and utilisation at a practical level. This does not suggest that one of these is more preferable than the other (indeed, the transfer and dissemination of knowledge may be a legitimate goal of an organisation). However, through making a distinction between increasing stakeholder's knowledge or increasing stakeholders usage of knowledge, managers are able to better align knowledge activities to organisational goals.

Importance of relational activities for knowledge utilisation

The principles emphasise the importance of relational activities as a means to motivate stakeholders to use knowledge in a way that facilitates the achievement of organisational objectives. In particular, it differentiates between planning in a static environment and implementation in a dynamic environment: the latter requires moving beyond purely stakeholder analysis and become embedded in the system in which the organisation or individual needs to see change. This encompasses understanding stakeholder views (as well as the stakeholders themselves) and highlights the importance of adapting to changes in the environment through developing feedback channels into the organisation.

Skills and support mechanisms for knowledge utilisation

Through differentiating more clearly between knowledge transfer and utilisation, skills sets that support the relational activities associated with knowledge utilisation were defined. In particular, these were differentiated between: communication skills associated with the development of content and mediums for the transfer of knowledge; and the relational skills, associated with understanding stakeholder views and adapting to systems influences. In addition to skills, the principles also present support mechanisms that were seen as crucial to facilitating knowledge utilisation, namely: clear objectives (set at either an organisational or school level); and support in the form of resource availability, reward structures and recognition criteria).

8.4. Limitations And Directions For Future Research

The previous section has presented a number of contributions to both theory and practice. There are some limitations to this study which are presented below. Subsequently, potential directions for future research are discussed.

The design of the research

The study adopted a two-case study approach using purposeful sampling in order to investigate the subject of interest. The organisations chosen in the study were also chosen due to accessibility issues and the closeness of the organisations. Therefore, both case studies were from the same area within the United Kingdom.

The nature of the study meant that a single researcher collected and analysed the data. This, combined with the role of the researcher as detailed in section 3.8, means that there is a subjective view of the data (i.e. the researcher and data are intrinsically linked) and the potential for researcher bias. In line with the methodology literature, researcher bias has been minimised through the awareness of potential bias, use of Nvivo software, sending interim reports where possible, looking for alternative explanations for findings and discussing findings with supervisors. However, despite these efforts, bias may still exist.

The context of the study was specifically related to the UK low carbon innovation system. The influences found within innovation systems of both differing fields and differing countries may vary across these contexts. However, the discussions have been related back to the extant knowledge transfer/utilisation literature, with the belief that the findings are relevant to other sectors and locations. In particular, the findings are suggested to be relevant to other knowledge intensive organisations that over-emphasise technology development, without considering the system context and the utilisation of knowledge, as per the findings of this study.

Directions for future research

There are a number of directions for future research. Firstly, this study provides an in-depth perspective of knowledge transfer and utilisation from the perspective and perceptions of a knowledge creating researcher or organisation at the meso-level. This can potentially be extended to explore perceptions from knowledge recipients and other key stakeholders within the system (i.e. Research Councils and other public funders) at the macro-level. Similarly, conducting future investigations within different sectors, organisational structure and in different countries would allow for comparative work and enrich the overall literature on knowledge utilisation.

This study adopted an inductive research approach to describe and explore the system under investigation. Findings from this study can be used as a basis for hypothesis generation for deductive based studies, while quantitative work may validate the findings across a larger sample.

The data for this study was collected over a period of a year and does reflect changes that occurred over that time period. The dynamic nature of innovation systems, and the increasing emphasis within academia pertaining to the generation of demonstrable impact, mean that future studies could provide useful understandings as to how influences change over an extended time period.

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APPENDICES

APPENDIX 1 – ECKM 2015 PUBLISHED PAPER

A Topography of Knowledge Transfer and Low Carbon Innovation

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Abstract: The growth of the knowledge economy and the changing relationship between science and society, have triggered the emergence of a 'new role' for universities as catalysts for innovation within national innovation policy frameworks. The Triple Helix concept of knowledge generation and innovation introduces triadic relationships between government, academia and industry. These often incorporate state driven aims of innovation development and diffusion for greater societal and economic benefit as conditions of the funding programmes. This concept is witnessed in the UK low carbon energy innovation system, where collaborative relationships are formed to develop new technologies for application by industry and society.

The dynamics of the Triple Helix model bring many challenges to policy makers and those engaged in knowledge transfer relationships, stemming from the inherent nature of knowledge and the complex human interactions involved with inter-organisational knowledge transfer. Low carbon innovation has an increased need for inter-disciplinary knowledge transfer where specialised pools of knowledge are brought together for the purposes of innovation, in environments typified by uncertainty and unclear user impacts. Obstacles are compounded by the complexity of defining knowledge transfer processes and the debate surrounding the transferability of knowledge. Significant additional challenges exist within low carbon innovation, where influencing technology adoption by the public is seen as a multifaceted problem with no easy solution and requires innovation outputs to be transformed to societal outcomes.

This paper aims to explore the nature of these challenges through a review of the literature on knowledge transfer, the continuing transition of academia, government and industry within knowledge generation frameworks and the specific dilemmas faced by the low carbon innovation system. This literature review provides a foundation for future research which aims to explore the concept of knowledge transfer within the UK low carbon innovation system and gather empirical data pertaining to the optimisation of collaborative project performance.

Keywords: knowledge transfer, research systems, innovation policy, low carbon innovation, collaboration

1. Introduction

This exploratory paper reviews the literature pertaining to knowledge transfer (KT) within the context of UK low carbon energy innovation. It examines the knowledge requirements of the innovation system and presents the enablers and inhibitors associated with KT. This paper employs a broad meaning of the term 'knowledge transfer' which includes the multi-directional processes pertaining to the acquisition, assimilation, transformation and exploitation of knowledge. The review was undertaken at the initial stages of a PhD study. A comprehensive and flexible review process was adopted as an appropriate method to navigate broad themes, develop researcher knowledge, define research questions and identify novel perspectives (Boell and Cezec-Kecmanovic, 2011; Ridley, 2012). The review will act as a foundation for empirically exploring the optimisation of KT processes within the UK low carbon innovation system.

The past century has witnessed the diminution of traditional production activities and the emergence of the 'knowledge economy', in which the value of knowledge increases and innovation becomes imperative (Drucker, 1969). In this paradigm, external modes of knowledge acquisition become normalised (Chesbrough, 2003). Concurrently, the co-evolution of science and society exerts novel pressures on research generation, with society demanding greater accountability from the state and academia (Nowotny, Scott and Gibbons, 2001). The emergence of a 'new role' for universities within the Triple Helix model witnesses academia as catalysts for innovation within national policy frameworks (Etzkowitz and Leydesdorff, 2000). This role often incorporates state driven objectives to deliver greater societal and economic benefit (deMan, 2008).

Consequently, there is growing incentive for collaborative engagements, applied research and social impact measures for universities.

The growth in UK low carbon innovation is motivated by the UK government's ambitious energy commitments. Subsequent government manifestos prescribe initiatives designed to develop and diffuse innovation, through increased collaborative knowledge generation and by influencing consumer behaviours (Foxon et al., 2005; van der Schoor and Scholtens, 2015). Knowledge transfer within this environment is therefore a critical issue to policy makers, academia and industry. The system encompasses many diverse technologies, each with individual characteristics, policy influences and knowledge requirements, and is epitomised by uncertainty and unclear user impacts. The existing literature suggests numerous facilitators and inhibitors of KT which transpire across individual, organisational, partnership and sectorial layers. Theseh must be identified and controlled to facilitate successful KT.

The paper is structured as follows: firstly it reviews the co-evolution of science and society and explores the 'new roles' for academia and industry. Secondly it reviews the UK low carbon innovation system and establishes the contextual challenges. It then explores the enablers and inhibitors of KT before concluding on the specific KT challenges of the low carbon innovation system.

2. The co-evolution of science and society

The importance of knowledge is asserted by Drucker (1969) who suggests a post-war move from an economic paradigm of predominantly goods production to a 'knowledge economy'. This shift has seen an increase in the value of knowledge and significance of innovation, necessitating that governments become instigating forces in delivering national growth and competiveness (Drucker, 1969; Nonaka and Takeuchi, 1995; deMan, 2008). Concurrently, the relationship between science and society is progressively symbiotic, influencing new research generation models (Burns and Stalker, 1994). This has resulted in society becoming increasingly influential and demanding in scientific agendas (Nowotny, Scott and Gibbons, 2001). Knowledge generation now embodies a series of dynamic models of research generation (e.g. Mode 1, Mode 2 and Triple Helix) (Etzkowitz and Leydesdorff, 2000).

The Triple Helix concept introduces balanced triadic relationships between government, academia and industry (Etzkowitz and Leydesdorff, 2000). Public-private partnerships offer the potential to leverage the resources and expertise of others to generate new knowledge (Szulecki, Pattberg and Biermann, 2011). The dynamics of these collaborations bring many challenges to those engaged in KT activities, particularly where diverse value propositions exist for the realisation of social benefit (deMan, 2008; Pinkse and Kolk, 2012).

This co-evolution witnesses knowledge moving from being deemed a 'public good' to that of a 'private good', prompting greater academic participation in market behaviours and applied research (Slaughter and Rhoades, 2004). This shift has also increased the focus on 'social impact' as a measurement of research quality (Smith, Ward and House, 2011; Hicks, 2012). Knowledge has become highly mobilised, widely distributed and more easily accessible, spurring industry to adopt open innovation paradigms (Chesbrough, 2003) and form alliances with universities (Afonso, Monteiro and Thompson, 2012). This is despite markedly different motivations, rewards and objectives between industry and academia (Cummings and Teng, 2003; Philbin, 2008; Hughes and Kitson, 2012).

3. The UK low carbon innovation system

The UK government has committed to increasing renewable energy in the UK's energy mix and reducing greenhouse gas emissions (Energy and Climate Change Committee, 2014). Subsequently, policy measures focus on: reducing emissions (Foxon et al., 2005); driving innovation and engaging energy consumers (van der Schoor and Scholtens, 2015); and managing the energy 'trilemma' of security, sustainability and affordability (Szulecki and Westphal, 2014). This includes addressing both technology push and market pull dimensions, which requires the ability to traverse many knowledge boundaries to effectively deliver both technological outputs and social outcomes. These challenges drive inter-disciplinary KT where specialised pools of knowledge are brought together for the purpose of innovation, in environments typified by uncertainty and unclear user impacts.

The Department of Business, Innovation and Skills (2013: 7) describes the low carbon energy sector as a "flexible construct or umbrella term for capturing a range of activities spread across many existing sectors like

transport, construction, energy etc., but with a common purpose – to reduce environmental impact" The high-level subsectors it identifies are presented in Figure 1.

Environmental	Renewable Energy	Low Carbon
• Air Pollution • Contaminated Land • Environmental Consultancy • Environmental Monitoring • Marine Pollution Control • Noise & Vibration Control • Recovery and Recycling • Waste Management • Water Supply and Waste Water Treatment	• Biomass • Geothermal • Hydro • Photovoltaic • Wave & Tidal • Wind • Renewable Consulting	• Additional Energy Sources • Alternative Fuel/ Vehicle • Alternative Fuels • Building Technologies • Energy Management • Carbon Capture & Storage • Carbon Finance • Nuclear Power

Figure 1: Low carbon environment and goods sector classifications (Department of Business, Innovation and Skills, 2013: 7).

Individual technologies have associated variables including: incremental versus radical innovation aims, end users, risks profiles, infrastructure requirements, fluctuating levels of collaborative knowledge flows (Foxon et al., 2005); costs, public acceptability rates, commercial availability (Fankhauser, 2013); and political, technical and market uncertainties (Kannan, 2009). The collection of technologies necessitates an elaborate funding network, reflecting the diverse expertise and knowledge required and differing policy objectives between technologies dependent on changing government priorities (Foxon et al., 2005).

The following analysis of the low carbon innovation system establishes its distinctive characteristics which cultivate idiosyncratic knowledge challenges. The structure of this analysis is based on Foxon et al's (2005: 2127) innovation system map and offers a trichotomic perspective to system influences including the innovation regime, policy support and demand factors. The holistic functions of KT within this system include: creating and diffusing new knowledge; supplying tangible and intangible resources; building capacity; and creating positive economic movement through effective knowledge sharing in public-private partnerships (Foxon et al., 2005; Szulecki, Pattberg and Biermann, 2011).

3.1 Innovation Regime

Figure 2 represents a simplified version of the low carbon innovation system.

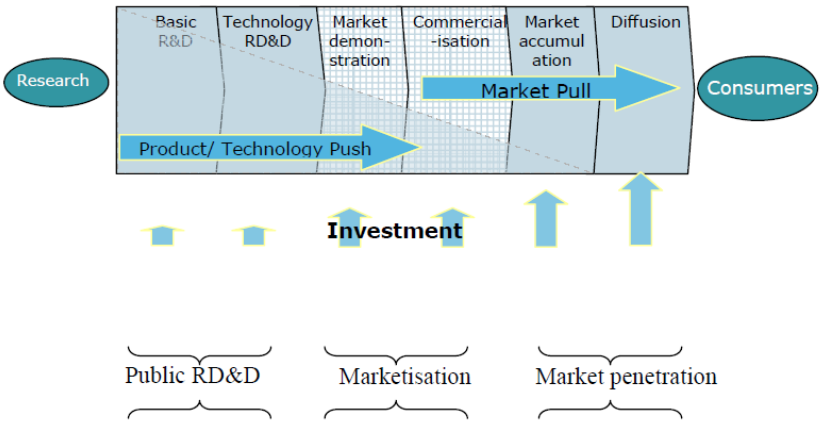

Figure 2: Main stages of the innovation system (Grubb, Haj-Hasan and Newbery, 2008: 335).

In reality the stages of the system are iterative and non-linear, with the potential for a technology to become stagnant within a stage (Foxon et al., 2005) therefore lacking a definitive route from research to consumer.
Each stage has unique variables including distinct funding requirements, risk profiles, market uncertainties, costs and development capacities (Grubb, Haj-Hasan and Newbery, 2008). Within this system, the Triple Helix framework creates organisational, industrial, cultural and process based boundary crossing challenges (Easterby-Smith, Lyles and Tsang, 2008). To facilitate cross-boundary knowledge flows, commonalities must be introduced via common language, common forms of communication and advocated shared meanings (Grant, 1996; Carlile, 2002). This is a notable challenge in the low carbon system due to: the novelty and

uncertain nature of the innovations; the multiple parties which hold complex specialised knowledge; interdependent flows of knowledge; and the high risk of 'reusing' both existing knowledge and previously held assumptions (Carlile, 2002).

3.2 Policy support

The need for government intervention occurs when a societal problem exists which cannot be voluntary resolved by other actors in a market economy (Foxon et al., 2005). Innovation policy aims to drive innovation through three stages: R&D and technology demonstration; pre-commercialisation; and market accumulation and penetration (Grubb, Haj-Hasan and Newbery, 2008; Jamasb et al., 2008).

Policy challenges include: defining collaboration incentives, sourcing effective 'knowledge suppliers' (Foxon et al., 2005); creating long-term targets and stability to encourage commitment in knowledge collaborations (Heffron et al., 2013; Kruckenberg, 2015); providing a shared vision for academia and industry (Szulecki, Pattberg and Biermann, 2011); establishing optimal structures to fund, coordinate and facilitate KT activities dependent on desired outcomes (Kruckenberg, 2015); and designating roles that avoid certain partners becoming 'knowledge senders only' which can limit effective KT (Kruckenberg, 2015). Policy focus should arguably be on innovation generation (Fankhauser, 2013). However, there are sizable demand side boundaries to overcome (Heffron, 2013; van der Schoor and Scholtens, 2015) which are reviewed below.

3.3 Demand

Influencing the technology adoption of domestic and industrial end users is a multifaceted problem with no easy solution and requires extensive knowledge to realise large scale, sustainable adoptions (Kruckenberg, 2015; van der Schoor and Scholtens, 2015). The complexity of climate change is challenging for energy users to fully grasp and not easily understood without a contextual knowledge base from which to interpret the circulated information. The distribution of knowledge is complicated by societies being decentralised 'clans' of individuals with varying beliefs, backgrounds and values (World Bank, 2015). This necessitates substantial regional engagement with society on low carbon issues to influence local mental models and drive technology adoption through social contagion (World Bank, 2015). This complexity must be addressed as part of a portfolio of coordinated approaches of relevant information sharing with the public. The knowledge boundary between research outputs and societal outcomes is therefore extremely taxing.

This section has identified the innovation system as non-linear and cross-disciplinary which incorporates policy, innovators and consumers, and has set the context from which to view KT enablers and inhibitors.

4. Inhibitors and enablers of knowledge transfer

This section reviews the inhibitors and enablers of KT within the context of the low carbon innovation system.

4.1 Clarification of knowledge transfer

The nature of epistemology is highly contentious and predominantly based on perception (Newell et al., 2009) leading to an array of heavily debated research about knowledge and KT. The well cited dimensions of explicit and tacit knowledge (e.g. Nonaka and Takeuchi, 1995; Tsoukas, 2003; Busch, 2008), differentiating information and knowledge (e.g. Rowley, 2007) and knowledge as an asset and a practice (e.g. Cook and Brown, 1999; Sveiby, 2007) question the transferability of knowledge.

The transfer of knowledge is arguably not possible due to the inherent nature of tacit knowledge (Polanyi, 1958; Grant, 1996; Tsoukas, 2003; Busch, 2008). However the word 'transfer' by definition suggests that knowledge can be packaged and relocated from one position to another (Liyanage et al., 2009). Information (i.e. codified knowledge) must be processed through unique filters within each individual, dependent on personal experiences and values (Bender and Fish, 2000; Rowley, 2007). Therefore interdisciplinary partnerships should ensure knowledge is de-contextualised by senders and effectively re-contextualised by each stakeholder (Cummings and Teng, 2003).

The multifaceted concept of knowledge fashions a catalogue of terminology, definitions and constructs for KT. Graham et al. (2006) identify twenty-nine similar terms, based on perceptions of incorporated processes and activities. The number of multi-disciplinary stakeholders identified in low carbon innovation which hold differentiated knowledge stores, necessitates that each party has clear expectations on the objectives of the KT process.

4.2 Adequate time allocation

Building knowledge and forming effective KT environments takes significant commitment (Riege, 2005; McNichols, 2010; Hughes and Kitson, 2012) particularly if physical distance is great (Cummings and Teng, 2003) or complex technical knowledge needs to be exchanged and assimilated multi-laterally across a variety of sectors or cultures (Cummings and Teng, 2003; Philbin, 2008; Pinkse and Kolk, 2012). The number of diverse actors and the complex knowledge located within the low carbon innovation system necessitates increased time allocation for projects. Time requirements are amplified due to the extended time frames in energy innovation transitions which incorporate diffusion to a decentralised public.

4.3 Generation of trust

Developing trusting relationships is essential for successful knowledge sharing across networks (Levin and Cross, 2004; McNichols, 2010; Filieri et al., 2014). It is facilitated when both formal and informal opportunities exist to share knowledge over extended time periods (Riege, 2005; Philbin, 2008) and when there is perceived power equality between partners (Easterby-Smith, Lyles and Tsang, 2008; van Burg and Oorschot, 2013). The diverse groups within the low carbon innovation system necessitate frequent interactions to build trust and require that all partners perceive equality in terms of knowledge input opportunities.

4.4 Social capital development

Social capital enables the access to collectively owned assets which deliver returns to individuals and organisations including: access to restricted knowledge, enhanced reputation, exclusive insight into network norms (Inkpen and Tsang, 2005); and improved learning capabilities, resource development and opportunities for new collaborations (Philbin, 2008). Critically, social capital has a direct bearing on the success of industry-University partnerships (Philbin, 2008; Filieri et al., 2014). It is optimised by the development of: strong network ties, a presence of multiple knowledge connections between all partners, goal clarity, tolerance for organisational cultural diversity (Inkpen and Tsang, 2005); a cohesive, engaged network, a long term view to collaboration and frequent interactions (Filieri et al., 2014). However, low carbon innovation is typified by a short term policy focus which may not extend beyond governmental terms. Cohesiveness may also be affected due to the number of collaborative stakeholders who hold diverse objectives and represent different cultures.

4.5 Value creation in rewards and incentives

Common rewards and incentives should be established across multi-sectorial partnerships. Within academia a balance is required between traditional peer review publishing based incentives and industry engagement (Geuna and Muscio, 2009) so participants perceive a presence of sustainable value creation (Gattringer, Hutterer and Strehl, 2014). Espoused values should aim to generate increased commitment; for academia this includes: access to new funding sources, ideas and methods; and exposure to real life problems (Gattringer, Hutterer and Strehl, 2014). Industry values include: cost savings (world class research which leverages government funding), increased production capacities, enhanced business performance and reduced operational costs (Hughes and Kitson, 2012; Gattringer, Hutterer and Strehl, 2014). Low carbon collaborations must therefore deliver value drivers which span the diversity of academic and industry value perceptions.

4.6 Flexibility in intellectual property management

Government funded programmes may stipulate standard terms. Contractual obligations can create clarity in collaborations but concurrently may inhibit trust formation (Malhotra and Lumineau, 2011). Industrial partners are more likely to engage when contract management employs a flexible, customised approach which considers each partner's vulnerabilities (Malhotra and Lumineau, 2011; Bstieler, Hemmert and Barczak, 2015). Policy around government funded collaborations must therefore consider both academic and industry requirements pertaining to low carbon innovation.

4.7 Establish joint norms and objectives

Cultural difference is a well cited barrier to effective KT (Cummings and Teng, 2003; Riege, 2005; Philbin, 2008; Hughes and Kitson, 2012) with the above discussions inferring a need for commonality and the ability to 'speak the same language' to overcome this. This may be achieved through a collaboration agent who is familiar with both cultures and manages the multidisciplinary teams (Cummings and Teng, 2003; Philbin, 2008). The alignment of common goals can bridge cultures (Inkpen and Tsang, 2005; Riege, 2005) but the addition of high

level societal goals can inhibit effective network management (deMan, 2008; Pinkse and Kolk, 2012). Therefore methods to manage these high levels goals need to be developed to provide a joint value driver within low carbon collaborations.

4.8 Provision of training

Training programmes may assist actors within low carbon innovation to develop both diverse technical knowledge and the 'soft skills' of business and communication (Donofrio, Sanchez and Spohrer, 2010). This can occur through informal networks and via forums and workshops (Riege, 2005; Easterby-Smith, Lyles and Tsang, 2008; Geuna and Muscio, 2009). These can help to create a common understanding of process expectations, generate awareness and provide opportunities to foster social networks (Geuna and Muscio, 2009).

4.9 Absorptive capacity development

Absorptive capacity is the ability to recognise the value of new external knowledge and assimilate it internally, to enhance learning and innovation through knowledge transformation and exploitation (Cohen and Levinthal, 1989; Zahra and George, 2002; Bishop, D'Este and Neely, 2011). Diversity in knowledge is essential to generate new and distinct knowledge for innovation, but is challenging to assimilate due to existing knowledge stores being contextually based (Cummings and Teng, 2003). Current complementary stocks of knowledge are a necessary foundation for the development of new knowledge (Cohen and Levinthal, 1990; Easterby-Smith, Lyles and Tsang, 2008). Therefore absorptive capacity is increased when there is a commonality in contextual language (Cummings and Teng, 2003). Organisations must possess adequate infrastructure to support the dissemination of knowledge internally (Riege, 2005) and provide opportunities for person-to-person engagement to allow exposure to tacit knowledge (Fabrizio, 2009). Therefore policy makers in the low carbon innovation system must provide structures which attract partners with complementary knowledge stocks, whilst the partnership itself must combine both diversity and commonality in knowledge to facilitate new knowledge development. Policy and partnership strategies must endow end-users with a sufficient knowledge base to assimilate relevant knowledge to aid low carbon technology adoption.

5. Conclusion

This paper aimed to review the KT literature in the context of UK low carbon energy innovation and to present specific knowledge requirements relevant to the system. It demonstrated that the Triple Helix framework triggers academia to become more engaged with external bodies and deliver impact as a measure of research quality. Public-private partnerships within the UK low carbon innovation system must integrate methods which facilitate the attainment of high level societal goals. This challenge will require longer term and more stable policy initiatives, which support the innovation system through a portfolio of inter-disciplinary approaches, addressing both technology development and demand side motivation factors.

The KT enablers suggested in the literature must be considered within the context of the system to optimise cross boundary knowledge flows and navigate the innovation stages. Specifically, the time and commitment required to build trust, develop social and absorptive capacities and align values and objectives is increased due to: the number of stakeholders and technologies, the diversity and complexity of knowledge, differing value perceptions, the integration of distinct end-user requirements and lengthy innovation diffusion timeframes. Training would aid collaborators in comprehending KT objectives and processes and ensure knowledge is effectively contextualised between the partners. Finally, in order to aid technology adoption it is necessary to incorporate a focus on knowledge dissemination to the public, a factor which may go beyond the traditional objectives of some partners.

This paper sets the foundation for future empirical research which aims to explore the concept KT within the context of the UK low carbon innovation system and investigate the optimisation of collaborative project performance.

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APPENDIX 2 – ECKM 2016 PUBLISHED PAPER

A Question of Impact: Exploring Knowledge Utilisation within the UK Low Carbon Innovation System

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Abstract: Successful innovation requires organisations to promote the utilisation of both technology and knowledge amongst the diverse actors who operate within innovation eco-systems. Many of these programmes utilise public funds to drive innovation and engage stakeholders. These public funded programmes come under increasing scrutiny to demonstrate impact as a return on research investment.

Knowledge generated within the UK low carbon energy innovation system has the potential to facilitate the achievement of national and supra-national emission targets. Research and practical application in this field has historically centred on technology transfer whilst under-emphasising the crucial role of knowledge within this complex, socio-technical innovation system.

This paper presents the results of a qualitative case study undertaken within a knowledge intensive public-private partnership as a component of its knowledge management strategy. The study aimed to explore the perceptions of staff relating to the organisation's knowledge activities prior to a planned stakeholder engagement event. Fourteen semi-structured interviews were undertaken, and thematic network analysis applied to reveal four major themes. The analysis shows that wider system influences affect how actors perceive their role within the innovation system. Implications for the organisation's managers are herein suggested which could add value to the organisation and increase knowledge utilisation amongst stakeholder groups. Implications include: clarifying utilisation objectives; tailoring knowledge activities; and introducing ongoing feedback cycles.

This paper provides a foundation for future empirical work, which aims to compare knowledge utilisation within different organisational structures and identify best practice within the UK low carbon innovation system.

Keywords: knowledge utilisation; innovation; low carbon energy; thematic network analysis; case study

1. Introduction

Creating new knowledge is a critical component of the innovation process; however this must lead to products and processes which are economically viable (Edquist, 1997). Current literature principally explores the enablers and inhibitors of knowledge transfer. Knowledge utilisation (KU) research is concentrated in health care and policy environments, with no application in low carbon innovation. Concurrently the low carbon innovation literature is primarily concerned with techno-economic analysis positioned within positivist philosophical paradigms. However, there are no studies which investigate the knowledge flows which underpin successful low carbon innovation from an explicitly interpretivist stance.

This paper aims to address these gaps by empirically investigating how staff in a knowledge intensive, low carbon, public private partnership (PPP) perceive their role in the innovation system. It is guided by the question: how is knowledge utilisation perceived within the UK low carbon innovation system? Additionally it aims to provide managerial implications which add value to the organisation through potentially increasing KU amongst stakeholders. This study is part of the PPP's knowledge management strategy which emphasises the importance of delivering impact. Thematic network analysis reveals a number of factors that could add value to the PPP, including clarifying knowledge utilisation objectives and introducing ongoing feedback cycles to monitor and measure KU.

The paper is structured as follows: firstly a literature review is conducted before discussing the study's context and research design. The themes identified during the analysis are explored, before presenting the implications for managers and, finally, concluding.

2. Literature review

The following review analyses the KU literature in the context of innovation, and sets the scene for the study.

2.1 Innovation

Innovation is an enabler of national competitiveness (Drucker, 1969; Nonaka and Takeuchi, 1995; Swan et al., 2010) and underpinned by the availability of knowledge (Du Plessis, 2007). Increased innovation complexity has caused a departure away from the previously assumed linear innovation models, towards more systems perspectives (Chiva, Ghauri and Alegre, 2014; Edquist, 1997; Newell et al., 2009). Systems approaches are characterised by interdependence, where the interactions between actors become as vital as the actors themselves (Edquist, 1997). A systems perspective is therefore useful for investigating wider systems influences.

Fender (2010) proposes that innovation encompasses more than the management of technical knowledge: rather it is concerned with the conversion of innovation outputs into value creating mechanisms. Technologies may create value, but successful KU captures value (Robertson and Jacobson, 2011; Wood, 2004). In the low carbon innovation system, an over emphasis on the techno-economic factors distorts the role of institutional behaviour by assuming bounded rationality and perfect knowledge. This results in a lack of understanding of human influences in innovation (Rutten and Boekema, 2007).

2.2 Knowledge utilisation

Extant literature contains many terms with overlapping constructs concerning the use of knowledge including: knowledge implementation, knowledge utilisation, knowledge uptake and knowledge integration. For the purposes of this paper, the term knowledge utilisation is employed throughout and is defined as "activities aimed at increasing the use of knowledge to solve a human problem" (Backer, 1991:226). This is distinguished from knowledge dissemination which is the "conscious effort to spread new knowledge…to specific target audiences" (Green et al., 2009:152). Whilst both dissemination and utilisation are interpersonal processes, KU incorporates the motivations and cognitive abilities of the user (Aita, Richer and Héon, 2007). Subsequently, non-utilisation can occur when knowledge does not reach intended users or users are unable or unwilling to apply it (Knott and Wildavsky, 1980; Weiss, 1979).

Rich (1997) suggests different conceptualisations for knowledge use (see figure 1). Importantly, this proposes differing goals of KU, which must be clearly understood in order to plan appropriate activities and measure effectiveness.

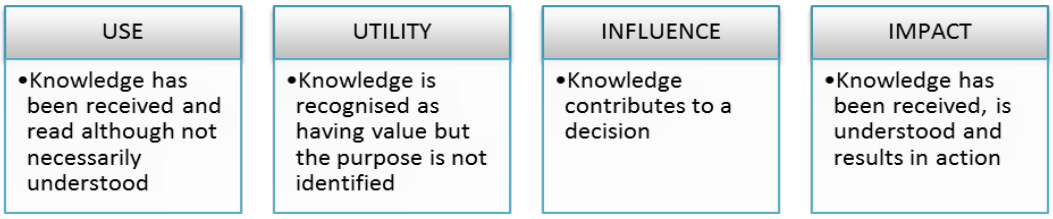

Figure 1: Four distinctions of knowledge utilisation (adapted from Rich, 1997:15)

It is a challenge to succinctly map any cause and effect relationships between specific knowledge inputs and specific outcomes. This is due to: various types of knowledge (Gredig and Sommerfeld, 2008; Lomas, 2005) the non-linear path of knowledge, non-rational use of knowledge (Rich, 1997); differences in user preferences, cultural influences (Head, 2010); irrationality in decision making (Foxon and Pearson, 2008); and institutional influences (Dunlop, 2014; Jordan and Russel, 2014). In political environs, knowledge is more likely to inform policy rather than be a pre-requisite for policy formation, due to the strong influence of political alliances and risk mitigation on policy formation (Head, 2010).

KU can be science driven emphasising the delivery of robust technical evidence which will be adopted by end users (Gano, Crowley and Guston, 2006; Landry, Amara, and Lamari 2001). This approach suggests a linear process where knowledge is an object which will be transferred and utilised. Empirical evidence from the

health sciences suggests this linear approach does not contribute to practice changes (Best et al., 2008). Subsequently there is growing realisation of the importance of social factors to KU (Heinsch, Gray and Sharland, 2016). This relational outlook generates iterative process models of KU, influenced by system dynamics and context (Best et al., 2008; Dobrow et al., 2006; Green et al., 2009; Nutley, Walter and Davies, 2003). Despite this, empirical studies within the energy sector are sparse, and limited primarily to techno-economic analysis underpinned by positivist foundations; there are no studies which adopt an explicitly interpretivist philosophy which explore these relational aspects. The need for such studies is particularly crucial given: the complexity of socio-technical innovation systems (Chmutina and Goodier, 2014); the greater accountability on innovation mechanisms which utilise public funds (Belkhodja et al., 2007); and the urgency of action needed to be taken by wide-ranging stakeholders to achieve national emissions targets (Vincent, 2012).

This review illustrates the importance of integrating relational models into the exploration of low carbon innovation. It proposes that KU objectives need to be understood to effectively plan and monitor knowledge activities.

3. Research context

The aim of this section is to present the contextual factors of the study. The level of detail provided represents a balance between sufficiently illustrating the system under investigation, whilst concurrently maintaining organisational confidentiality.

3.1 The UK low carbon innovation system

The fundamental importance of low carbon innovation is evidenced by the UK government's ambitious commitments to energy and emission targets. These are to be achieved by 2050 through a system of evolving policy, institutional and economic mechanisms which aim to drive innovation and engage stakeholders (van der Schoor and Scholtens, 2015). The system has unique characteristics which complicate innovation: a diverse technology portfolio with many knowledge requirements (Foxon et al., 2005); short-term, unstable policy (Grubler, 2012); and the need for policy measures which address innovation generation (Fankhauser, 2013) and demand side factors (Byrne et al., 2012; Chmutina and Goodier, 2014; Heffron, 2013; Ockwell and Mallett, 2012; Vincent, 2012).

3.2 The research organisation

The research organisation is a public-private partnership (PPP) established by the UK government and major industrial companies. Its purpose is to accelerate low carbon technologies to deliver both near term and longer term benefits. Strategic objectives include: building research capacity; producing nationwide economic benefits; and facilitating the attainment of national and supra-national energy targets. The project work is completed via a network of academic, government and private actors, with the organisation's funding provided by contributions from its public and private membership. The PPP operates through strategic, programme delivery, operational and stakeholder engagement functions. Its knowledge management strategy identifies knowledge as a key product and recognises that knowledge needs to go to, and be received from stakeholders to add value. Knowledge management objectives include: actively seeking feedback from stakeholders; strengthening organisational credibility and capabilities; and supporting staff in knowledge activities.

4. Research design and approach

The literature review revealed the need to explore the human influences on innovation systems. This is one of the first case studies to adopt an explicitly interpretivist stance in order to achieve this. Additionally this philosophical underpinning best facilitates the research aims, and attempts to re-balance the reliance on positivist approaches within this field. Although there are well-cited limitations of a case study approach (e.g. Flyvbjerg, 2006), in line with the aims of this paper, case studies can influence organisational actions (Ragsdell, 2009). Case studies are useful when "the focus is on a contemporary phenomenon within some real-life context" (Yin, 2003:1) and where an understanding of organisational processes is needed, whilst considering the wider environment (Hartley, 2004). This study explores staff expectations of knowledge activities at a one day stakeholder event, prior to the event taking place. The event was an opportunity for the PPP to showcase its work portfolio to a range of stakeholders. Staff from all functions within the PPP would be in attendance, but primarily the authors of a number of recently published reports by the PPP.

5. Data collection and analysis

Purposeful sampling methods were used and an interview schedule comprising of ten questions was designed which centred on the aims, benefits, activities and success measures of the above mentioned event. Fourteen semi-structured interviews were undertaken in compliance with the University's established ethical Codes of Practice. Participants represented the different organisational functions (strategic, delivery, operational and stakeholder engagement) and hierarchical levels (up to executive level). The initial two interviews acted as a pilot; feedback was sought on the appropriateness of the questions. All interviews lasted between forty and fifty minutes, and were subsequently transcribed using Nvivo10 software. Notes were made immediately after each interview, whilst code, theory and operational memos were recorded as analysis progressed (Corbin and Strauss, 2008). Thematic network analysis (Attride-Stirling, 2001) was used as a basis for methodically analysing the textual data. This facilitates exploration of underlying metaphors beyond the purely descriptive themes in line with the interpretivist position. The systematic nature of the analysis facilitates the identification of meaningful results in a bottom up approach (see Figure 2).

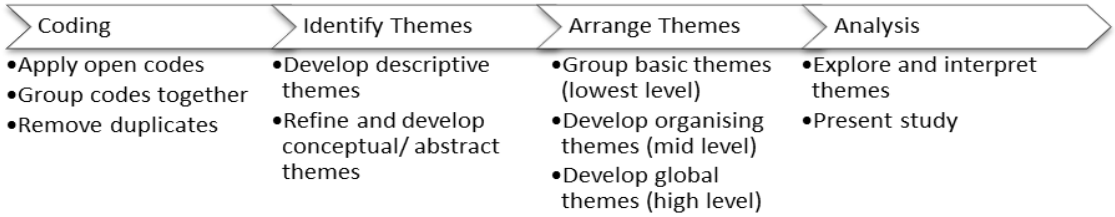

Figure 2: The coding and analysis process (adapted from Attride-Stirling, 2001: 388)

6. Empirical research findings

This section presents the four main themes which were revealed by the analysis. The resulting thematic network is shown in Figure 3. The themes that emerged from the data were: context, target audience, aims and activities, and measurements of success.

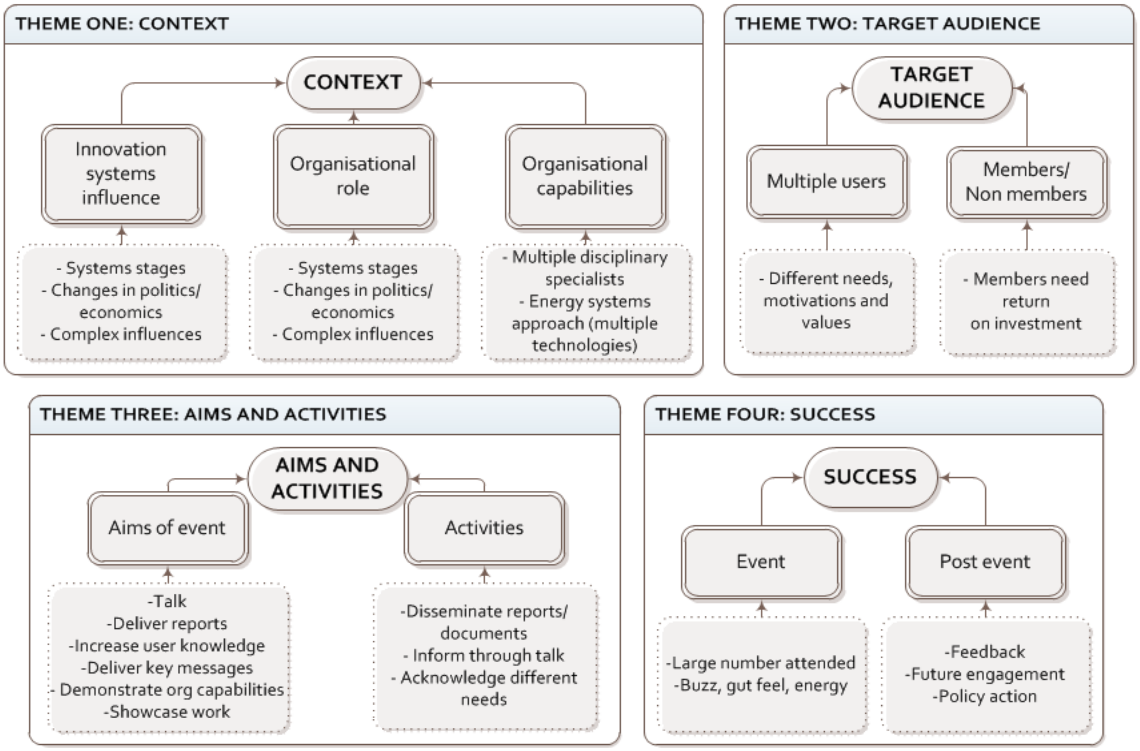

Figure 3: Thematic network analysis of the identified themes

6.1 Innovation system context

The first theme to emerge was the innovation system context, including the role and capabilities of the PPP and other actors within the system. Participants suggested the PPP's role was that of an informer, with the

overall goal of aiding the achievement of 2050 emissions targets. The innovation system was deemed to be complex and dominated by economic-political decisions. There was a distinction between the PPP's role as informer (passive) and other actors who make the decisions (action orientated). Participant A07 suggested "[We can] say these are the areas that are going to matter, and this is the evidence…we can't make the decision, because many of the decisions are governed by policy decisions".
Participants suggested organisational capabilities consisted of being evidence based and working with multiple technologies and stakeholder groups. However, it was suggested that the PPP adopts a predominantly technical focus which does not facilitate knowledge use beyond technical audiences. Participant A04 stated:

> There's lots of work that needs to be done beyond just the pure generation of the underlying techno-economic insight. Traditionally we love to create models… but how do you actually turn that into [an impact on] reality?

This theme suggests a linear and technically focussed model of KU is perceived to be operating. This focuses on influencing through evidence delivery, rather than generating impact through relational processes.

6.2 Target audience

The engagement of broader stakeholders was widely associated with delivering impact. Stakeholders were seen to include industry, government and academics. Those who had invested financially in membership of the PPP were seen as 'important stakeholders' who need a return on their investment. It was suggested that the membership model facilitated the influencing agenda: "[Members] see that they get more value from influencing the landscape than they do from holding the knowledge to themselves" (Participant A10).

Historically the organisation has predominantly engaged technical audiences. The progressive move from technology development to deployment requires appropriate engagement of audiences beyond technical communities. Participant A05 suggested this is slowly happening but "we should be constantly challenging ourselves to do more of it". A recent portfolio of non-technical reports was seen to be delivering more impact by "painting a broader picture" to reach more decision makers. This alludes to an emerging paradigm shift which embraces different world views as a means to create impact.

6.3 Aims and activities

The majority of participants suggested that talking to people or demonstrating technologies would be the predominant activities. Participant A09 stated: "If [the stakeholders] are interested in the subject…they'll come to that area on the day and I'll talk…about the projects we've done".

Emphasis was placed on the dissemination of reports. Participant A05 stated "I've got two science reports that I'll be there…to talk to people about". Participant A14 showed concern about this:

> If you think about reports... when something goes on a shelf it rarely gets picked up again, and you need to keep it alive to make people keep referring back… what you want them to do is change their opinions, change their values, change their direction.

The PPP's knowledge management strategy recognises that value can be gained from seeking and obtaining knowledge from stakeholders (i.e. exchanging knowledge). However, the analysis showed that stakeholder engagement was predominantly perceived to be one-way dissemination. This further emphasises a knowledge transfer mind-set, rather than as a relational process where utilisation is the goal. A minority of participants mentioned obtaining knowledge from stakeholders. Participant A14 suggested: "I will go and see people I know…and find out what they're doing [and] tell them what we've been doing".

6.4 Measuring success

Participants perceived the number of attendees and length of stay to be indicators of success. One participant suggested that the event could be considered a success already because of the number of people registered. However, this may be a reflection of the fact that a broader audience has been invited. More subjective dimensions of success were identified, with phrases such as 'energy' and 'buzz' used frequently: "I'll measure it by gut feel…it will be the number and the quality of the conversations" (Participant A04).

Measures of success were seen by some to only be visible in future activity which results as a direct consequence of the event: "[It's] not 'what did people think of the event itself', it's the uptake of the messages after" (Participant A10). Particular value was seen to be created if invitations were received to attend other broader audience events, as evidence that the organisation is moving beyond a predominantly technical audience.

Interestingly there were only limited responses which linked success with a reflective process which led to internal change:

> There is another level of success, in terms of how effectively we use the event to establish where to go next. If we do something different as a result of the event…then I think there's success (Participant A01).

This section has identified a number of themes. It is evident that the knowledge management strategy is known throughout all functions. Staff can identify the need to increase stakeholder engagement in order to meet organisational objectives (and subsequently impact national emission targets). Staff espouse the need to move beyond a technical focus so to deliver greater impact. Despite this, the organisation occupies a position of a knowledge generator and informer, whilst perceiving the ability to create action as something relating to other actors in the system. In line with this, the activities undertaken strongly revolve around a one-way generator-to-user model, dominated by information dissemination and technology demonstration, which may be caused by unclear utilisation goals. Whilst no previous studies have investigated this field empirically, these findings align with similar work in the medical field which suggest that linear modules of knowledge use do not effectively generate impact on practice (Best et al., 2008). Similarly the literature suggests that usage goals need to be clear in order to design knowledge activities for each specific goal (Rich, 1997).

In order to address these challenges, the next section presents implications for managers in the PPP. These aim to: reduce any ambiguity; move the organisation to a more proactive position; and ultimately maximise opportunities for KU that lead to impact. Overall they aim to provide a practical framework from which to view knowledge utilisation less as a linear transfer model, and more from a relational systematic perspective.

7. Implications for managers

The thematic network analysis attempts to meet the first objective of this paper (i.e. to explore perceptions of knowledge utilisation). This section contributes to the attainment of the second objective (i.e. to provide implications which add value). These implications are underpinned by the literature review and the themes identified in the analysis, and focus on creating value through KU.

7.1. Clarification of goals

Firstly, a clarification of KU objectives should be made. A clear understanding of the success measures aids the planning of effective KU activities directed to a particular goal (Rich, 1997). Currently there is ambiguity about KU objectives including passive orientated dissemination or action orientated impact creation. The focus is also on long term larger targets, but lacks attention on specific actions which deliver nearer term benefits.

7.2. Increasing knowledge utilisation

Secondly, the process of influencing KU to generate impact is a continuous, complex process and consists of many interdependent factors (Green et al., 2009). The model in figure 4 has been constructed from the literature review and in response to the themes identified in the analysis. It consists of a number of iterative steps which consider individual knowledge user requirements (Map), the conveyance of knowledge (Message) and the integration of feedback cycles to actively monitor these (Monitor and Maintain). It is underpinned by organisational support mechanisms (Objectives, Skills and Support).

7.2.1 Map: Mapping stakeholders and their environment

Stakeholders should continue to be mapped and their practical needs, commitments, values, objectives, resources, culture and other institutional influences established. This includes: understanding the linkages and networks which exist between different stakeholders; and instigating ongoing personal contact with the stakeholders to seek their input and build relationships.

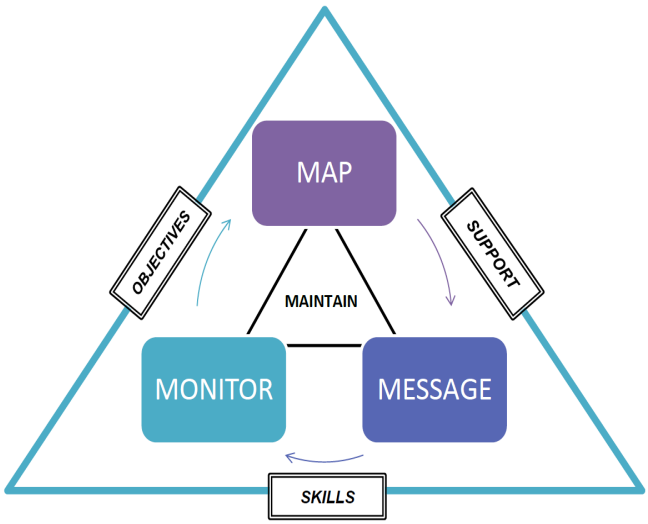

Figure 4: Influencing knowledge utilisation framework

7.2.2 Message: Using appropriate and effective content and medium

The key messages the PPP wish to deliver must be accessible, understandable and beneficial to stakeholders. The messages should be congruent with the needs, values and objectives of the stakeholders and delivered in a timely manner. The PPP has a strong reputation for being credible and evidence based which can be used as a foundation for sending messages. However, this foundation needs to be considered within the context of the other institutional influences mapped (e.g. organisational and individual level commitments, objectives and irrational constraints).

7.2.3 Monitor: Continuous feedback and measurement of activities

It is essential that feedback is sought on the usefulness, accessibility and other 'fit for purpose' criteria with all stakeholders. This can be achieved through the building of long term and interactive relationships throughout the stakeholder network (including opportunities for building inter-network relationships). Adjustments should be made based on this feedback and any other changes that occur within the evolving environment.

7.2.4 Maintain: Sustained engagement supported by appropriate internal resources

The 'map, message and monitor' cycle needs to be maintained as an ongoing process to maximise potential for KU, particularly given the complexity of the innovation environment.

7.2.5 Support mechanisms

The above model is underpinned by a triad of support mechanisms:

- Clear objectives: establish the expected outcomes of knowledge activities and corresponding reward instruments which monitor and encourage the achievement of these objectives.
- Leadership support and sufficient resources: leadership need to fully engage with these objectives. The interpersonal nature of KU activities means that it is a time consuming challenge. Adequate resources must therefore be provided for this purpose.
- Skills development: technical and 'soft' abilities are underpinned by different skills sets. Therefore staff must receive adequate training and development to ensure relevant activities are undertaken.

8. Conclusion

This paper aimed to gain an understanding how staff in a knowledge intensive, low carbon PPP perceive their role in the innovation system. It was guided by the question: how is knowledge utilisation perceived within the UK low carbon innovation system? Additionally it aimed to develop managerial implications aligning KU activities with organisational strategic objectives.

The literature review recognised the need to expand on the predominant positivist studies and explore the interactions, interdependences and human influences that occur within innovation systems. This study is first which explicitly adopts an interpretivist position to achieve this. The thematic network analysis revealed that the organisation has potentially ambiguous aims regarding what it intends to achieve through its KU

programme. The perceptions of the wider system influences, has led to the organisation to occupy the passive role of knowledge generator and informer, which undertakes knowledge transfer activities. However, a potential paradigm shift is potentially underway which begins to recognise the relational aspects of knowledge activities. In order to facilitate action orientated goals, a framework was provided for managers, which supports an ongoing cycle of tailored knowledge activities, interpersonal activities and feedback cycles to monitor KU.

Whilst this study focusses on one organisation, future work will explore other publicly funded mechanisms within energy research. This will give the opportunity to compare and contrast the different influences on KU within the innovation system.

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APPENDIX 3 – INTERVIEW SCHEDULE

**any information that can identify the organisations has been removed*

Interview Schedule

Introduction: The purpose of this interview is to gain an understanding into your perceptions about the activities and outcomes of your work within the [redacted] This is part of a larger PhD study which investigates knowledge transfer within the UK low carbon innovation system.

Confidentiality: All responses and comments are anonymous and will be treated in the strictest confidence. No information regarding the responses and comments will be passed to the organisation.

Voluntary participation: Participation in this interview is voluntary and you may withdraw at any time without explaining your reason for doing so.

Questions

- Background of participant (role, research interests, time at university etc.)

Aims

1. What are the aims of [redacted] overall?
2. What are your personal objectives for your research/role? (if relevant)

Activities

3. What activities do you undertake to meet these objectives?
4. How do these activities support the aims of the [redacted]?
5. How do these activities support your personal objectives/role? (if relevant)

Support

6. How does [redacted] support you in fulfilling these aims and objectives?
7. What other [redacted] functions are involved in fulfilling these aims and objectives? How?

Audience

8. Who are the stakeholders of [redacted]?
9. How do you attract these stakeholders?
10. Examples of interactions you have with stakeholders?

Benefits

Thinking about the outcomes of your research:

11. What are the benefits for the stakeholders involved?
12. What are the benefits of your research outcomes for you and your career?
13. What are the benefits of your research outcomes for [redacted]?

APPENDIX 4 – EXAMPLE OF MEMOS WRITTEN DURING ANALYSIS

Memo 5	Participant talks about talking at two different events – one geared towards a [very specific] audience and the other to a wider audience. Discusses different 'tactics' needed at both. Discusses the ability to talk technical at one event but having to put everything in layman's terms at other. Focus on language used within and between groups.
Memo 12	Participants discusses how their portfolio of work is different from everybody else's – doesn't see overall stakeholder engagement as a priority – only stakeholders specific to them. Different worldview to others. Only seeking knowledge to be utilised by small group of stakeholders (rather than larger group).
Memo 21	Participant discusses other groups within the organisation and the emphasis on cross project work and how this reduces silos within the organisation. But this seems to relate to technical projects. Other participants who are not involved in technical work discuss silos between themselves and technical staff. Communication and 'language differences' seem to occur between differing backgrounds. Investigate where boundaries are between groups. Focus on language and objectives between groups. Big divide between technical and non-technical groups?

APPENDIX 5 - EXAMPLE OF CODING STRUCTURES IN NVIVO

IMPACT	9	54
Timeframes to impact	3	4
skills for impact	3	5
research accessibility	3	6
public engagement	2	2
measuring impact	4	9
FUNDING	9	37
research council	5	13
pathways to impact	3	6
Internal funding support for impact	1	1
income	4	4
auditing	2	6