Department of Marketing

Explicating Natural-Resource-Based View Capabilities

A dynamic framework for innovative sustainable supply chain management in UK agri-food

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Declaration of Authenticity & Authors Rights

This thesis is the result of the authors original research. It has been composed by the author and has not been previously submitted for examination that has led to the award of a degree.

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Whilst at times the completion of this thesis seemed an impossible task, and there have certainly been tantrums along the way, it has been a process which I have taken great pride and enjoyment in. I would undoubtedly feel differently if it weren't for all the people who helped me along the way, and to them I express the utmost gratitude.

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Abstract

The natural-resource-based view resonates with significance some twenty years after its conception. The theory features prominently in modern literature where it enjoys links with enhanced competitiveness, and responds to the need for innovative sustainable operations in modern business. However, literature argues that a lack of practical guidance has resulted in a theory-practice gap, which to some extent is typical of resource-based theory research. This study resolves this via definition of dynamic natural-resource-based view capabilities.

Exploration of links between natural-resource-based view, sustainable supply chain management and innovation literature identifies implications for capabilities. Categorizing these capabilities according to the four natural-resource-based view resources of pollution prevention, product stewardship, clean technologies and base of the pyramid, dynamic capabilities activities of sensing, seizing and transforming and an internal versus external focus facilitates the creation of a conceptual framework of dynamic capabilities.

Employing the UK agri-food sector as a contextual setting, an empirical study comprising of two phases is undertaken. Phase 1 involves seven in-depth interviews with agri-food experts to empirically validate links between the natural-resource-based view, sustainable supply chain management and innovation. Phase 2 involves twenty semi-structured interviews and six observations with UK agri-food companies to empirically define and explain dynamic natural-resource-based view capabilities.

In its completion, this study demonstrates the existence of pollution prevention, product stewardship and clean technologies in UK agri-food, confirms their synergies with sustainable supply chain management and innovation and explicates and elucidates their dynamic capabilities. Whilst base of the pyramid did not feature in the empirical study, the resource is not falsified and further investigation is recommended. This study concluded with five contributions: empirical definition of dynamic natural-resource-based view capabilities; dynamic capability and internal-external categorization; the four-resource perspective of the natural-resource-based view; linking the natural-resource-based view, sustainable supply chain management and innovation; and conceptualisation of local philanthropy and proposal of the natural-resource-based view cycle.

1.0 Introduction

The natural-resource-based view of the firm was presented by Stuart Hart in 1995 as a means by which to realise competitive reward via the prioritisation of sustainability. The theory still features with prominence in modern literature as an innovative and competitive approach to sustainable operations (Shi et al, 2012; Matapolous et al, 2014; Johnson et al, 2014; Miemczyk et al, 2016). Positive connotations surrounding the theory result from links with enhanced competitiveness. which have largely dominated natural-resource-based view literature (Hart & Dowell, 2011), whilst its modern-day resonance is more likely a product of its innovative approach to the alleviation of ecological and social degradation (e.g. Shi et al, 2012; Matapolous et al, 2014; Miemczyk et al, 2016). In spite of this, academics have argued that the natural-resource-based view suffers from a theory-practice gap, in that misinterpretation and lack of practical guidance and applicability (Menguc & Ozanne, 2005) have deterred its transference into industry (Hart & Dowell, 2011). In particular, literature fails to define the capabilities in support of natural-resource-based view resources, in some conflict of the intrinsic nature of resources and capabilities (Christmann, 2000; Barney, 2001; Butler & Priem, 2001). To some extent, this is inherited from its resource-based theory roots, in that the complex relationship between competitive resources, capabilities and competitiveness remains understudied (Grant, 1991; Rashidirad et al, 2015).

Of particular interest are links between the natural-resource-based view and sustainable supply chain management. Whilst literature picks up on this to an extent (e.g. Ashby et al, 2012; Johnson et al, 2014; Miemczyk et al, 2016), the synergistic relationship between each natural-resource-based view resource and sustainable supply chain management strategies is yet to be comprehensively investigated. Such an investigation may be of great value in the realisation of the natural-resource-based view given sustainable supply chain management's extensive study in academia and its widespread practical appeal and acceptance (Johnsen et al, 2014; Pagel & Shevchenko, 2014). In addition, this offers some definition to the management of sustainable supply chains, which remains a complex topic (Miemczyk et al, 2016).

In addition, the topic of innovation emerges as a consistent theme in both natural-resource-based view (Hart, 1995; Aragon-Correa & Sharma, 2003; Hart & Christensen, 2002; Hart & Dowell, 2011) and sustainable supply chain management (Yam et al, 2010; Ageron et al, 2013)

literature. However, in spite of being identified as a fundamental natural-resource-based view capability (Hart & Dowell, 2011), the relationship between each resource and corresponding innovation typologies is yet to be explored. Given the indivisibility of innovation and sustainability (Birkenshaw et al, 2008) and the growing drive for sustainable innovations in industry (Cuerva et al, 2014), this too is a topic worthy of investigation in relation to the operationalisation of the natural-resource-based view.

Thus, this study explores links between the natural-resource-based view, sustainable supply chain management and innovation literature, extracting implications for capabilities for each of the four natural-resource-based view resources: pollution prevention, product stewardship, clean technologies and base of the pyramid. Teece's (2007) dynamic capability activities of sensing, seizing and transforming are used to categorize capabilities, maximising lucidity and acknowledging the need for adaptability in competitive resources (Teece et al, 1997; Fiol, 2001; Aragon-Correa & Sharma, 2003; Hart & Dowell, 2011). Further categorization according to an internal versus external focus of capabilities adds further lucidity and supports the endogenous and exogenous derivation of resources (Wernerfeldt, 1984; Barney, 2001; Hart, 1995). This permits the construction of conceptual frameworks of dynamic capabilities for each resource with which to guide the empirical study. The UK agri-food sector serves as an appropriate contextual setting, based on the sector's dependency on sustainability as a source of competitiveness (FHIS, 2013b; Mintel, 2013b; The Guardian, 2016; Harvey, 2016) and its heavy investment and research in sustainable and innovative operations (Department for Business & Innovation, 2013; Parliament UK, 2014; Tassou et al, 2014). Assuming a critical realist philosophical stance, a qualitative multi-method abductive study is undertaken, comprising of two phases: phase 1 which involves seven in-depth interviews with UK agri-food experts to explore links between the natural-resource-based view, sustainable supply chain management and innovation; and phase 2 which involves twenty semi-structured interviews and six participant observations to explicate and elucidate the dynamic capabilities in support of each resource.

The results of this thesis reinforce the value of pollution prevention, product stewardship and clean technologies in industry, empirically validate links with sustainable supply chain management and innovation, and provide empirical definition and explanation of pollution prevention, product stewardship and clean technologies capabilities. The fourth natural-resource-based view resource of base of the pyramid does not feature in the empirical study, preventing empirical validation of its sustainable supply chain management or innovation

synergies or definition of its capabilities. Nonetheless, this makes significant contributions, rendering implications for both theory and practice. The empirical definition of natural-resource-based view capabilities responds to calls for enhanced practical guidance of the theory and addresses research gaps surrounding the complex relationships between resources and capabilities. In addition, this offers a framework for competitive sustainability in UK agri-food. Categorization realises the long overdue application of dynamic capabilities as a tool with which to guide and explain capabilities, and exemplifies the endogenous and exogenous nature of competitive resources. The four-resource perspective adds distinction to the natural-resource-based view and sustainability and diverges from its environmental dominance. Empirically verified inks with sustainable supply chain management and innovation refine over twenty years of literature, and add practical appeal and approachability to the natural-resource-based view. In addition, two emergent findings challenge existing understandings of the natural-resource-based view: local philanthropy as the fifth resource; and the shift from a natural-resource-based view hierarchy to a natural-resource-based view cycle.

1.1 Research Aims & Objectives

The purpose of this research study is to explore links between the natural-resource-based view, sustainable supply chain management and innovation in order to identify implications for the capabilities of pollution prevention, product stewardship, clean technologies and base of the pyramid. This permits conceptual definition of dynamic natural-resource-based view capabilities, which in turn guides empirical investigation of dynamic natural-resource-based view capabilities. The research question guiding this is: *what are the organisational capabilities that support the four natural-resource-based view resources in practice?* In order to resolve this, the following research objectives are set and are met throughout this study:

- Identify natural-resource-based view capabilities from a review of seminal studies and exploration of sustainable supply chain management and innovation synergies;
- Categorize and refine capabilities into a dynamic capability framework;
- Investigate the existence of the natural-resource-based view in UK Agri-Food;
- Explore links between each resource and sustainable supply chain management and innovation in UK agri-food;
- Empirically define dynamic natural-resource-based view capabilities

1.2 Thesis Overview

This thesis begins with a comprehensive literature review, exploring the conceptualisation of the NRBV, from its roots in resource based theory to its progression from a three resource framework to a four resource framework, something which is largely overlooked in existing literature (Hart & Dowell, 2011). Several prominent extensions and adaptations of the natural-resource-based view are reviewed: Aragon-Correa & Sharma's (2003) contingent proactive environmental strategy; Menguc & Ozanne's (2005) natural environment orientation; and Shi et al's (2012) conceptual natural-resource-based green supply chain management model. Following on from this, synergies between each resource and corresponding sustainable supply chain management strategies are reviewed, before concluding with review of the dominant role of innovation in each resource. This resolves the first research objective: *identify natural-resource-based view capabilities from a review of seminal studies and exploration of sustainable supply chain management and innovation synergies.*

Chapter 3 reinforces the need to define natural-resource-based view capabilities, and reduces and refines capability implications extracted from literature. Dynamic capability activities of sensing, seizing and transforming are used to categorize the refined capabilities, with support of inter-coder reliability assessments. Capabilities are then further categorized according to their internal or external focus. This resolves the second research objective: *categorize and refine capabilities into a dynamic capability framework.*

Chapter 4 offers an industry review of UK agri-food, involving the collection and analysis of secondary data from media, government, NGO and company sources. As well as reinforcing the appropriateness of UK agri-food as the contextual setting for this study, this demonstrates with strength the existence of pollution prevention, product stewardship and clean technologies in UK agri-food, and implies some demand for base of the pyramid. This challenges claims of a theory-practice gap (Hart & Dowell, 2011) and resolves the third research objective: *investigate the existence of the natural-resource-based view in UK agri-food.*

Chapter 5 introduces the critical realist philosophy underpinning this study, detailing ontological, epistemological and methodological assumptions. More specifically, critical realism stimulates the ontological assumption that the natural-resource-based view exists as its own entity that can be observed within a real-life setting. Within this, natural-resource-

based view capabilities exist as strata to be explicated by the researcher. The value of a qualitative multi-method abductive approach is also discussed, in which theory and practice serve as a point of reference for one another and discursive data is prioritised. Following on from this, chapter 6 details the research methods employed throughout this study: critical literature review; in-depth interviews with purposefully selected UK agri-food experts; and semi-structured interviews and participant observations with purposefully selected UK agri-food companies. The use of content analysis and inter-coder reliability throughout this study is also discussed, stressing their value in supporting the validity of results.

Chapter 7 reports the results of phase 1 of the empirical study, discussing the existence of pollution prevention, product stewardship and clean technologies in UK agri-food and empirically validating links with sustainable supply chain management and innovation. This resolves the fourth research objective*: explore links between each resource and sustainable supply chain management and innovation in UK agri-food*. Chapter 8 reports the results of phase 2, concluding with empirical definition of dynamic pollution prevention, product stewardship and clean technologies capabilities. This resolves the fifth and final research objective: *empirically define dynamic natural-resource-based view capabilities.* Thus, it is here in which the research question '*what are the organisational capabilities that support the four natural-resource-based view resources in practice?'* is resolved, permitting completion of this study. In addition, reflection of the results permit definition of common natural-resource-based view capabilities.

Chapter 9 introduces emergent findings. The emergence of social sustainability in a competitive context out-with a base of the pyramid concept in the industry review and empirical study encourages the proposal of a fifth natural-resource-based view resource: local philanthropy. Detailed descriptions of this in phase 2 permits conceptualisation of local philanthropy and its capabilities. In addition, the shift from a natural-resource-based view hierarchy in which realisation of each resource is dependent on its forerunner (Hart, 1997) to a natural-resource-based view cycle in which resources can be realised in any order or exclusively is proposed. This is inspired by the presentation of social sustainability as a predecessor for environmental sustainability and the dominance of product stewardship in phase 2 results.

2.0 Literature Review

This chapter provides a comprehensive review of the natural-resource-based view (NRBV), ranging from its origins in traditional resource-based theory to its more recent adaptations and developments. The relevance of the NRBV in modern business is evidenced, as is its value via repeated links with competitiveness. However, gaps in research are also exposed, including in a distinct lack of practical guidance, the need for dynamic capabilities and the NRBV's largely overlooked evolution from three resources to four resources. In response, this chapter attempts to identify implications for capabilities in support of the four NRBV resources: pollution prevention, product stewardship, clean technologies and base of the pyramid.

This takes place over three stages. Following on from review of competitive resources and capabilities, literature featuring the NRBV and any or all its resources is reviewed, permitting the extraction of capabilities and identification of synergies with sustainable supply chain management and innovation. Second, synergies between each NRBV resource and specific sustainable supply chain management strategies are reviewed, again allowing for the extraction of prominent capabilities in support of such strategies. This process is then repeated with synergistic innovation typologies, serving as the third stage of literature review. This results in a comprehensive list of capability implications, resolving the first research objective:

- Identify natural-resource-based view capabilities from a review of seminal studies and exploration of sustainable supply chain management and innovation synergies.

2.1 Resource-Based Theory

Resource-based theory has established a formidable presence in industry, expanding from its roots in economics to merit considerable attention and impact in schools of marketing (Song et al, 2008; Nath et al, 2010), strategy (Newbert, 2007) and supply chain and operations management (Nath et al, 2010; Walker et al, 2012; Hitt et al, 2015). Most commonly this refers to its employment as a theoretical lens with which to study and describe firm operations (Lockett et al, 2009). In some contrast to this are claims that the operationalisation of resource-based theory itself lacks clear guidance (Grant, 1991; Hitt et al, 2015) or feasibility (Butler & Priem, 2001). In particular, there appears a distinct lack of empirical evidence of competitive resources and the capabilities required to support their realisation (Newbert, 2007) or

competitiveness over time (Lockett et al, 2009). The need for research in this area features in seminal resource-based theory research, with Grant (1991, p133) stating:

> *'The key to a resource-based approach in strategy formulation is understanding the relationship between resources, capabilities, competitive advantage and profitability – in particular, an understanding of the mechanisms through which competitive advantage can be sustained over time'.*

Nonetheless, the complex relationship between resources and capabilities and competitiveness remains a neglected area in literature (Hitt et al, 2015), exposing a research gap (Rashidirad et al, 2015).

Notably, the empirical study of resources and capabilities has to date proved troublesome (Hitt et al, 2015). Butler & Priem (2001) suggest that the complex and tacit nature of resources, as discussed throughout this chapter, renders them unobservable, whilst Lockett et al (2009) suggest their ambiguity acts as a deterrent to empirical investigation. Consequently, this prevents access to the capabilities that support resources, which are themselves believed to be implicit, inherent (Lockett et al, 2009) and immeasurable (Amit & Schoemaker, 1993). In addition, the intended heterogeneity of resources and capabilities raises query to the feasibility or value of their definition at all (Black & Boal, 1994; Russo & Fouts, 1997; Sharma & Vrendenburg, 1998; Christmann, 2000; Barney, 2001).

However, whilst such issues do warrant consideration, they are arguably worsened by the positivistic dominance of resource-based theory research (Acedo et al, 2006) which is limited in its propensity to study intangibles or consider contextualities. The positivist's reliance on tangible or measurable realities (Edwards et al, 2014) is somewhat conflictive of the very nature of resources, whilst dependencies on statistical analysis encourages quantification of resources and capabilities, as opposed to their explanation. It is for such reasons that existing research surrounding resource-based capabilities, based on quantifiable justifications (Grant, 1991; Newbert, 2007; Nath et al, 2010), struggles to address research gaps surrounding the complex relationship between resources and capabilities. This is not to argue that such research doesn't contribute to the theory, but rather that it is inadequately equipped to observe tacit resources and elucidate the role of a specific capability. Thus, the need for a more qualitative approach to resource-based theory research emerges if the relationship between resources and capabilities is to be explained (Rashidirad et al, 2015) and operationalisation realised (Grant, 1991).

This section offers review of competitive resources and the fundamental role of capabilities in their realisation. The significance of dynamic capabilities is also discussed, and implications for environmental and social sustainability explored.

2.1.1 Resources

Links between competitiveness and resources date back to Penrose (1959), in which firm growth and success is linked with effective execution of resources. Rubin (1973) added to this, discussing the need for groups of resources to work together. Expanding on these works, Wernerfeldt (1984) conceptualised the resource-based view of the firm, claiming that the firm itself is made up of resources, derived from organisational activities developed over time (Penrose, 1959) and external opportunities and threats (Barney, 1991). Such resources when '*presently scarce, difficult to imitate, nonsubstitutable and not readily available in scarce markets'* (Powell, 1992, p552) are expected to generate a sustainable competitive advantage. There are two founding arguments within this: resource heterogeneity results in uniqueness that contributes to competitive advantage; and resource immobility means such resources cannot be easily attained (Peteraf & Barney, 2003). Barney (1991) offers further clarity, contending that resources must be valuable, rare, inimitable or non-substitutable (VRIN) in order to sustain competitiveness. More specifically, resources of value exploit opportunities or neutralize threats in external environments, rare resources are those of limited supply, inimitable resources are those which are difficult to copy on account of social complexity or causal ambiguity and non-substitutable resources are those that cannot be replaced by another resource (Lockett et al, 2009). Whilst competitive rewards vary (Collis & Montgomery, 1995), the relationship between resources and financial gain has dominated literature (Grant, 1991; Powell, 1992; Priem & Butler, 2001) generating considerable academic support (Hart, 1995; Russo & Fouts, 1997; Christmann, 2000; Barney, 2001; Shi et al, 2012; Hitt et al, 2015).

This said, the relationship between resources and competitiveness is not without criticism, and issues of tautology feature prominently in resource-based theory literature (Lockett et al, 2009). That is, the argument that resources may differ from firm to firm (Penrose, 1959) which forms the basis of resource-based view's resource heterogeneity (Wernerfledt, 1984), renders ambiguity from with which differentiation can be derived. Taking this at its most basic level, firms can then out-compete one another on the basis of competitive differentiation, which Lockett et al (2009) suggests offers a trivial depiction of market competition. Moreover, according to Butler & Priem (2001), the argument that a valuable resource can be a source of

competitive advantage is circular in that definitionally value and competitive advantage are inseparable, both ultimately resulting in increased rents. However, such criticisms are contested with some strength by Barney (2001) and Peteraf & Barney (2003) via the argument that resource-based theory's relationship with competitiveness is more complex. First, referring back to the work of Rubin (1973), competitiveness is rarely derived from a resource in isolation but rather from bundles of combinative resources (Teece et al, 1997). Second, as the name suggests, competitiveness is resource-based and thus subject to variance (Collis & Montgomery, 1995; Lockett et al, 2009). More specifically, deriving competitiveness from heterogenous resources delivers heterogenous results (Hitt et al, 2015). Or as Amit & Schoemaker (1993) argue, resources along with capabilities create heterogenous strategic assets from which competitiveness may be derived but not guaranteed. Thus, resource-based theory does not contend that possession of a resource will result in competitive advantage, but that the effective exploitation of the right resources may deliver competitive benefits (Peteraf & Barney, 2003; Hitt et al, 2015) which will differ from firm to firm (Lockett et al, 2009).

2.1.2 Capabilities

Such complexities heighten the need for guidance in support of the operationalisation of resources, and it is here that a reliance falls upon capabilities (Grant, 1991; Shi et al, 2012). That is, presented as '*capacities to deploy resources'* (Christmann, 2000, p665), capabilities are believed to play a fundamental role in the realisation of competitive resources (Rashidirad et al, 2015). This dates back to Penrose's (1959) study in which a causal relationship between capabilities and resources and competitiveness is discussed. This is formalised by Amit & Schoemaker's (1993) argument that resources and capabilities together create strategic assets from with which competitiveness can be derived. Such an argument remains a prominent feature in resource-based theory literature (Newbert, 2007; Nath et al, 2010). In particular, attention is drawn to the role of managers in creating and executing the capabilities required to identify and exploit the right resources (Amit & Schoemaker, 1993; Lockett et al, 2009) and the specific relationship between capabilities and competitiveness (Rashidirad et al, 2015). The need for combinations of capabilities is also commonly discussed (Lockett et al, 2009), surrounding argument that such combinations over time form routines, or as Grant (1991) describes them, 'organisational skills'.

However, whilst capabilities exist as a constant theme in resource-based theory literature (Newbert, 2007; Rashidirad et al, 2015), they remain ill-defined and under researched. That is, initial conceptualisation of the resource-based view offers no definition of capabilities

(Wernerfeldt, 1984), whilst Amit & Schoemaker (1993) discuss uncertainty and complexity surrounding capabilities. According to Newbert (2007) and Lockett et al (2009) subsequent studies have struggled to go beyond somewhat vague discussions of common capabilities (e.g. Russo & Fouts, 1997; Teece et al, 1997; Aragon-Correa & Sharma, 2003). According to Johnson et al (2014), such academic neglect of resource-based theory capabilities presents a major theoretical limitation, undoubtedly adding to its impracticality.

In addition, the resource-based view is criticised for assuming a dominant internal focus (Hart, 1995; Russo & Fouts, 1997; Lockett et al, 2009; Hitt et al, 2015). That is, implications for internal capacities in seminal resource-based theory literature (Penrose, 1959) have facilitated a dominant focus on internal capabilities (Matthews, 2003; Rashidirad et al, 2015). Whilst Barney (2001) addresses this to some extent via discussion of the exogenous nature of the resources, the *extended* resource-based view conceptualises this with greater strength (Lavie, 2006). The extended resource-based view agrees that resources may be derived from external sources, but more specifically may be derived from interrelations with other firms. However, whilst this forces networks and collaborations to the forefront (Arya & Lin, 2007) it has had little impact on resource-based capabilities. In fact, it is scarcely acknowledged in resource-based literature. As such, Rashidirad et al (2015) call for research that acknowledges and distinguishes between both internal and external capabilities (Rashidirad et al, 2015).

2.1.3 Dynamic Capabilities

Emerging as a significant theme in resource-based theory (Eisenhardt & Martin, 2000; Butler & Priem, 2001; Fiol, 2001; Aragon-Correa & Sharma, 2003; Ashby et al, 2012; Hitt et al, 2015) and of particular significance to this study is dynamic capabilities. Produced by Teece et al (1997), dynamic capabilities responds to criticisms surrounding the feasibility of sustained resource competitiveness. In part, such criticisms arise from resource-based theory's reliance on rarity or inimitability which warrants concerns of impermanency, but more prominently there exists a conflict between the exogenous nature of resources (Lockett et al, 2009) and the erratic nature of external environments (Fiol, 2001; Aragon-Correa& Sharma, 2003). Either way, resources are at risk of becoming competitively invalid or irrelevant (Barney, 1991; Grant, 1991; Black & Boal, 1994) and a need for resource renewal emerges (Grant, 1991; Fiol, 2001; Hitt et al, 2015). Dynamic capabilities acknowledges this need, encouraging firms to '*integrate, build and reconfigure internal and external competencies to address rapidly changing environments'* (Teece et al, 1997, p516). Consequently, dynamic capabilities is credited with overcoming a major resource-based theory limitation (Fiol, 2001;

Hart & Dowell, 2011; Chakrabarty & Wang, 2012; Hitt et al, 2015) and considered a competitive necessity (Gebauer, 2011; Li & Liu, 2014).

Pertinently, dynamic capabilities does not explain *how* firms do this, and as such the concept is itself criticised for lacking practical guidance. In particular, it is unclear what constitutes as a 'dynamic capability', rendering criticisms of tautology (Eisenhardt & Martin, 2000) and obscurity (Gebauer, 2011) that literature has failed to overcome (Johnson et al, 2014). However, in a later paper (Teece, 2007) contests this, arguing dynamic capabilities cannot be defined as to do so would conflict the heterogeneity or immobility which resource-based theory is based upon. Rather, dynamic capabilities should be used to guide resources, which remain the source of competitiveness, and explain capabilities. In support of this, and in correspondence with the need for combinations of capabilities (Grant, 1991; Lockett et al, 2009), three bundles of dynamic capabilities are introduced: sensing activities, seizing activities and transforming activities (Teece, 2007).

Sensing

As its title suggests, sensing involves sensing opportunities and threats and shaping them to suit the firm. More specifically, Teece (2007, p1322) describes sensing as a "*scanning, creation, learning and interpretive activity'* in which firms recognise opportunities via entrepreneurial access to existing information or the creation of new information throughout the market. In turn this is divided into four separate activities: processes to direct internal R&D and select new technologies; processes to tap supplier and complementor innovation; processes to tap developments in exogenous science and technology; and processes to identify target market segments, changing customer needs and customer innovation. According to Gebauer (2011), sensing is undertaken frequently to encourage market-searching efforts and anticipate market developments and customer requirements.

Seizing

Seizing follows on from sensing, and again as the title suggests, is about responding to 'sensed' opportunities, in turn resulting in growth and profitability. Teece (2007) describes this as a hazardous activity for any organisation, as the decision of which opportunity to invest in and when to invest is a complex one which requires the creation and adoption of new business models and effective decision making. As such, it is often the case that organisations that have sensed opportunities fail to seize them and accordingly seizing does not occur as often as sensing (Gebauer, 2011). Seizing is also divided into four separate activities: delineating the

customer solution and business model; selecting decision making protocols; selecting enterprise boundaries to manage compliments and control platforms; and building loyalty and commitment (Teece, 2007).

Transforming

The transforming stage involves the reconfiguration of intangible and tangible assets to enhance, combine or protect firm capabilities, resulting in augmented resources and assets and path-dependent organisational evolution (Teece, 2007). It is here where operational efficiency is realised via capabilities that can adapt to changing environments on a continuous basis (Gebauer, 2011). Again, this can be a complex procedure which is divided into four separate activities: decentralisation and near decomposability; governance; cospecialization; and knowledge management. According to Gebauer (2011), transforming activities are undertaken continuously and are embedded in internal learning in which existing capabilities are unlearned and new ones learned.

Thus, with regards to operationalisation of resources, the value of dynamic capability activities of sensing, seizing and transforming emerges with significance. However, according to Teece (2007), literature remains dominated by the misinterpretation of dynamic capabilities as a distinct set of capabilities to be added on to resource-based theory. As such, one of the fundamental flaws of resource-based theory, with regards to resource renewal and adaptability, still needs to be addressed.

2.1.4 Implications for Environmental and Social Sustainability

Discussion of the creation of competitive resources from externalities (Barney, 2001; Lockett et al, 2009) warrants some consideration of sustainability. That is, it is suggested that ecological and societal issues emerge as one of the most prominent threats or opportunities to business in the 21st century (Ashby et al, 2012; Pagell & Shevchenko, 2014). The idea that sustainability should be incorporated into strategy can be traced back to Davis' (1960) claim that businesses have a 'social responsibility' to support environmental, social and political issues. Formalised by Carroll (1979), this idea became 'corporate social responsibility', in which the four roles of business are presented as economic, legal, ethical and discretionary responsibilities. Whilst the roots of corporate social responsibility focus on the moral principles of business (Davis, 1960), links with competitiveness do emerge (Drucker, 1984; Galbreath, 2009; Green & Peloza, 2011). That is, going above and beyond economic and legal responsibilities which are considered mandatory (Carroll, 1999; McWilliams & Siegel, 2001),

ethical and discretionary responsibilities allow the firm to demonstrate commitment to environmental and social issues, consequently delivering opportunities for differentiation (McWilliams & Siegel, 2001). Moreover, environmental responsibilities have also been linked with enhanced efficiency and quality (Matapolous et al, 2014). However, to some extent the corporate social responsibility perspective finds conflict between its moral intentions (Davis, 1960; Carroll, 1979) and its employment as a tool for firm benefit (Drucker, 1984), resulting in a paradox which is still debated in literature (Galbreath, 2009; Li & Lui, 2014). Also emerging with significance is Elkington's (1994) triple-bottom-line concept that presents economic, environmental and social issues as the three pillars of sustainability that must be addressed if firms are to compete in modern business markets (Berger-Walliser & Shrivasta, 2015). Here links with competitiveness are more prominent, surrounding enhanced business performance (Norman & MacDonald, 2004) and the creation of competitive advantage (Wilson, 2015).

Building on links between business strategy, sustainability and competitiveness, the presentation of sustainability as competitive resources emerges with logic. Resource heterogeneity features in the diverse approaches to sustainability that support uniqueness and firm-specificity (McWilliams & Siegel, 2001; Ashby et al, 2012 Pagell & Shevchenko, 2014). Resource immobility is also recognisable in that the increasing complexities of ecological and social environments (Hart & Dowell, 2011; Shi et al, 2012) that supports unattainability, and the ambiguity of sustainability (Davis, 1960; Menguc & Ozanne, 2001; Abbasi & Nilsson, 2012) that supports inimitability. Pertinently, this is not to be simplified to the argument that sustainability offers a resource with which competitive advantage can be derived. Rather, returning to the resource-based theory contention that competitiveness is derived from the effective exploitation of resources (Wernerfeldt, 1984; Barney, 1991), environmental and social issues emerge as opportunities from with which resources may be created and exploited for competitive gain. Nonetheless, according to Shi et al (2012), the realisation of sustainable operations as complex, competitive resources is long over-due.

2.2 The Natural-Resource-Based View

Hart's (1995) natural-resource-based view of the firm (NRBV) conceptualises the presentation of sustainability as competitive resources, advancing understandings of both resource-based theory and of sustainability. More specifically, the NRBV exemplifies many of the resource-based theory complexities discussed earlier. The internal and external nature of resources

maximised via the argument that NRBV resources are dependent on internal organisational capabilities and routines and exploitation of external issues of environmental and social degradation (Hart, 1995; Hart & Dowell, 2011), demonstrating resource heterogeneity. The need for combinative resources is also realised via the NRBV's hierarchal resources of pollution prevention, product stewardship and sustainable development, the latter of which was later divided into clean technologies and base of the pyramid (Prahalad & Hart, 2002), which are proposed to be of greater value when incorporated conjunctively (Hart, 1997), demonstrating resource immobility. Resource-based theory's dominant focus on financial gain (Grant, 1991; Powell, 1992; Butler & Priem, 2001) is also destabilised by NRBV's competitive rewards of competitive cost cutting, enhanced efficiency, differentiation and access to scarce resources and unsaturated markets. Hart also stresses that such rewards are not guaranteed but reliant on effective exploitation of resources. With regards to sustainability, the NRBV goes beyond corporate social responsibility's (Carroll, 1979) contentions and the triple-bottom-line's discussions (Elkington, 1994) of the need to respond to ecological and societal degradation (Berger-Walliser & Shrivasta, 2015) to elucidate the business case for doing so via maximisation of competitiveness (Russo & Fouts, 1997; Shi et al, 2012). In doing so, the NRBV promotes an 'environmental revolution' (Hart, 1997) intended to change the way business operated entirely (Svensson & Wagner, 2012). Moreover, the NRBV serves as dominant theory in sustainable operations literature (Walker et al, 2015) where it is believed to have contributed significantly to the development of the field (Johnson et al, 2014).

However, the NRBV falls short of the operationalisation of sustainability as competitive resources by succumbing to the same resource-based theory limitations discussed earlier. That is, the NRBV suffers from a significant lack of practical guidance (Menguc & Ozanne, 2005; Shi et al, 2012) which is believed to have prevented its transition into industry (Andersson & Bateman, 2000; Hart & Dowell, 2011; Golicic & Smith, 2013). More specifically, Hart (1995) offers only vague implications for NRBV capabilities despite their fundamental role in supporting competitive resources (Grant, 1991; Amit & Schoemaker, 1993; Newbert, 2007). Subsequent studies (e.g. Russo & Fouts, 1997; Hart & Christensen, 2002; Aragon-Correa & Sharma, 2003; Menguc & Ozanne, 2005; Hart & Dowell, 2011; Shi et al, 2012) also struggle to offer definition of capabilities, with capabilities rarely being the focus of research and implications commonly lacking empiricism or categorization according to each resource.

In addition, the NRBV somewhat heightens the need for dynamic capabilities (Fiol, 2001; Aragon-Correa & Sharma, 2003; Golicic & Smith, 2013), but fails to conceptualise this. That

is, besides some acknowledgement for the value of adaptability, the NRBV does little to define how firms can overcome the unpredictability of ecological and societal environments, in which issues of competitive impermanency are arguably intensified (Chakrabarty & Wang, 2012; Li & Liu, 2014). According to Butler & Priem (2001), such oversight adds to impracticality and infeasibility that are typical of resource-based theories. Whilst dynamic capabilities does feature prominently throughout subsequent NRBV literature (e.g. Aragon-Correa & Sharma, 2003; Hart & Dowell, 2011; Golicic & Smith, 2013; Johnson et al, 2014; Miemczyk et al, 2016), studies often overlook its role as a tool with which to guide and explain capabilities towards the realisation of competitive resources over time (Teece, 2007). In particular, application of dynamic capabilities activities of sensing, seizing and transforming is neglected in such literature. As such, the NRBV fails to elucidate the complex relationships between resources and capabilities and competitiveness over time, which according to Grant (1991) and Rashidirad et al (2015) prevents operationalisation of resources. Moreover, the theory's contributions to resource-based theory and competitive sustainability in modern business are consequently limited.

Pertinently, consideration must again be rendered to the complexities of the empirical study of heterogenous and ambiguous resources (Amit & Schoemaker, 1993; Lockett et al, 2009) and implicit or inherent capabilities (Newbert, 2007; Lockett et al, 2009). It is notable that to date literature offers no empirical evidence or explanation of NRBV resources. However, this is arguably a result of the positivistic dominance of resource-based theory research (Acedo et al, 2006), which may also have stimulated the argument that the NRBV does not exist in industry (Mencug & Ozanne, 2005; Hart & Dowell, 2011; Golicic & Smith, 2013). Thus, from a non-positivistic stance such an argument may be contested, and access to complex and tacit resources of the NRBV more feasible. In some consequence, this study seeks empirical exploration of NRBV resources, and within that, explication of dynamic NRBV capabilities. This begins with comprehensive review of each NRBV resource and extraction of implications for capabilities, as detailed throughout this section and summarized in table 2.1.

2.2.1 Pollution Prevention

Hart's (1995) first NRBV resource is pollution prevention, which in acknowledgement of growing concerns of ecological degradation, promotes the minimisation of waste and emissions throughout operations. The focus is shifted away from traditional management or disposal of waste and emissions, to instead prevent their initial occurrence (Aragon-Correa & Sharma, 2003). In doing so, pollution prevention is intended to reduce costs associated with

waste and emissions and maximise efficiency (Hart, 1995; Russo & Fouts, 1997), encouraging its presentation as a competitive cost cutting strategy (Hart, 1997; Christmann, 2000; Hart & Dowell, 2011).

With regards to supportive capabilities, Hart (1995) places a reliance on improved house-keeping, substitution of materials, recyclability and total quality management, whilst minor references to continuous innovation, process innovation and employee involvement can also be noted. Following on from this, Russo & Fouts (1997) reinforce employee involvement as an integral pollution prevention capability, highlighting the importance of organisational commitment and learning, cross functional integration and employee skill and participation. Their study also exposes some reliance upon technology, human resource management, reputation and political acumen. Hart & Dowell (2011) later define continuous improvement as the key strategic capability of pollution prevention, whilst innovative capabilities, commitment and proactivity also warrant discussion. This corresponds with additional studies in which continuous innovation (Vachon & Klassen, 2008; Golicic & Smith, 2013), and process innovation (Aragon-Correa & Sharma, 2003) are linked with pollution prevention. However, again such implications for capabilities lack empiricism and are principally based upon propositions or comparison, inviting more rigorous assessment.

Pertinently, pollution prevention is presented as the dominant resource, and according to Hart & Dowell (2011) has detracted attention from the other resources. This is evidenced to some extent in Russo & Fouts (1997) and Aragon-Correa & Sharma's (2003) studies which focus solely on pollution prevention, and in particular its links with financial gain. This conflict's both Hart's proposition that natural-resource-based view resources are interconnected and are of greater value when implemented conjunctively, and his attempt to diverge away from resource-based theory's dominant focus on financial gain. Also neglected in literature (e.g. Russo & Fouts, 1997; Menguc & Ozanne, 2005; Shi et al, 2012) is Hart's proposition that over time pollution prevention moves from an internally-focused strategy towards an externally focused, legitimacy-based process. Thus, there appears some disregard of the resource-based roots of pollution prevention, in that the value of combinative resources, their exogenous nature and their competitive heterogeneity has been somewhat overlooked. As such, along with the need for enhanced practical guidance, there is a need to elucidate pollution prevention as a competitive resource.

2.2.2 Product Stewardship

The second NRBV resource is product stewardship, which encourages the prioritisation of the natural environment throughout each stage of the product lifecycle (Hart, 1995). That is, assuming a lifecycle perspective of production and presenting the natural environment as a key stakeholder, environmentally damaging processes are minimised and conservation and avoidance of harmful productions maximised. Attention is also turned to environmental end-of-life practices, with Hart (1995) discussing the value of recyclability, biodegradability or take-back as opposed to traditional disposal methods which pose environmental threats. Interestingly, this warrants the argument that '*product stewardship is a concept that relates to the realm of the circular economy'* (Jensen & Remmen, 2017, p381) in that its lifecycle processes support conservation, reuse, remanufacturing, resale and recyclability. According to Leigh & Li (2015) such a cradle-to-cradle approach assumes aspects of industrial ecology and industrial symbiosis. Explicitly, both product stewardship and industrial ecology seek environmentally maximised production systems, whilst industrial symbiosis promotes this from an integrative supply chain approach. Reinforcing this is Hart's (1995) proposition that product stewardship is rooted in production and operations, and overtime shifts from internal cross-functional processes to external stakeholder orientated processes. Not only is this demonstrative of Hart's exemplification of the internal and external characteristics of resource-based theory, but it is here that opportunities for competitiveness arise. That is, along with its environmental advantages, the externally focused lifecycle approach is intended to permit access to scarce resources such as raw materials, markets and locations, whilst the creation of wholly, sustainable products may act as a source of differentiation (Hart, 1995; Menguc & Ozanne, 2005; Ashby et al, 2012; Svensson & Wagner, 2012; Golicic & Smith, 2013; Miemczyk et al, 2016), albeit dependent upon effective firm execution (Hart & Dowell, 2011).

With regards to capabilities, implications surround the lifecycle and stakeholder perspective, with Hart (1995) stressing the significance of lifecycle analysis and stakeholder management. That is, according to Hart, lifecycle analysis supports the minimisation of environmental damage throughout production, and as such is correspondent with a product stewardship, and industrial ecology (Leigh & Li, 2015), approach. To some extent this may be due to the argument that in order to minimise such damage it must first be measured (Shi et al, 2012; Jensen & Remmen, 2017), and lifecycle analysis permits a cradle-to-cradle approach that corresponds with product stewardship's intentions (Leigh & Li, 2015). With regards to stakeholder management, the involvement of each stage of production places dependencies on

other actors, or rather stakeholders, in the supply chain (Hart, 1995). In fact, in line with industrial symbiosis, Ashby et al (2012) claim that the creation of wholly sustainable products and processes is rarely achieved by a company in isolation but rather dependent upon a contribution from each actor. As such, there exists a logical need to manage stakeholders in a way which environmental concerns can be maximised (Leigh & Li, 2015; Jensen & Remmen, 2017). Reinforcing this with some strength is Hart & Dowell (2011) who in their ten-year review of the NRBV present stakeholder integration as the key strategic capability of product stewardship. In addition, discussions of the development of new, lower impact processes and restructuring of production systems renders some minor and obscure references for innovation in product stewardship.

Notably, besides some reinforcement for the significance of lifecycle analysis (Christmann, 2000; Johnsen et al, 2014), stakeholder management (Vachon & Klassen, 2008; Leigh & Li, 2015) and innovation (Hart, 1997; Menguc & Ozanne, 2005; Johnsen et al, 2014), subsequent studies have not afforded product stewardship capabilities the same attention as those of pollution prevention. As such, the definition of product stewardship capabilities remains a research gap, and one which warrants resolution if the resource's operationalisation is to be realised.

As well as neglect of capabilities, product stewardship suffers from similar theoretical misinterpretation as pollution prevention. That is, returning to the presentation of pollution prevention as an internally focused strategy, there is a tendency to present product stewardship as its external counterpart (Menguc & Ozanne, 2005; Shi et al, 2012). To some extent this assumes some logic in that Hart (1995) does suggest that the two resources are embedded in and strengthen one another and possess similar intents surrounding recyclability, waste and innovation. However, this disregards pollution prevention's own external processes and product stewardships internal processes, and offers something of naïve construal of resource-based theory's combinative resources (Rubin, 1973; Teece et al, 1997; Lockett et al, 2009). This again implies some disregard for the resource-based theory roots of the NRBV, and conflicts Hart's (1995) efforts to exemplify both the internal and external aspects of competitive resources. As such, the presentation and explanation of both pollution prevention and product stewardship as the complex competitive resources of which they are intended is overdue (Shi et al, 2012).

2.2.3 Sustainable Development

The third NRBV resource is sustainable development which aims to promote the consideration of economic, environmental and social issues on a global scale (Hart, 1995). Sustainable development links economic, environmental and social issues together to '*seek ecologically sustainable and socially-just development world-wide'* (Shrivastava & Hart, 1995, p155). As such, firms are expected to go beyond the environmental alleviation intentions of pollution prevention and product stewardship in pursuit of positive impact operations (Hart, 1997). A particular focus falls upon the economic development of the third world, with Hart (1995, p996) stressing its '*deeper poverty feeds the cycle of population growth and environmental degradation'*. This exemplifies links between economic, environmental and social issues, and attempts to overcome the dominance of sustainability efforts aimed at the developed north in neglect of the poorer south at the time of NRBV conceptualisation (Hart, 1995). It is also here that the fundamental role of business in sustainable development is stressed, in that in order to overcome such third world issues and meet the demands of growing populations, industrial and economic activity would have to substantially multiply, further adding to environmental degradation. More specifically, such increased activity intensifies pressures on the earth's natural resources, which are already mismanaged via traditional business processes, contributing to degradation of eco-systems which human life is dependent (Song et al, 2015). Thus, sustainable development encourages both the creation of new manufacturing processes in support of environmental advancement and new business markets in the south in support of economic and societal advancement (Hart, 1995). Opportunities for competitive gain arise in the creation of such processes ahead of competitors and access to new, unsaturated markets of the future (Prahalad & Hammel, 1994).

Notably, Hart's conceptualisation of sustainable development and its prioritisation of economic, environmental and social issues cannot be considered novel. To some extent it offers little more than a reiteration of the widely cited World Commission on Environment and Development's (WCED) (1987, p8) Bruntland report definition of sustainable development as meeting '*the needs of the present without compromising the ability of future generations to meet their needs'*. Similarities can also be noted with Carroll's (1974) corporate social responsibility and Elkington's (1994) triple-bottom-line approach: both of which predate the NRBV and advocate the consideration of economic, environmental and social issues in business. In fact, there exist prominent links between sustainable development and corporate social responsibility (Mencug & Ozanne, 2005; Markley & Davis, 2007; Matapolous et al, 2014), whilst Elkington (1994, p91) makes direct reference to sustainable development

in the triple-bottom-line approach, stating *'it has become increasingly clear that business must play a central role in achieving the goals of sustainable development strategies'*. Moreover, as discussed earlier both corporate social responsibility (McWilliams & Sigel, 2001; Li & Liu, 2014) and the triple-bottom-line approach (Wilson, 2015) warrant links with competitive gain, and unlike Hart's sustainable development, are widely recognised in both academia and practice. In fact, Hart's sustainable development appears to have made little impact on growing academic and business interests surrounding the pursuit of economic, environmental and social issues on a global scale (Berger-Walliser & Shrivasta, 2015). In some consequence, it is argued that the resource is neglected in literature (Hart & Christensen, 2002; Hart & Dowell, 2011; Ashby et al, 2012; Kolk et al, 2014), with NRBV studies tending to focus on pollution prevention and product stewardship (e.g. Russo & Fouts, 1997; Aragon-Correa & Sharma, 2003; Shi et al, 2012; Miemczyk et al, 2016). Arguably worsening its practical limitation is inattention of its capabilities, which besides the need for long-term vision, Hart (1995) offers no definition.

Offering some resolve is the subsequent division of sustainable development in to two separate but interrelated, resources: clean technologies and base of the pyramid (Hart, 1997; Hart & Christensen, 1997; Prahalad & Hart, 2002). Such division adds some definition to Hart's (1995) obscure and theoretically underdeveloped sustainable development (Ashby et al, 2012). For one, the division exemplifies sustainable development's somewhat dispersed intentions: clean technologies encompasses the development of new manufacturing systems in support of global environmental sustainability, resulting in competitive pre-emption; and base of the pyramid involves the development of new markets in support of global economic and social sustainability, creating unsaturated markets for expansion. Whilst to some extent this detracts from Hart's efforts to marry economic, environmental and social issues, clean technologies and base of the pyramid are presented as interrelated resources intended to follow on from pollution prevention and product stewardship (Hart, 1997), corresponding with the need for combinative resources (Rubin, 1973; Teece et al, 1997). In addition, the division of sustainable development is arguably where Hart attempts to go beyond corporate social responsibility and the triple-bottom-line approach, consequently advancing understandings of sustainable business. That is, it adds some clarity to the ways in which business might address economic, environmental and social issues, which in spite of the prominence of corporate social responsibility and the triple-bottom-line, remains complex (Boken et al, 2013; Pagell & Shevcheno, 2014; Song et al, 2015; Echebarria et al, 2017). In particular, Norman & MacDonald (2004) discuss a lack of research concerning the application of a triple-bottom-

line approach, whilst Hall & Vrendenberg (2012) highlight the need for greater guidance surrounding economic, environmental and social sustainability. Moreover, the classification of sustainable development as two complex competitive resources offers a clear depiction of the competitive value of economic, environmental and social issues, thus encouraging their exploitation in a way which corporate social responsibility or the triple-bottom-line do not (Menguc & Ozanne, 2005). Specifically, returning to the roots of resource-based theory, clean technologies and base of the pyramid present environmental and social issues as exclusive opportunities from which competitive resources may be derived and exploited for firm gain.

However, in spite of this clean technologies and base of the pyramid are scarcely acknowledged in literature, with NRBV literature remaining dominated by pollution prevention and product stewardship (e.g. Russo & Fouts, 1997; Aragon-Correa & Sharma, 2003; Shi et al, 2012) or assuming a three-resource perspective that disregards sustainable development's division altogether (e.g Markely & Davis, 2007; Shi et al, 2012; Matapolous et al, 2014; Miemczyk et al, 2016). Such academic neglect (Hart & Dowell, 2011) arguably adds to issues of practical inapplicability and overlooks the significance of sustainable development as competitive resources. Thus, review and definition of sustainable development according to its segregated resources of clean technologies and base of the pyramid is long overdue. Adding value to this are calls for a more distinct sustainable development framework (Boken et al, 2013) in response to claims that existing ones are '*insufficient, incremental and incomplete'* (Berger-Walliser & Shrivasta, 2015, p419).

Clean Technologies

Hart (1997) describes clean technologies as stage 3 where pollution prevention is stage 1 and product stewardship is stage 2. More specifically, whilst pollution prevention and product stewardship aim to reduce operational impact or even to realise zero impact operations, clean technologies is focused upon the pursuit of positive impact operations within an environmental context. As such, Hart (1997, p73) contends that companies '*must begin to plan for and invest in tomorrow's technologies'*, building upon the argument that technological innovations provide substitutes for non-renewables. There is a need to move away from traditional routines and processes to support the creative redesign of industries in which sustainability is maximised (Hart & Milstein, 1999). Clean technologies is defined as:

'Any product, service or process that delivers value using limited or zero non-renewable resources and/or creates significantly less waste than traditional offerings'

Pernick & Wilder (2007, p2)

Various clean technologies are discussed throughout literature, such as Hart & Dowell's (2011) prioritisation of biotechnologies and bioengineering, and Bjornali & Ellingson's (2014) discussions of solar, wind and hydro powers and green transportation and buildings. Offering some clarity is Pernick & Wilder (2007) who divide clean technologies into four definitive categories: energy technologies including solar energy, wind power, smart grid and mobile applications; transportation technologies including hybrid electric vehicles, plug in hybrid and electric vehicle technology; water technologies including water filtration, desalination technology and nanotechnologies; and material technologies including green buildings, biofuels and biomaterials.

With regards to clean technologies capabilities the focus falls upon innovative and entrepreneurial activities (Hart & Milstein, 1999; Hart & Dowell, 2011). Pertinently, this is not at the continuous improvement or greening levels seen in pollution prevention or product stewardship, but rather innovation of high investment on an advanced level (Hart & Dowell, 2011). Hart & Milstein (1999) argue that organisations require vision and manage and accept disruptive change in the form of creative destruction, whilst Hart & Dowell (2011) stress the need for future positioning and commercialisation capabilities and an aptitude for cannibalising technologies. Bjornali & Ellingsen (2014) also discuss the significance of political acumen, highlighting it as means by which to overcome policies and legislative barriers. However, as with pollution prevention and product stewardship, such implications lack empiricism and clarity and offer only a limited insight to some of the capabilities required to realise a '21st century clean-tech revolution' (Pernick & Wilder, 2007).

As with pollution prevention and product stewardship, the value of the empirical study of clean technologies is not limited to definition of its capabilities but is supportive of its elucidation as a complex, competitive resource. Adding to the value of this is the rarity of its discussion in modern NRBV literature (e.g. Menguc & Ozanne, 2005; Shi et al, 2012; Matapolous et al, 2014; Miemczyk et al, 2016) and criticisms of incomplete conceptualisation (Bjornali & Ellingsen, 2014). Certainly, it appears that clean technologies has done little to overcome sustainable development's unintelligibility and has to date made little impact in NRBV literature. Not only is this conflictive of its conceptualisation which aims to offer definition to sustainable development (Hart, 1997), but it overlooks the value of clean

technologies as its own, valuable resource of great significance in modern business (Pernick & Wilder, 2007).

Base of the Pyramid

Base of the pyramid is presented as the socially focused counterpart of sustainable development, focusing on the alleviation of social ills in and support of emerging markets at the base of the economic pyramid via stimulation of economic development (Hart & Christensen, 2002). Base of the pyramid argues that engaging in business with underprivileged areas of the world may ease poverty whilst simultaneously, and somewhat paradoxically, increase profits by serving previously neglected and unsaturated markets (Hart & Milstein, 1999). Such markets offer considerable opportunities for growth (London & Hart, 1994) and permit the exploration of radical innovations in a low risk environment (Hart & Christensen, 2002). Successful innovations can then be transferred back to domestic markets, minimising disruption (Prahalad & Hart, 2002; Hart & Dowell, 2011; Hart et al, 2016). Links are drawn with clean technologies, in that base of the pyramid markets, which are often in possession of high levels of environmental and social degradation, present appropriate markets for the exploration of clean technologies (Prahalad & Hart, 2002; Hart, 2007; 2011), whilst simultaneously easing poverty via the improvement of living standards (Arnold & Valentin, 2013). In addition, the long-term environmental impact of the growth of emerging economies increases the need for clean technologies (Hart & Christensen, 2002; Hart, 1997; London & Hart, 2004) and stresses the interconnectedness of the NRBV and the value of resource bundles.

With regards to capabilities implications for embedded innovation (Hall & Vrendenburg, 2004; Hart & Dowell, 2011), technological innovation (Prahalad & Hart, 2002) and entrepreneurship (Arnold & Valentin, 2013) are identifiable. The emphasis on innovativeness and entrepreneurship is derived from the argument that in order to succeed in emerging markets products and services may need to be specifically designed to suit unfamiliar needs (Hart & Christensen, 2002; Prahalad & Hart, 2002; Arnold & Valentin, 2013; Kolk et al, 2014). Market entry strategies (Hart & Christensen, 2002; Prahalad & Hart, 2002; London & Hart, 2004) and collaborations with governments, non-governmental organisations (NGO), communities, financial institutes and other firms (Prahalad & Hart, 2002; London & Hart, 2004) also warrant some discussion. More recently, Hart et al (2016) place an emphasis on co-creating with base of the pyramid stakeholders, international strategizing, dynamic business models and structure and base of the pyramid specific measurements and incentives. However,

again such implications lack empirical validation or explanation and additional capabilities identified if the resource is to overcome resource-based theory's practical limitations.

Notably, whilst the resource is subject to the same practical limitations as pollution prevention, product stewardship and clean technologies that are typical of resource-based theory (Grant, 1991; Lockett et al, 2009), inapplicability is arguably heightened with base of the pyramid. That is, Hall & Vrendenburg (2004) suggest that it is the social aspects of sustainable development that managers struggle to tackle, offering some explanation to the dominance of environmentally focused pollution prevention and product stewardship. Of further concern is obscurity surrounding what constitutes as a base of the pyramid market or what can be considered profit or sustainable development in such markets (Karnani, 2007), which is subject to considerable variance in literature (Kolk et al, 2014). In fact, the plausibility of the resource altogether warrants criticism, with questions raised to the complexities of consumerism in underdeveloped economies and the potential for and integrity of profiting from the world's poorest (Arnold & Valentin, 2013). In particular, Karnani (2007, p91) stresses the complexities of entering and working in base of the pyramid markets, with particular regards to weak infrastructures, logistical barriers, geographical and cultural disparities and the improbability of creating economies of scale, and consequently argues:

> *'The [base of the pyramid] proposition is indeed too good to be true. It is seductively appealing but riddled with fallacies. There is little glory or fortune at the bottom of the pyramid - unfortunately, it is (almost) all a mirage'.*

Taking such criticisms into account, Kolk et al (2014) suggest that base of the pyramid has evolved away from its initial conceptualisation as global, profit driven resource to become a more attainable, locally-focused social sustainability strategy detached from profitability. However, this arguably undermines base of the pyramid's resource-based theory roots that celebrates the rarity of resources and their inimitability on account of social complexity and causal ambiguity (Barney, 2001). In addition, there exists some disconnect between a locally-focused social sustainability resource and the global intents of sustainable development, and the WCED's (1987) Bruntland report for that matter, from which base of the pyramid is derived. Furthermore, such a radical realignment of base of the pyramid conflicts the growth of social sustainability efforts focused upon the development of emerging markets (Berger-Walliser & Shrivasta, 2015). In line with base of the pyramid, this is not only to assist in the alleviation of social ills (Matapolus et al, 2014), but is in pursuit of new business markets

(Karnani, 2007) and consequently firm gain (Hart et al, 2016). Again, corporate social responsibility and the triple-bottom-line approach emerge with significance, with both believed to be encouraging and supporting business in emerging markets from a sustainability perspective (Maloni & Brown, 2006; Hutchins & Sutherland, 2008; Matapolous et al, 2014) and pertinently warranting links with competitiveness and base of the pyramid (Berger-Walliser & Shrivasta, 2015). Thus, it is perhaps the presentation of such efforts as a competitive resource that is lacking in literature and practice, resulting in base of the pyramids falsification (Kolk et al, 2014). Reinforcing this, is the tacit nature of resources (Hart, 1995) which often prevents their identification (Butler & Priem, 2001). It is for such reasons that Hart et al (2016) contend that in spite of its complexity and scarcity, base of the pyramid at it was initially conceptualised is feasible and still of value in modern business, calling for its further investigation.

This said, Kolk et al's (2014) discussions of locally-focused social sustainability should not be entirely disregarded. Rather, such discussions render some consideration of the competitiveness of locally-focused social sustainability. Social sustainability within a local context prioritises social issues in the domestic market such as charitable donations, education, healthcare and employment and render opportunities for firm benefit (Hutchins & Sutherland, 2008). More specifically, it is argued that alleviation of such issues may result in positive social impact in the domestic market which in turn improves the economic climate rendering opportunities for profit (Kolk et al, 2014). In addition, demonstrating such commitments, often via corporate social responsibility (Menguc & Ozanne, 2005), enhances reputation resulting in differentiation (Matapolous et al, 2014). In spite of this, locally-focused social sustainability is not represented in any of the NRBV's four resources, revealing a gap in the NRBV framework. Stressing the pertinence of such a gap are claims that locally-focused social may support the realisation of globally-focused social sustainability (Echebarria et al, 2017), rendering some implications for interrelated resource bundles, and calls for greater conceptualisation of social sustainability in the domestic market (Hutchins & Sutherland, 2008).

Table 2.1 Implications for NRBV capabilities derived from seminal studies

Pollution Prevention
➢ Total quality management (Hart, 1995) ➢ Improved housekeeping (Hart, 1995) ➢ Substitution of materials (Hart, 1995) ➢ Recyclability (Hart, 1995) ➢ Continuous innovation/ improvement (Hart, 1995; Hart & Dowell, 2011; Vachon & Klassen, 2008; Golicic & Smith, 2013) ➢ Process innovation (Hart, 1995; Aragon-Correa & Sharma, 2003) ➢ Employee involvement & skills (Russo & Fouts, 1997) ➢ Cross functional integration (Russo & Fouts, 1997) ➢ Organisational commitment & learning (Russo & Fouts, 1997; Hart & Dowell, 2011) ➢ Technological know-how (Russo & Fouts, 1997) ➢ Human resource management (Russo & Fouts, 1997) ➢ Reputation (Russo & Fouts, 1997) ➢ Political acumen (Russo & Fouts, 1997)
Product Stewardship
➢ Stakeholder management/ integration (Hart, 1995; Hart & Dowell, 2011; Leigh & Li, 2015) ➢ Cross-functional management (Hart, 1995) ➢ Lifecycle analysis (Hart, 1995; Christmann, 2000; Johnsen et al, 2014) ➢ Development of new, lower impact products (Hart, 1995) ➢ Restructuring of production systems (Hart, 1995)
Clean Technologies
➢ Advanced development of new, clean processes and products (Hart, 1995) ➢ Investment in innovation (Hart, 1997; Hart & Dowell, 2011) ➢ Technological innovation (Hart, 1997; Hart & Dowell, 2011) ➢ Disruptive change (Hart, 1997; Hart & Milstein, 1999; Hart & Dowell, 2011) ➢ Future positioning & Vision (Hart & Milstein, 1999; Hart & Dowell, 2011) ➢ Commercialization of clean technologies (Hart & Dowell, 2011) ➢ Entrepreneurial activities (Hart, 1997; Hart& Milstein, 1999; Hart & Dowell, 2011) ➢ Political acumen (Bjornali & Ellingsen, 2014)
Base of the Pyramid
➢ Entrepreneurial redesign of business models & products (Hart & Christensen, 2002; Prahalad & Hart, 2002; Arnold & Valentin, 2013; Kolk et al, 2014; Hart et al, 2016) ➢ Technological innovation (Prahalad & Hart, 2002) ➢ Strategic market entry (Hart & Christensen, 2002; London & Hart, 2004; Arnold & Velntin, 2013; Hart et al, 2016) ➢ External collaboration (Prahalad & Hart, 2002; Hart et al, 2016) ➢ Social embeddedness (London & Hart, 2004) ➢ Embedded innovation (Hall & Vrendenburg, 2004; Hart & Dowell, 2011) ➢ Base of the pyramid specific measurements & incentives (Hart et al, 2016)

2.3 Extensions of the Natural-Resource-Based View

Whilst there is undoubtedly a need for further investigation of the NRBV, the theory has benefitted from considerable academic interest and development (Johnsen et al, 2014). In particular, several prominent attempts at theoretical extension exist and are discussed throughout this section: Aragon-Correa & Sharma's (2003) contingent proactive environmental strategy; Menguc & Ozanne's (2005) natural environment orientation; and Shi et al's (2012) conceptual natural-resource based green supply chain management model.

Notably, such extensions fail to include all four NRBV resources and wholly neglect clean technologies and base of the pyramid. Nonetheless, as depicted in table 2.2 at the end of this section, they do offer some additional insight to pollution prevention and product stewardship capabilities.

2.3.1 A Contingent Proactive Environmental Strategy

Aragon-Correa & Sharma's (2003) contingent proactive environmental strategy uses the NRBV, dynamic capabilities and contingency theory to add applicability to pollution prevention by presenting proactivity as a fundamental capability in competitive environmental strategies. According to Aragon-Correa & Sharma, firms who adopt a proactive environmental strategy are increasingly innovative and likely to benefit from rare advantages in uncertain markets, reduced costs and waste, and improved efficiency and productivity. This builds upon earlier research in which Sharma & Vrendenburg (1998) stressed the significance of both proactivity and dynamic capabilities in environmental strategies, empirically evidencing that continuous investment in environmental strategies and analysis of external environments delivered cost benefits and enhanced innovativeness. Similarly, an earlier study by Aragon-Correa (1998) exposed a positive correlation between strategic proactivity and responsiveness to the natural environment, whilst Russo & Fouts' (1997) study concluded that proactivity is fundamental to achieving competitive and environmental business strategies. As such, Aragon-Correa & Sharma's linking of pollution prevention and proactivity benefits from considerable reinforcement and logic. This said, in line with resource heterogeneity and supported by the application of contingency theory, Aragon-Correa & Sharma (2003) stress that adoption of a proactive environmental strategy does not guarantee organisational reward and may even impact negatively according to variations in the alignment of resources and capabilities.

Whilst some variations with resources and capabilities are to be expected, some references to prevalent capabilities do exist in such discussions. For example, Russo & Fouts (1997) place a dependency on managerial competence in environmental strategies, whilst Aragon-Correa (1998) make references to stakeholder integration and relationship management, higher-order learning and continuous innovation. This again is reflected in Aragon-Correa & Sharma's (2003) contingent proactive environmental strategy in which stakeholder integration, continuous improvement, higher order shared learning, the interpretation of environmental issues as opportunities, and the reconfiguration and recombination of resources are highlighted as integral capabilities.

However, as with the earlier identification of NRBV capabilities, such references are anecdotal and lack empiricism. In addition, Aragon-Correa & Sharma's decision to focus solely on pollution prevention in neglect of product stewardship and clean technologies which are also environmentally motivated (Hart, 1997) suggests further work is needed and adds to pollution prevention's dominance (Hart & Dowell, 2011). It is perhaps for such reasons that Li & Liu (2014) argue that the contingent environmental strategy remains in its infancy.

2.3.2 The Natural Environment Orientation

Menguc & Ozanne (2005) claim to be the first to empirically test Hart's (1995) NRBV, and in doing offer perhaps the most explicit attempt at addressing issues of practical inapplicability. Menguc & Ozanne create a higher order construct of natural environment orientation (NEO) in an attempt to translate natural environment strategies and resources into industry. This is based upon three individual 'first order factors': corporate social responsibility, entrepreneurship and commitment to the environment. Corporate social responsibility is added to pollution prevention, entrepreneurship to product stewardship and commitment to the environment to sustainable development, in notable neglect of its division into clean technologies and base of the pyramid.

The amalgamation of pollution prevention and corporate social responsibility takes into account Hart's (1995) total quality management inspirations in conceptualisation of the resource and Aragon-Correa & Sharma's (2003) prioritisation of proactivity. This is intended to encourage firms to go beyond environmental regulations and legislation to place a stronger emphasis on the natural environment and the way in which operations may render negative environmental impacts. In doing so, firms develop specific resources that facilitate the creation of a sustained competitive advantage. An entrepreneurial framework of innovativeness, proactiveness and risk-taking is added to product stewardship. This is in response to product stewardship's need for the innovative redesign of product systems and development of new, low impact processes and products. Menguc & Ozanne argue that a firm in possession of entrepreneurial capabilities will be better equipped to deal with challenges of managing the natural environment.

Pertinently, the natural environment orientation does benefit from empirical reinforcement, in that Menguc & Ozanne explored their theory in Australian manufacturing firms. The results support the role of corporate social responsibility, entrepreneurship and commitment to the environment in the realisation of natural environment orientated strategies and positively

linked them with increased profit and market share. However, whilst this offers a considerable contribution to improved applicability of the NRBV, and offers some insight to the relationship between the NRBV and corporate social responsibility, Menguc & Ozanne state that variance between results suggests additional capabilities may also be of value, enforcing the need for further investigation.

2.3.3 A Structural Model of Natural-Resource-Based Green Supply Chain Management

Building upon links between pollution prevention and product stewardship and green supply chain management, Shi et al (2012) create a conceptual natural-resource-based green supply chain model. This is intended to offer a holistic framework with which to promote the management of energy efficient and low carbon operations. The model is based on the proposition that intra-organisational environmental practices and inter-organisational environmental practices exist as complex resources which stimulate competitiveness, presenting a link between the NRBV and green supply chain management. Intra-organisational environmental practices are presented as causally ambiguous resources within a firm's internal green supply chain management strategy in support of pollution prevention, encouraging a proactive approach to environmental management. Conversely, inter-organisational environmental processes are presented as socially complex resources given that they require collaboration with supply chain members, and are linked with product stewardship. These practices are defined as green purchasing, green distribution and design for the environment. Implying a hierarchal approach and giving nod to combinative resource bundles, Shi et al (2012) go on to suggest that firms who have already developed intra-organisational environmental practices stand better equipped to develop inter-organisational environmental practices.

As well as intra-organisational and inter-organisational environmental practices, Shi et al's natural-resource-based green supply chain management model places an emphasis on key performance indicators and institutional theory. With regards to performance measurement, environmental, operational and financial measures (Shi et al, 2012) are prioritised. Environmental measures include measurements of environmental impact, environmental cost and social impact. Operational measures include measures such as ISO 14001, eco-efficiency and support systems such as just-in-time and lean. Financial measures focus on long term financial indicators, drawing inspiration from Menguc & Ozanne's (2005) natural environmental orientation. This emphasis on performance measurement is derived from the

argument that in order to realise environmental goals, environmental behaviour must be measurable (Shi et al, 2012; Miemczyk, 2012). The inclusion of institutional theory, which is argued to play a fundamental role in green supply chain management (Sarkis et al, 2011), is intended to highlight the significance of external pressures such as governments, policy makers and customers. More specifically Shi et al (2012) suggest that the ability to identify these pressures and transform them into action is a fundamental component of their natural-resource-based green supply chain management model.

However, whilst Shi et al (2012) offer a convincing argument of the relationship between the NRBV and green supply chain management, their paper is conceptual and would benefit from empirical analysis. In this respect it fails to overcome the theory-practice gap, but nonetheless offers a substantial basis for future research. Of particular significance in this study are the capabilities which form intra-organisational and inter-organisational environmental practices, which are discussed in some detail later in this chapter.

Table 2.2 Implications for NRBV capabilities derived from extensions & developments

Pollution Prevention
➢ Proactivity (Russo & Fouts, 1997; Sharma & Vredenburg, 1998; Aragon-Correa, 1998; Aragon-Correa & Sharma, 2003; Shi et al, 2012)
➢ Managerial competence (Russo & Fouts, 1997)
➢ Stakeholder integration (Aragon-Correa, 1998; Aragon-Correa & Sharma, 2003)
➢ Continuous innovation/ improvement (Aragon-Correa, 1998; Menguc & Ozanne, 2005)
➢ Higher order shared learning (Aragon-Correa, 1998; Aragon-Correa & Sharma, 2003; Menguc & Ozanne, 2005)
➢ Interpretation of environmental issues as opportunities (Aragon-Correa & Sharma, 2003)
➢ Resource reconfiguration (Aragon-Correa & Sharma, 2003)
➢ Corporate social responsibility (Menguc & Ozanne, 2005)
➢ Environmental, operational & financial measurement (Shi et al, 2012)
➢ Transforming environmental changes into action (Shi et al, 2012)
Product Stewardship
➢ Entrepreneurship (Menguc & Ozanne, 2005)
➢ Innovativeness (Menguc & Ozanne, 2005)
➢ Proactiveness (Menguc & Ozanne, 2005)
➢ Risk Taking (Menguc & Ozanne, 2005)
➢ Inter-organisational environmental practices (Shi et al, 2012)
➢ Environmental, operational & financial measures throughout supply chain (Shi et al, 2012)
➢ Transforming environmental changes into action throughout supply chain (Shi et al, 2012)

2.4 The Natural-Resource-Based View & Sustainable Supply Chain Management

It is not just Shi et al (2012) who argue links between the NRBV and the supply chain, but rather an inherent reliance on supply chain management is implied throughout NRBV literature (e.g. Hart, 1995; Johnsen et al, 2014; Matopoulos et al, 2014). This is perhaps linked to the argument that sustainability falls into supply chain jurisdiction (Faisal, 2010) on account of the broadly accepted assumption that sustainability is dependent on a contribution from each player in a supply chain (Seuring & Müller, 2008; Abbasi & Nilsson, 2012 Giminez & Tachizawa, 2012; Miemczyk et al, 2012; Jensen et al, 2013). More specifically, it has been argued that supply chain management should be maximised in order to support the protection and conservation of natural resources (Matopoulos et al, 2014). The same too can be said of competitiveness, in that it is not derived from a firm in isolation but rather from the supply chain as a whole (Markley & Davis, 2007; Prajogo & Sohal, 2013). Thus, links between the NRBV and supply chain management emerge with logic.

Of particular interest is the growing school of sustainable supply chain management (SSCM), which as a result of its focus on competitiveness and sustainability (Faisal, 2010; Ashby et al, 2012; Walker & Jones, 2012; Svensson & Wagner, 2012; Golicic & Smith, 2013; Prajogo & Sohal, 2013; Wu, 2013), bears considerable parallels the NRBV, and interestingly profound connections with corporate social responsibility and the triple-bottom-line concept (Boken et al, 2013; Berger-Walliser & Shrivasta, 2015). As well as benefitting from extensive research surrounding its successful application (Abbasi & Nilsson, 2012; Giminez & Tachizawa, 2012; Miemczyk et al, 2012; Johnsen et al, 2014; Fahimnia et al, 2015), SSCM is also argued to benefit from widespread industry acceptance (Johnsen et al, 2014). This said, Ashby et al (2012) argue that the true potential of SSCM in ecological operations is yet to be realised, whilst Pagel & Shevchenko (2014) call for the topics refinement. Thus, linking the NRBV with SSCM may be of great value: the latter offering practical applicability for the former and both benefiting from refinement and definition.

This section explores NRBV and SSCM synergies. The four resources of the NRBV refine SSCM strategies and emphasise their role as competitive and complex resources, whilst potential NRBV capabilities are derived from review of SSCM strategies. Notably, a distinction is made between SSCM and green supply chain management which has guided previous NRBV studies (e.g. Shi et al, 2012). The shift towards SSCM is intended to facilitate

inclusion of the social aspects of the NRBV which have previously been neglected (Hart, 1997). Pertinently, Perotti et al (2012) suggest that green supply chain management is a fundamental part of SSCM, and as such it is perhaps logical that expansion of existing literature's focus on pollution prevention and product stewardship should also warrant expansion from green supply chain management to SSCM.

2.4.1 Pollution Prevention & Sustainable Supply Chain Management

As with pollution prevention's dominance in the NRBV (Hart & Dowell, 2011), the management of waste (Miemczyk, 2012) and its financial rewards (Markley & Davis, 2007) exert dominance in SSCM literature. Moreover, Sarkis et al (2011) argue that the management of pollution and waste in SSCM is heavily reliant on internal activities, corresponding with pollution prevention's internal dominance (Hart, 1995). This perspective is forcefully demonstrated via Shi et al's (2012) natural-resource-based green supply chain management model, where it is only intra-organisational environmental practices which are linked with pollution prevention, as detailed in this section. Also warranting discussion on account of synergies with pollution prevention is environmental management systems and lean supply chain management. Capabilities extracted from such pollution prevention and sustainable supply chain management synergies are depicted in table 2.3.

Intra-Organisational Environmental Practices

Shi et al (2012) argue that pollution prevention is dependent on a series of intra-organisational environmental practices. Whilst these capabilities are conceptual, they demonstrate correspondence with the pollution prevention capabilities derived from seminal studies. Such intra-organisational environmental practices are defined as: environmental policy; use of environmentally friendly materials; substitution of questionable materials; consideration of environmental criteria; process optimisation to reduce solid waste; internal recycling; environmental total quality management; internal environmental management procedures and advanced prevention and safety methods. Offering some reinforcement is Luthra et al (2014), who via review of green supply chain management stress the significance of environmentally friendly materials, avoidance of harmful or diminishing substances and recyclability as dominant organisational environmental practices (Luthra et al, 2104).

Notably, whilst Shi et al (2012) do offer some valuable insights into pollution prevention capabilities, their focus on intra-organisational practices is somewhat limited. That is, their linking of pollution prevention with intra-organisational practices and product stewardship

with inter-organisational practices is representative of the aforementioned misperception of these resources as internal-external counterparts. Moreover, it somewhat neglects the argument that resources are both endogenous and exogenous (Penrose, 1959; Barney, 2001) and dependent on both internal and external competencies (Hart, 1995). As such, the need to expand upon Shi et al's pollution prevention intra-organisational capabilities to consider externally capabilities, and similarly product stewardship's inter-organisational practices to consider internal capabilities, is evidenced.

Environmental Management Systems

Throughout pollution prevention literature various references are made to environmental management systems, with particular reference to total quality management (Hart, 1995; Russo & Fouts, 1997) and total quality environmental management or total environmental management (Aragon-Correa & Sharma, 2003; Shi et al, 2012). Environmental management systems also play an integral role in SSCM where they are praised for their ability to reduce risk and costs whilst boosting performance and competitiveness (Seuring & Müller, 2008). It is this which has encouraged direct links to be drawn between pollution prevention and environmental management systems (Hajmohammad et al, 2012; Shi et al, 2012). Stressing their value in this study is the presentation of environmental management systems as systematic processes that support the realisation of environmental operations (Ferenhof et al, 2014), on account of high practical applicability, supported by clear environmental objectives (Sarkis, et al, 2011). Reinforcing this is Johnsen et al (2014) who argue that environmental management systems force companies to meet environmental criteria whilst highlighting economic gain, whilst Ferenhof et al (2014) suggest they are particularly useful in companies with low understanding of sustainability. Thus, the potential of environmental management systems in supporting the realisation of pollution prevention is difficult to ignore.

There exists a vast array of environmental management systems, however some emerge with more significance than others. As mentioned total quality management features prominently in initial conceptualisation of pollution prevention (Hart, 1995), whilst NRBV extensions place an emphasis on total quality environmental management (Aragon-Correa & Sharma, 2003; Shi et al, 2012). Links have also been drawn between pollution prevention and supplier management inventory (Ageron et al, 2013), vendor managed inventory (Jensen et al, 2013), just-in-time (Sarkis et al, 2011; Galeazzo et al, 2013) and ISO 14001 (Hajmohammad et al, 2012; Shi et al, 2012). The scope of environmental management systems make it difficult to define specific capabilities, but prominent references are made to environmental plans, measurement and policies (Shi et al, 2012), the modification of activities such as procurement,

packaging or distribution to reduce waste (Abbasi & Nilsson, 2012; Ashby et al, 2012; Svensson & Wagner, 2012) and the need for knowledge and expertise, high investment, internal and external cooperation and long term value (Ferenhof et al, 2014).

Lean Supply Chain Management

When it comes to the topic of waste or pollution in SSCM, lean asserts some dominance (Sarkis et al, 2011; Miemczyk, 2012), with the school of 'lean and green' presented as an extension of SSCM (Hajmohammad et al, 2012). More specifically, lean and SSCM are somewhat inseparable (Wiese et al, 2015), with the perception that one is mutually influential on the other commonly projected (Dües et al, 2013; Galeazzo et al, 2013; Hajmohammad et al, 2013; Pagel & Shevchenko, 2014). Hajmohammad et al (2013, p313) define lean as:

> *'A set of inter-related, complimentary and mutually reinforcing operating practices – often referred to as bundles – that aim at reducing or eliminating non-value adding activities throughout a product's entire value stream, within an organisation and along its supply network'*

Discussions of the elimination of non-value activities warrant implications for reduction of both pollution and inefficiencies (Rothenberg et al, 2009), which in turn warrants comparison with sustainable supply chain management (Galeazzo et al, 2013; Wiese et al, 2015). More specifically, both lean and sustainable supply chain management seek value-maximised operations (Pagell & Shevchenko, 2014) and encompass the practices, policies and systems required for an efficient environmental strategy (Rothenberg et al, 2009; Wiese et al, 2015). Not only does this warrant their comparison, but their conjoint adoption is recommended (Wiese et al, 2015) and according to Dües et al (2013) delivers cost and time savings above and beyond their implementation in isolation.

This said, lean does not automatically deliver a successful environmental strategy (Rothenberg et al, 2009), and in some cases lean and green are considered conflictive of one another (Miemczyk, 2012). In particular, Rothenberg et al (2009) argues that a complex relationship exists between lean and environmental manufacturing, discussing the need for 'trade-offs. For example, whilst lean promotes frequent replenishment to avoid over-production, green promotes reduced shipments in an attempt to minimise emissions (Galeazzo et al, 2013; Dües et al, 2013). Similarly, lean's desire to reduce all forms of waste arguably outweighs green's focus on the ecological environment (Dües et al, 2013), raising a conflict

as to what can be considered a competitive priority (Galeazzo et al, 2013). As such, Rothenberg et al (2009, p241) caution that *'whilst lean practices can influence environmental management practices and perhaps improve resource use, they will not be able to address all environmental issues'*.

Nonetheless, leans potential to maximise environmentalism and efficiency whilst cutting costs (Dües et al, 2013) still warrants considerable links with Hart's (1995) pollution prevention (e.g. Galeazzo et al, 2013; Hajmohammad et al, 2013). Offering some justification for such links, Rothenberg et al (2009) find that in spite of lean and green trade-offs, lean does support the prevention of waste and the maximisation of resource efficiency throughout manufacturing processes. Reinforcing this, Dües et al's (2013) systematic review of lean argues that lean and green inconsistencies are largely outweighed by their harmony, particularly surrounding the prevention of waste. Adding further significance is industry based conception of lean that arguably adds practical appeal and approachability (Pagel & Shevchenko, 2014) capable of supporting the operationalisation of pollution prevention (Rothenberg et al, 2009). Moreover, pollution prevention may in turn advance understandings of lean with Wiese et al (2015) suggesting that the competitive value of lean is commonly overlooked. As such, lean along with its prominent capabilities of environmental management systems such as total quality management or just-in-time (Rothenberg, 2009; Galeazzo et al, 2013; Hajmohammad et al, 2013), stakeholder integration (Dües et al, 2013) and continuous improvement (Rothenberg et al, 2009; Dües et al, 2013) emerge with significance in this study.

Table 2.3 Implications for pollution prevention capabilities derived from sustainable supply chain management synergies

Pollution Prevention
➢ Use of environmentally friendly materials (Shi et al, 2012; Luthra et al, 2014) ➢ Substitution of questionable materials (Shi et al, 2012; Luthra et al, 2014) ➢ Consideration of environmental criteria (Shi et al, 2012) ➢ Process optimisation to reduce solid waste (Abbasi & Nilsson, 2012; Ashby et al, 2012; Shi et al, 2012; Svensson & Wagner, 2012) ➢ Internal recycling (Shi et al, 2012; Luthra et al, 2014) ➢ Environmental total quality management (Shi et al, 2012) ➢ Internal environmental management procedures & systems (Shi et al, 2012) ➢ Advanced prevention and safety methods (Shi et al, 2012) ➢ Environmental plans, measurement & policies (Rothenberg et al, 2009; Hajmohammad et al, 2012; Shi et al, 2012; Galeazzo et al, 2013) ➢ Internal knowledge & expertise (Ferenhof et al, 2012) ➢ Internal & external cooperation (Ferenhof et al, 2012; Dües et al, 2013)

2.4.2 Product Stewardship & Sustainable Supply Chain Management

NRBV and SSCM synergies are perhaps most obvious in product stewardship, where the shift towards a lifecycle perspective of environmentalism (Hart, 1995) forces consideration of the supply chain (Miemczyk et al, 2016). As such, it is generally accepted that product stewardship places a dependency on supply chain strategies (Vachon & Klassen, 2008; Ashby et al, 2012; Shi et al, 2012; Wu, 2013). With specific reference to SSCM, comparisons to product stewardship emerge out of paralleled motives of sustainability and competitiveness via the creation of innovative and holistic operations (Soosay et al, 2008; Vachon & Klassen, 2008, Ashby et al, 2012; Golicic & Smith, 2013; Jensen et al, 2013; Prajogo & Sohal, 2013; Wu, 2013). Synergies between product stewardship and sustainable supply chain collaboration and closed-loop supply chain management are discussed in this section, whilst dependencies placed on green purchasing, green distribution and design for the environment in Shi et al's (2012) natural-resource-based green supply chain management model are also discussed. Notably, again Shi et al's (2012) inter-organisational product stewardship capabilities disregard the internal aspects of the resource, stressing the need for expansion.

Green Purchasing

Shi et al (2012) identify green purchasing as the first inter-organisational environmental process in their natural-resource-based green supply chain management model, and its significance in the realisation of environmental operations is reinforced by Luthra et al (2014). According to Markley & Davis (2007) green purchasing assumes a central role in SSCM based on the argument that purchasing behaviour can have a direct impact on the environment. Moreover, the reduction of negative environmental impacts via purchasing is presented as a source of competitive advantage (Vazifedoust et al, 2013). It is this, along with a lifecycle

perspective, that render links between green purchasing and product stewardship. Green purchasing is defined as:

> *'The selection and acquisition of products and services that most effectively minimise negative environmental impacts over their lifecycle of manufacturing, transportation, use and recycling or disposal'.*
>
> Vazifedoust et al (2014, p2490)

Notably, whilst green purchasing arguably plays some role in the realisation of product stewardship, it in its own right is dependent upon specific capabilities. Fortunately, Shi et al (2012) offer a comprehensive list of such capabilities which they link directly with product stewardship: holding awareness seminars for suppliers and contractors, guiding suppliers to set up environmental programmes; bringing together suppliers in the same industry to share know-how and problems; informing suppliers about the benefits of cleaner production and technologies; pressuring suppliers to take environmental action; choice of suppliers by environmental criteria; eco-labelling of products; cooperation with suppliers for environmental objectives; environmental audits for suppliers' internal management; suppliers ISO 14001 certification; and second tier supplier environmentally friendly practice evaluation. In addition to these capabilities, Min & Galle (2001) stress the importance of environmentally corporate culture, employee training, energy and water conservation, minimised waste and pollutants, recycled or reused materials in production and waste segregation at source in green purchasing.

Green Distribution

Distribution places a heavy strain on the environment on account of the associated high levels of emissions and effluents and exploitation natural resources (Jumadi & Zailani, 2010). As such the need to improve distribution activities is of great significance (Perotti et al, 2011; Miemczyk, 2012) encouraging the emergence of green distribution. Green distribution is not only of critical importance in SSCM (Langella & Zanoni, 2011; Perotti et al, 2012) but it forms the second of Shi et al's (2012) inter-organisational environmental practices in support of product stewardship. Given that green distribution enjoys considerable links with competitiveness, efficiency and cost reduction (Markley & Davis, 2007; Jumadi & Zailani, 2010; Langella & Zanoni, 2011) it is easy to understand the motives for this, and to identify a synergistic relationship between the two strategies.

Jumadi & Zailani divide green distribution into five separate activities: green transportation which uses the most environmentally friendly fuels, allocations and multi-transportation formats; green storage which includes increased mechanization, environmentally friendly sterilization techniques and centralized stock; green packaging which aims to use environmentally friendly materials, reduce overall waste and conserve resources; reverse logistics which focuses on recovery or responsible disposal; and green innovation which includes communication, biological and monitoring technologies throughout the logistical process. With specific reference to product stewardship, Shi et al (2012) identify green distribution capabilities as: environmentally friendly waste management; environmental improvement of packaging; eco-labelling; taking back packaging; recovery of company's end of life product; providing consumers with information on environmentally friendly products; and use of environmentally friendly transportation.

Pertinently, it is reverse logistics which emerges with the greatest significance, having featured in Hart's (1995) initial discussions of product stewardship, as well as being linked with product stewardship in more recent literature (e.g. Miemczyk, 2008; Ashby et al, 2012; Matopoulos et al, 2014). Reverse logistics facilitate environmental efficiency via recycling, reusing and reducing materials used (Carter & Ellram, 1998) and according to Langella & Zanoni (2011) should be prioritised in the pursuit of sustainable operations. Markley & Davis (2007) reinforce this, arguing that companies who do prioritise reverse logistics benefit from reduced scrapping and material costs, improved handling of hazardous materials and additional revenues from the conversion of waste into by-products. Moreover, Miemczyk (2008) directly links recovery strategies with reduced impacts on the natural environment. Thus, reverse logistics capabilities also warrant consideration, and Carter & Ellram (1998) define these as: the management of uncertainty; vertical coordination; stakeholder commitment; incentive systems; top management support; and 'policy entrepreneurs' who take personal responsibility for environmentalism. Miemczyk's (2008) paper also identifies 13 capabilities in support of product recovery: marketing; position in the supply chain; networking to find expertise; developing measures and technologies to support recovery; introducing measures and technologies to support recovery; controlling and coordinating the supply chain; influencing design for product recovery; influencing legislation; influencing future legislation; building up processes over time; creating customer focused programmes; providing revenue to reduce compliance costs; and re-establishing customer links.

Design for the Environment

Design for the environment features prominently in product stewardship literature: firstly, in initial conceptualisation of the resource (Hart, 1995); secondly, in Markley & Davis' (2007) study which notes parallels between it and the NRBV; and thirdly, design for the environment forms one third of Shi et al's (2012) intra-organisational environmental practices in support of product stewardship. This is understandable given that design for the environment encourages the modification of design processes to prioritise environmental factors, delivering organisational benefits (Kurk & Eagan, 2008). As with product stewardship, this takes on a lifecycle perspective in that environmental considerations are prioritised through each stage of the supply chain (Diwekar & Shastri, 2011). Design should be maximised to create products which minimise negative environmental impacts throughout production and after end-of-life (Kurk & Eagan, 2008). Doing so at the earliest possible point renders the greatest opportunities for cost, operational and technical risk reductions and efficiency improvements (Diwekar & Shastri, 2011).

Again, Shi et al (2012) offer a comprehensive list of design for the environment capabilities which they directly link with product stewardship: recovery and reuse, disassembly, recyclability, waste minimisation, material conservation, accident prevention, reduced consumption of energy or material, reduced use of hazardous products and processes, remanufacturing and disposal. This demonstrates some correspondence with Kurk & Eagan's (2008) assessment of design for the environment, in which the use of biodegradable or recyclable material, renewable energy sources, technologies that support recovery or reusability and reduction of hazardous materials and waste are prioritised. Lifecycle analysis and measurement also emerges with significance (Diwekar & Shastri, 2011) with particular attention drawn to the need for appropriate use of checklists, scorecards and environmental management systems such as ISO 14001 (Kurk & Eagan, 2008). Innovation also emerges as a common topic in design for the environment (Markley & Davis, 2007; Kurt & Eagan, 2008) and most commonly relates to product design innovativeness (Chen, 2001).

Sustainable supply chain collaboration

A need for supply chain collaboration in product stewardship is implied throughout existing literature; ranging from Hart's (1995) initial prioritisation of stakeholder integration to Shi et al's (2012) inter-organisational practices that call for awareness seminars for suppliers, bringing together of suppliers to share know-how and problems and cooperation with suppliers for environmental objectives. Literature contends that if environmental objectives are to be

met, collaboration throughout the supply chain is essential (Vachon, 2007; Seuring & Müller, 2008; Abbasi & Nilsson, 2012 Giminez & Tachizawa, 2012; Miemczyk et al, 2012; Jensen et al, 2013). Accordingly, there already exist explicit links between product stewardship and supply chain collaboration (e.g. Vachon & Klassen, 2008; Johnsen et al, 2014; Miemczyk et al, 2016). However, such is the precedence of collaboration in discussions of sustainability and supply chain management that Ashby et al (2012) suggest is has evolved into its own discipline of sustainable supply chain collaboration. Given that sustainable supply chain collaboration promotes *'the direct involvement of an organization with its suppliers and customers in planning jointly for environmental management and environmental solutions'* (Vachon & Klassen, 2008, p301), the topic possesses considerable synergies with product stewardship.

According to Vachon (2007), working with suppliers to meet environmental objectives requires collaborative planning and solution finding, investment in cooperative activities and resources, joint planning and knowledge sharing via workshops and seminars and environmental monitoring and auditing via assessment of suppliers. In a later paper, Vachon & Klassen (2008) reinforce the need for knowledge sharing and intra-organisational learning, and also identify technology and the construction of mutual goals as important capabilities in sustainable supply chain collaboration. This demonstrates correspondence with Shi et al's (2012) natural-resource-based green supply chain management model's inter-organisational environmental practices. In addition, the need for innovation and wholly sustainable initiatives throughout each stage of production in sustainable supply chain collaboration (Von Hippel, 1988; Soosay et al, 2008; Ashby et al, 2012; Ageron et al, 2013; Golicic & Smith, 2013; Johnsen et al, 2014) corresponds with Menguc & Ozanne's (2005) natural environment orientation which amalgamates product stewardship and entrepreneurial innovativeness. Notably, criticisms exist to the feasibility of achieving sustainable supply chain collaboration (Ashby et al, 2012; Walker & Jones, 2012; Johnsen et al, 2014; Pagel & Shevchenko, 2014; Miemczyk et al, 2016), adding further value to the empirical investigation of associated capabilities.

Closed-loop supply chain management

Closed-loop supply chain management also emerges with significance in product stewardship literature (Hart & Milstein, 1999; Vachon & Klassen, 2008; Ashby et al, 2012; Golicic & Smith, 2013; Matopoulos et al, 2014). In the most part this comes down to closed-loop supply chain management's incorporation of both forward and reverse logistics (Jensen, et al, 2013;

Garg et al, 2015), corresponding with product stewardships lifecycle approach and emphasis on recyclability (Hart, 1995). More specifically, closed-loop supply chains permit by-products, unsold products and effluents to be reincorporated into the supply chain to be reused in a way which creates added-value (Ashby et al, 2012; Bell et al, 2012; Garg et al, 2015; Govindan et al, 2015). Miemczyk et al (2016) add specificity and strength, explicitly linking closed-loop supply chain management and product stewardship, arguing that a closed-loop approach drives successful sustainable stewardship throughout the supply chain and stakeholders. Closed-loop supply chain management is defined as:

> *'The design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time.'*
>
> Govidan et al (2015, p603)

Closed-loop supply chain management is of increasing importance in the maximisation of sustainability (Eskandarpour et al, 2015; Garg et al, 2015), and accordingly the topic warrants considerable discussion in literature, implicating a number of capabilities. Jensen et al (2013) call for a cradle-to-cradle approach, product acquisition, reverse logistics, inspection and disposition, remanufacturing, refurbishment and repair and remarketing. Garg et al (2015) discuss the reuse, renewing and recycling of products and effluents either in primary or secondary markets, optimization of transport systems to reduce greenhouse gases and the prioritisation of environmental considerations throughout manufacturing systems and network design. Govidan et al (2015) reinforce the significance of network design and planning, paying particular attention to the need for inventory planning and strategic decision making. Miemczyk et al's (2016) empirical study suggests that a product stewardship approach to closed-loop supply chain management is dependent upon internal resource acquisition and development, external development of capabilities with partners, supply chain leadership, commitment to redesign and new relationships, co-evolution with customers and suppliers and control of supply chain activities.

Table 2.4 Implications for product stewardship capabilities derived from sustainable supply chain management synergies

Product Stewardship
➢ Holding awareness seminars for suppliers & contractors (Shi et al, 2012) ➢ Guiding suppliers to set up environmental programmes (Shi et al, 2012) ➢ Bringing together suppliers to share know-how & problems (Vachon, 2007; Shi et al, 2012) ➢ Informing suppliers about the benefits of cleaner production & technologies (Shi et al, 2012) ➢ Pressuring suppliers to take environmental action (Shi et al, 2012) ➢ Choice of suppliers by environmental criteria (Min & Galle, 2001; Shi et al, 2012) ➢ Eco-labelling of products (Shi et al, 2012; Vazifedoust et al, 2013) ➢ Cooperation for environmental objectives (Carter & Ellram, 1998; Vachon, 2007; Shi et al, 2012) ➢ Environmental auditing of suppliers (Min & Galle, 2001; Vachon, 2007; Shi et al, 2012) ➢ Suppliers ISO 14001 certification (Shi et al, 2012) ➢ Use of recycled or reused material & renewable energies in production (Min & Galle, 2001; Vazifedoust et al, 2013; Garg et al, 2015) ➢ Avoidance of hazardous materials (Min & Galle, 2001; Kurk & Eagan, 2008; Vazifedoust et al, 2013) ➢ Environmentally sensitive corporate culture (Min & Galle, 2001) ➢ Employee training (Min & Galle, 2001) ➢ Environmental auditing (Min Galle, 2001) ➢ Waste segregation at source (Min & Galle, 2001) ➢ Environmental improvement of packaging (Jumadi & Zailani, 2010; Shi et al, 2012) ➢ Green innovations/ joint sustainable innovation throughout supply chain (Von Hippel, 1988; Soosay et al, 2008; Jumadi & Zailani, 2010; Ashby et al, 2012; Blome et al, 2012; Ageron et al, 2013; Golicic Smith, 2013; Johnsen et al, 2014; Garg et al, 2015) ➢ Recovery of company's end of life product/ packaging (Markley & Davis, 2007; Kurk & Eagan, 2008; Jumadi Zailani, 2010; Langella & Zanoni, 2011; Shi et al, 2012; Jensen et al, 2013; Garg et al, 2015) ➢ Resale, remanufacture or recycling of unwanted goods (Miemczyk, 2008; Kurk & Eagan, 2008; Langella & Zanoni, 2011; Jensen et al, 2013; Garg et al, 2015) ➢ Management of uncertainty (Carter & Ellram, 1998) ➢ Vertical coordination (Carter & Ellram, 1998) ➢ Policy entrepreneurs (Carter & Ellram, 1998) ➢ Incentive systems (Carter & Ellram, 1998) ➢ Top management support (Carter & Ellram, 1998) ➢ Influnece design for recovery (Miemczyk, 2008) ➢ Developing & introducing measures for recovery (Miemczyk, 2008) ➢ Customer focused programme & link with customers (Miemczyk, 2008) ➢ Influencing legislation (Miemczyk, 2008) ➢ Provide revenue to reduce compliance costs (Miemczyk, 2008) ➢ Accident prevention (Shi et al, 2012) ➢ Lifecycle analysis (Kurk & Eagan, 2008; Diwekar & Shastri, 2011) ➢ Investment in cooperative resources & activities (Vachon, 2007) ➢ The construction of mutual goals (Vachon & Klassen, 2008) ➢ Cradle-to-cradle approach (Jensen et al, 2013) ➢ Network design & planning (Garg et al, 2015; Govidan et al, 2015) ➢ Internal resource acquisition & development (Miemczyk et al, 2016) ➢ External development of capabilities with partners (Miemczyk et al, 2016) ➢ Supply chain leadership (Miemczyk, 2008; Miemczyk et al, 2016) ➢ Commitment to redesign & new relationships (Miemczyk et al, 2016) ➢ Co-evolution with customers and suppliers (Miemczyk et al, 2016) ➢ Control supply chain activities (Miemczyk, 2008; Miemczyk et al, 2016)

2.4.3 Clean Technologies & Sustainable Supply Chain Management

Whilst NRBV literature somewhat neglects clean technologies, SSCM literature offers some insight into the topic, often under the synonymous titles of green technologies or sustainable supply chain technologies. This section reviews environmental technologies in SSCM, revealing considerable synergies with clean technologies. In addition, topics of corporate environmental responsibility, closed-loop supply chain management and resource efficient supply chains are discussed. Implications for clean technologies capabilities are depicted in table 2.5.

Environmental Technologies in the Supply Chain

The synergistic relationship between the NRBV, SSCM and technologies is discussed by Vachon (2007) and Schrettle et al (2014), both of whom stress the pertinence of supply chain management and technologies in the protection of the natural environment. As ecological degradation continues and demand for sustainability grows, so too does the market for environmental technologies (Weinberger et al, 2012). As a result, technology assumes a dominant presence in SSCM literature (e.g. Chakrabarty & Wang, 2012; Chen et al, 2012; Miemczyk et al, 2012), involving communication technologies required for collaboration (Vachon, 2007; Vachon & Klassen, 2008), tracking technologies used in distribution (Prajogo & Sohal, 2014) and the technologies required to support environmental management systems (Hajmohammad et al, 2012). However, of particular relevance to Hart's (1997) clean technologies is the growing body of work on environmental or green technologies in modern SSCM literature. Like clean technologies, environmental technologies in the supply chain focus upon sustainable and technological innovations which can boost performance and support a less damaging approach to production (Schrettle et al, 2014). As such, environmental technologies enjoy a favourable representation in literature (e.g. Ageron et al, 2013; Boons et al, 2013; Jensen et al, 2013; Szekely & Strebel, 2013; Prajogo & Sohal, 2014), directly linked with the realisation of sustainable operations (Weinberger et al, 2012).

A traditional example of an environmental technology is biotechnologies, which is prioritised in both Hart & Dowell's (2011) review of clean technologies and Maloni & Brown's (2007) SSCM model for corporate social responsibility. Biotechnologies involves turning biological process waste into products (Maloni & Brown, 2007), offering an advanced form of pollution prevention in line with clean technologies' initial intents (Hart, 1997), and consequently permitting quality, cost and performance improvements (Maloni & Brown, 2007). Other environmental technologies tend to focus on air pollution control, waste water

treatment and waste management (Weinberger et al, 2012). However, as a result of the fast-paced, changeable nature of technologies (Wu, 2013), it is both difficult and unnecessary to define specific technologies. It is of greater value, certainly to this thesis, to discuss the capabilities in support of environmental technologies in the supply chain.

Vachon's (2007) discussion of environmental technologies in production stresses the need for technological management systems, employee training and awareness, production planning, green scheduling and inventory management. Weinberger et al's (2012) environmental technology paper places a focus on organisational know-how, consumer and environmental consultation, knowledge transfer and capacity building, environmental and sustainability impact assessments, audits and environmental lifecycle analysis, and ecological leapfrogging in which any unsustainable process or product is rejected and replaced with a sustainable alternative. Environmental lifecycle analysis is reinforced by Schrettle et al (2014), which along with supply chain cooperation and design is believed to support the supply chain's aptitude for the adoption and implementation of emergent environmental technologies. Pertinently, as with Hart's clean technologies, there is a degree of avoidance surrounding environmental technologies (Wu, 2012; Schrettle, 2014), again reinforcing the value of a study such as this.

Corporate Environmental Responsibility

Whilst this study has already made comparisons between corporate social responsibility and the NRBV, Carroll's (1979) corporate social responsibility also exists as a dominant framework in SSCM (Gold et al, 2010; Golicic & Smith, 2013), with the belief that the two are intrinsically linked commonly projected (Maloni & Brown, 2006; Markley & Davis, 2007). Put simply, both SSCM and corporate social responsibility are based upon the prioritisation of economic, environmental and social issues (Kogg & Mont, 2011), and it is here that links are made with the NRBV's sustainable development (Menguc & Ozanne, 2005; Markley & Davis, 2007). However, such links fail to acknowledge sustainable development's division into clean technologies and base of the pyramid, and accordingly this study attempts to resolve this by linking corporate *environmental* responsibility with clean technologies, and later, socially responsible supply chains with base of the pyramid. Stressing the value of this is the broad industry acceptance of corporate social responsibility (Maloni & Brown, 2006), which regardless of its many facets, may add some much-needed approachability to clean technologies.

Kovács (2008) stresses the importance of stakeholder integration in corporate environmental responsibility, making particular reference to communication with and consideration of supply chain partners, policy makers, media, industry and the environment. References to extensive recycling throughout the supply chain, life-cycle analysis, supplier audits and guidance and ISO 14001 can also be identified in Kovács' paper. Holtbrügge & Dögl's (2012) review of the management of corporate environmental responsibility reveals compliance, policies and regulations, green product and process development, and environmental, financial and non-financial performance measurement as dominant managerial activities. Both Kogg & Mont (2011) and Montinel & Delgado-Ceballos (2014) reinforce the need for stakeholder integration, whilst Montinel & Delgado-Ceballos also corroborate the emphasis on performance measurement. Whilst these capabilities demonstrate strong correspondence with product stewardship, Kovác (2008) stresses that, unlike product stewardship, they do not apply just to the supply chain, but rather 'the ultimate supply chain'. This is in reference to the need to consider the very origins of all materials throughout all aspects of production and their overall impact on the global environment. This is reinforced by Kogg & Mont (2011) and Holtbrügge & Dögl (2012), who both emphasise a global, lifecycle perspective of operations. With this in mind, the management of global supply chains and governance also emerge with significance.

Closed-loop supply chain management

Whilst Miemczyk et al (2016) link closed-loop supply chain management with product stewardship, synergies can also be noted with clean technologies. That is, the definition of clean technologies as '*any product, service or process that delivers value using limited or zero non-renewable resources and/or creates significantly less waste than traditional offerings*' (Pernick & Wilder, 2007, p2), corresponds with closed-loop's advanced development of new, lower impact products and processes. More specifically, Jensen et al's (2013) exploration of a closed-loop food chain demonstrates the extent to which such an approach facilitates extensive waste reduction, increased conservation and creation of renewable energies, whilst the creation of value and competitive benefits are also well noted in literature (Ashby et al, 2012; Bell et al, 2012; Garg et al, 2015; Govidan et al, 2015). Reinforcing links with clean technologies, Szekely & Strebel's (2013) argue that closed-loop supply chain management is in its own right a powerful environmental innovation, perhaps offering the divergence from traditional routines and processes that clean technologies calls for (Hart & Milstein, 1999). Notably, Miemczyk et al's (2016) paper does not comment on clean technologies at all, instead assuming the traditional pollution prevention, product stewardship and sustainable

development perspective of the NRBV. This thesis argues that closed-loop supply chain management warrants exploration with regards to its role in both product stewardship and clean technologies, and given that clean technologies is considered an advancement of product stewardship (Hart, 1997), some overlap of strategies and capabilities can be expected. Therefore, along with the closed-loop capabilities identified earlier, technological and managerial innovativeness (Jensen et al, 2013) and a global network perspective (Kovác's, 2008; Garg et al, 2015; Govidan et al, 2015) emerge as potential clean technologies capabilities.

Resource efficient supply chains

Matopoulos et al (2014) offer a convincing argument for the need for resource efficiency in SSCM, linking it directly with the NRBV. This is based upon two main points: first that effective supply chain management supports the conservation of natural resources; and second, that the depletion of natural resources is in itself a supply chain risk. However, whilst Matopoulos et al link resource efficient supply chains with the NRBV in a broad sense, it perhaps resonates with greatest strength with clean technologies. More specifically, given that clean technologies aims to protect scarce resources via the substitution of non-renewables with technological innovations (Hart, 1997), the need to exercise resource efficiency assumes significance. As with clean technologies (Hart, 1997; Hart & Milstein, 1999), resource efficient supply chains are driven by factors such as global population growth, mineral shortages, water and food scarcity and agricultural pressures. Notably, Matopoulos et al are not alone in implicating resource efficiency and the protection of the planet's natural resources in SSCM; similar discussions can also be seen in papers by Shi et al (2012) and Bell et al (2012).

Matopoulos et al (2014) identify four fundamental activities of resource efficient supply chains: resource awareness, resource sparing, resource sensitivity and resource responsiveness. Resource awareness encourages consideration of the use of resources and their impact throughout operations. With regards to capabilities this involves performance measurement, communication and collaboration throughout the supply chain. Resource sparing avoids the use of resources by means of continuous improvement, the modification of products and processes and the reuse and recollection of resources via a closed-loop approach. Resource sensitivity involves the identification of external changes such as natural disasters, geopolitical activity and population growth. Resource responsiveness requires the firm, or rather the supply chain, to act upon those changes in a fashion which is both quick and cost

effective. This corresponds with Bell et al's study (2012), that stresses the need for recollection and reuse of resources and the need for awareness of and responsiveness to natural resource scarcity in resource efficiency. Interestingly, Bell et al also make references to closed-loop supply chain management, technological innovations and environmental and political regulations and policy. Pertinently, Matapolous et al (2014) suggest that resource efficient supply chains are neglected in supply chain research, and in particular, highlight the need for analysis of their management and capabilities, again reinforcing the value of this study.

Table 2.5 Implications for clean technologies capabilities derived from sustainable supply chain management synergies

Clean Technologies
➢ Technological management systems (Vachon, 2007)
➢ Organisational know-how (Weinberger et al, 2012)
➢ Consumer & environmental consultation (Weinberger et al, 2012)
➢ Knowledge transfer & capacity building (Weinberger et al, 2012)
➢ Environmental assessments & auditing (Weinberger et al, 2012)
➢ Environmental lifecycle analysis (Weinberger et al, 2012; Schrettle et al, 2014)
➢ Ecological leapfrogging (Weinberger et al, 2012
➢ Supply chain aptitude for new technologies (Bell et al, 2012; Schrettle et al, 2014)
➢ Stakeholder integration (Kovács, 2008; Kogg & Mont, 2011; Jensen et al, 2013; Matapolous et al, 2014; Montinel & Delgado-Caballos, 2014)
➢ Extensive recycling throughout the supply chain (Kovács, 2008)
➢ Supplier audits & guidance (Kovács, 2008)
➢ Global lifecycle perspective (Kovács, 2008; Kogg & Mont, 2011)
➢ Governance (Kogg & Mont, 2011)
➢ Policies and regulations (Holtbrügge & Dögl, 2012)
➢ Environmental, financial & non-financial performance measurement (Holtbrügge & Dögl, 2012; Montinel & Delgado-Caballos, 2014)
➢ Cradle-to-cradle lifecycle/ closed-loop approach (Bell et al, 2012; Jensen et al, 2013)
➢ Technological & managerial innovativeness (Bell et al, 2012; Jensen et al, 2013)
➢ Product acquisition (Jensen et al, 2013)
➢ Reverse logistics (Jensen et al, 2013; Matapolous et al, 2014)
➢ Inspection & disposition (Jensen et al, 2013)
➢ Remanufacturing, refurbishment & repair (Jensen et al, 2013; Matapolous et al, 2014; Garg et al, 2015)
➢ Network design (Garg et al, 2015; Govidan et al, 2015)
➢ Strategic decision making (Govidan et al, 2015)
➢ Resource impact assessment
➢ Performance measurement (Bell et al, 2012; Matopoulos et al, 2014)
➢ Scarce resource avoidance (Matopoulos et al, 2014)
➢ Continuous improvement (Matopoulos et al, 2014)
➢ Environmental & political regulations (Bell et al, 2012)
➢ Process & product modification (Matopoulos et al, 2014)

2.4.4 Base of the pyramid & Sustainable Supply Chain Management

As with the NRBV, SSCM research has shown a tendency to focus on environmental factors, but as competitiveness and sustainability become more complex a shift towards both social and environmental operations is called for (Markley & Davis, 2007; Johnsen et al, 2014; Fahimnia et al, 2015). In fact Faisal (2010) argues that a supply chain that possesses both environmentally and socially sustainable resources is difficult to replicate, and thus in reference to resource based theorisation (Wernerfeldt, 1984; Barney, 2001), is competitively superior. Moreover, Silvestre (2015) suggests that it is this added social dimension upon which SSCM is based, offering an evolution of environmental supply chain management or green supply chain management that is inclusive of societal considerations. As with the earlier discussion of clean technologies and corporate environmental responsibility, this section builds upon Markley & Davis' (2007) linking of corporate social responsibility and the NRBV's sustainable development to discuss base of the pyramid and socially responsible supply chains. Having been identified as a capability of base of the pyramid (Prahalad & Hart, 2002), external collaboration and its own capabilities are also discussed. Finally, the management of supply chains in developing economies is explored, highlighting further capabilities. Base of the pyramid capabilities are detailed in table 2.6, at the end of this section.

Socially Responsible Supply Chains

As with the NRBV and SSCM, corporate social responsibility at its highest level shifts towards consideration of societal objectives. The presentation of social responsibility as a competitive strategy (McWilliams & Siegel, 2001; Hoejmose et al, 2013) has encouraged some comparisons with the NRBV (e.g. Menguc & Ozanne, 2005; Markley & Davis, 2007), but it is Arnold & Valentin (2013) who directly link socially responsible supply chains with base of the pyramid. More specifically, Arnold & Valentin argue that the degree to which a company incorporates social responsibility throughout its supply chain may directly affect the success of base of the pyramid strategies. Given that social responsibility is intended to support emerging economies via the promotion of human rights and labour rights in the global market (Markley & Davis, 2007; Arnold & Valentin, 2013) links with base of the pyramid are understandable. Also of notability is Kolk et al's (2014) argument that base of the pyramid has lessened its focus on profit gain, highlighting further associations with the social dimension of corporate social responsibility which is detached from profitability (Carroll, 1979; Maloni &Brown, 2006).

According to Klassen & Vereecke (2012, p104) social issues in the supply chain *'focus on human safety and welfare, community development, and protection from harm'*, and accordingly an emphasis falls upon capabilities of purchasing, philanthropy, prioritisation of human rights and consideration of global communities (Markley & Davis, 2007). Arguably embodying each of these topics is fair-trade, which warrants particular mention in discussion of corporate social responsibility (Maloni & Brown, 2006). However, of great value to this study is Klassen & Vereecke's (2012) investigation of the management of socially responsible supply chains which empirically identifies three prominent groups of capabilities: monitoring which involves self-assessments, auditing, certification, training & capacity building, rewards and penalties and the management of information; collaboration which involves coordination with all stakeholders and joint planning for social objectives; and architectural and radical innovations which involves new markets, management systems and performance outcomes. In addition to these capabilities, Klassen & Vereecke also stress the significance of risk management and mitigation, vertical integration, transparency and third-party auditing, organisational culture and beliefs, shared values and supply chain auditing. Building upon this, Hoejmose et al (2013) reinforce the significance of stakeholder integration and organisational culture, and also prioritise top management support and regulations as pertinent in socially responsible supply chains.

External Collaboration

Whilst collaboration has already been discussed in relation to product stewardship, it is argued that the management of social considerations in the supply chain requires collaboration on a boarder and more advanced level (Seuring & Müller, 2008). More specifically, Klassen & Vereecke (2012) highlight three levels of collaboration pertinent to the management of social issues: internal level collaboration with stakeholders involved in direct operations; inter-firm level collaboration with stakeholders throughout the supply chain; and external collaborations with loosely connected stakeholder such as NGOs, communities and regulators. It is external collaboration which emerges with the greatest significance, having already being identified as a fundamental capability of base of the pyramid (Prahalad & Hart, 2002). Given that base of the pyramid requires entry into and support of emerging economies, the value of collaboration with communities and regulators is understandable. In correspondence with base of the pyramid, external collaboration assumes a global perspective (Markley & Davis, 2007) that demands that business plays its role in supporting social sustainability (Klassen & Vereecke, 2007) by shifting away from traditional economic objectives to instead serve human and social causes in the societies in which they operate (Sakarya et al, 2012). Adding further significance

is its presentation of external collaboration as a source of competitiveness in modern business (Markley & Davis, 2007). Moreover, pressure from external stakeholders such as governments, NGOs, communities, financial institutes, other firms and shareholders (Pagel & Shevchenko, 2013; Wu, 2013) is thought to be a main driver of social sustainability (Ehrgott et al, 2011; Sakarya et al, 2012; Hoejmose et al, 2013), but one in need of greater understanding (Hart et al, 2016).

With regards to capabilities, references to joint problem solving, resource integration, organisational culture, value and beliefs and technology can be noted (Sakarya et al, 2012). Wang et al (2015) offer a more concise definition of external collaboration capabilities, surrounding innovation, information and relational capabilities. Innovation includes the modification of organisational processes such as operations, management and marketing and the integration and exploitation of external resources to create value. Information is focused upon coordination and communication with stakeholders to support decision making and improve operations, placing a reliance on the use of advanced technologies. The relational capability refers to the firm's ability to develop and manage external stakeholders and the need to identify the best partners, build relationships and ensure effective collaboration via governance. As well as these three capabilities, Wang et al also place an emphasis on the need for internal assessments and evaluations, continuous monitoring of external environments and development of relevant dynamic capabilities. Adding to discussions of communication, cooperation and technology, Argyris & Monu (2015) suggest that various forms of social media can be used as effective tools in working with and developing relationships with external stakeholders. Notably, Wang et al (2015), drawing inspiration from resource based theory and dynamic capabilities, stress the significance of defining external capabilities, arguing that many firms are often unable to cope with the demands of collaborative relationships in turbulent external environments.

Supply chains in developing economies

Base of the pyramid's focus on entry into and support of developing economies invites some consideration of the impact of this on the supply chain. It is widely acknowledged that the transition into global markets puts strain on the supply chain (Klassen & Vereecke, 2012; Zsidisin et al, 2015), particularly in terms of ecological impacts and resources (Matapolous et al, 2014). With regards to developing economies, Faisal (2010) identifies complexities such as reduced control, reluctance to collaborate, access to information, contrasting perceptions of sustainability and capacity for certification and audits. Of particular concern to base of the

pyramid is the argument that sustainability presents one of the greatest challenges to organisations operating in developing economies (Faisal, 2010; Silvestre, 2015; Zsidisin et al, 2015) and that organisational resources may not translate into foreign markets and lose competitiveness (Darkow et al, 2015; Silvestre, 2015). In spite of this, Flynn et al (2015) suggest that developing economies present some of the most innovative and appealing markets, reinforcing the value of base of the pyramid and the need to support its realisation. In addition, Zsidisin et al (2015) stress the need for greater understanding of the management of supply chains in developing economies.

With regards to capabilities, Faisal (2010) lists information sharing, strategic planning of sustainable practices, consumer concern, collaborative relationships, measurement of sustainability benefits, regulatory framework, support of supply chain partners, top management commitment, awareness of sustainable practices throughout the supply chain and the availability of funds as capabilities in support of sustainability in developing economies. Ehrgott et al (2011) stress the importance of supplier selection and in doing so reinforce the need for information sharing, collaborative relationships and supplier support. Their paper also corroborates the significance of consumer concern, and stresses the role of managers, employees and stakeholders throughout the supply chain. Darkow et al's (2015) analysis of capabilities required to support operations in foreign markets demonstrates some correspondence with Faisal (2010) and Erghott et al (2011), listing pertinent capabilities as: supply chain collaboration, human resource management, knowledge management, network structure, flexibility or the need to adapt resources to suit new markets; and relationship building with externalities.

Table 2.6 Implications for base of the pyramid capabilities derived from sustainable supply chain management synergies

Base of the Pyramid
➢ Fair Trade (Maloni & Brown, 2006) ➢ Maximisation of human & working rights (Markley & Davis, 2006; Arnold & Valentin, 2013) ➢ Firm & supplier self-assessment (Klassen & Vereecke, 2012) ➢ Supplier/ third party auditing (Klassen & Vereecke, 2012) ➢ Supplier certification (Klassen & Vereecke, 2012) ➢ Supplier training & capacity building (Klassen & Vereecke, 2012; Wang et al, 2015) ➢ Supplier selection (Ehrgott et al, 2011; Wang et al, 2015) ➢ Support of supply chain partners (Faisal, 2010; Ehrgott et al, 2011) ➢ Rewards & penalties (Klassen & Vereecke, 2012) ➢ Information management/ transparency (Faisal, 2010; Ehrgott et al, 2011; Klassen & Vereecke, 2012; Agyris & Monu, 2015; Wang et al, 2015) ➢ Stakeholder integration (Faisal, 2010; Ehrgott et al, 2011; Klassen Vereecke, 2012; Hoejmose et al, 2013; Darkow et al, 2015; Wang et al, 2015) ➢ Joint planning for social objectives (Klassen & Vereecke, 2012; Sakarya et al, 2015; Wang et al, 2015) ➢ Architectural & radical innovation of new markets, management systems & performance outcomes (Klassen & Vereecke, 2012) ➢ Risk management & mitigation (Klassen & Vereecke, 2012) ➢ Vertical integration (Klassen & Vereecke, 2012) ➢ Organisational culture , beliefs & shared value (Klassen & Vereecke, 2012; Hoejmose et al, 2013; Sakaraya et al, 2015) ➢ Top management support (Faisal, 2010; Hoejmose et al, 2013) ➢ Regulatory framework (Faisal, 2010; Hoejmose et al, 2013; Darkow et al, 2015) ➢ Global perspective (Markley & Davis, 2007; Klassen & Vereecke, 2012) ➢ Integration of external resources (Sakarya et al, 2015; Wang et al, 2015) ➢ Exploitation of external opportunities (Wang et al, 2015) ➢ Use of advanced technologies (Sakarya et al, 2015;Wang et al, 2015) ➢ Monitoring of external environment (Wang et al, 2015) ➢ Social media communications (Argyris & Monu, 2015) ➢ Strategic planning of sustainable practices (Faisal, 2010) ➢ Availability of funds (Faisal, 2010) ➢ Employee awareness/ training/ management (Ehrgott et al, 2011; Darkow et al, 2015) ➢ Resource reconfiguration/ adaptation (Darkow et al, 2015) ➢ Consumer concern (Faisal, 2010; Ehrgott et al, 2011) ➢ Measurement of sustainability benefits (Faisal, 2010) ➢ Awareness of sustainable practices throughout the supply chain (Faisal, 2010; Ehrgott et al, 2011) ➢ Organisational learning (Ehrgott et al, 2011) ➢ Network structure (Darkow et al, 2015)

2.4.5 Dynamic Capabilities & Sustainable Supply Chain Management

Adding further strength to NRBV and SSCM synergies is their shared interest in dynamic capabilities (Reuter et al, 2010). As discussed, dynamic capabilities assumes some dominance in resource-based theory literature (e.g Eisenhardt & Martin, 2000; Butler & Priem, 2001; Aragon-Correa & Sharma, 2003; Ashby et al, 2012), where it's continuous renewal of resources in support of competitiveness over time (Teece et al, 1997) is presented as a major theoretical development (Fiol, 2001; Hart & Dowell, 2011; Chakrabarty & Wang, 2012). Such continuous renewal is also of relevance in modern supply chain management (DeFee & Fugate, 2010; Chicksand et al, 2012; Miemczyk et al, 2012) which calls for flexibility and

adaptability (Beske, 2012), particularly where competitiveness (Defee & Fugate, 2010; Beske et al, 2014) and sustainability are concerned (Chakrabarty & Wang, 2012; Li & Lui, 2014). That is, dynamic capabilities supports supply chain responsiveness to the external environment (Beske, 2012) and consequently is argued to improve the sustainable performance (Beske et al, 2014; Reuter et al, 2010; Hong et al, 2017) and competitiveness (Defee & Fugate, 2010; Reuter et al, 2010) of the supply chain as a whole.

However, going beyond discussions of the need for dynamic capabilities in the supply chain, Defee & Fugate (2010) suggest that supply chain capabilities are dynamic capabilities. Expanding on this within a sustainability context, Beske (2012) argues that recurring sustainable supply chain management practices form routines from which dynamic capabilities are derived. More specifically, when such routines are used to '*change the business environment, the resource-base of the supply chain, or to adapt from sudden changes from the outside'* they emerge as dynamic capabilities (Beske et al, 2014, p141). This corresponds with the definition of dynamic capabilities as capabilities that '*integrate, build and reconfigure internal and external competencies to address rapidly changing environments'* (Teece et al, 1997, p516). As such, there exists growing interest surrounding the definition and explanation of SSCM dynamic capabilities (e.g. Reuter et al, 2010; Beske, 2012; Beske et al, 2014; Miemczyk et al, 2016; Hong et al, 2017).

Notably, in spite of clear interrelations of sustainability, competitiveness and resources, the study of SSCM dynamic capabilities is yet to assume a NRBV focus, instead drawing upon corporate social responsibility and the triple-bottom-line concept (Reuter et al, 2010; Beske et al, 2014). That is, with the exception of Miemczyk et al's (2016) study of dynamic product stewardship capabilities within closed-loop supply chains, the relationship between the NRBV, SSCM and dynamic capabilities remains understudied, reinforcing the significance of this study.

2.5 The Natural- Resource-Based View and Innovation

Innovation has emerged as a consistent theme in this thesis. In the first instance, Hart himself places a reliance on innovation, discussing continuous and process innovations in pollution prevention (Hart, 1995), new product and process development in product stewardship (Hart, 1995) and technological innovation, disruptive change and investment in innovation in sustainable development, clean technologies and base of the pyramid (Hart, 1997).

Implications of innovation are also notable in later attempts at NRBV extension and development; for example Aragon-Correa & Sharma's (2003) discussions of continuous improvement in their contingent proactive environmental strategy; Menguc & Ozanne's (2005) presentation of innovativeness and entrepreneurship as NRBV capabilities in their natural environment orientation; and Shi et al's (2012) emphasis on green product design in their natural-resource-based green supply chain management model. Adding weight to its significance is the dominant role of innovation in SSCM literature (Yam et al, 2010; Ageron et al, 2013), as demonstrated by earlier implications for intra-organisational innovativeness (Chen, 2001; Markley & Davis, 2007; Kurk & Eagan, 2008), green innovations (Jumadi & Zailani, 2010), sustainable supply chain innovations (Von Hippel, 1988; Soosay et al, 2008; Ashby et al, 2012; Blome et al, 2012; Ageron et al, 2013; Golicic Smith, 2013; Johnsen et al, 2014) and technological innovations (Bell et al, 2012; Jensen et al, 2013) in NRBV and SSCM synergies. Innovation is defined as:

> *'Production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. It is both a process and an outcome'.*
>
> Crossan & Apaydin (2010, p1155)

To put it more simply, innovation is value that stems from new opportunities (Tidd & Bessant, 2009) and is driven by new ideas (Walker, 2014). Putting this into the context of the NRBV, the natural environment is presented as the 'new opportunity'. Dynamic capabilities, which is widely linked with innovation (Teece & Leih, 2016) supports the pursuit of new opportunities and ideas. However, despite its apparent relevance, innovation is rarely the focus in NRBV literature, and is yet to be empirically linked with pollution prevention, product stewardship, clean technologies or base of the pyramid.

Notably, linking the NRBV with innovation is not without complexity. Firstly, innovation itself is commonly presented as a high-risk strategy that does not guarantee success (Heimonen, 2012; Boons et al, 2013; Szekely & Strebel, 2013) and may even act detrimentally on the firm (Christensen, 1997), placing a strain on costs, time and skills (Crossan & Apaydin, 2010). Secondly, innovation has evolved since its origins in economic theory (Schumpeter, 1934), making it difficult to identify and define (Garcia & Calantone, 2002). However, such complexities arguably demonstrate some correspondence with the heterogenous, complex and

ambiguous nature of resources (Lockett et al, 2009). Adding further significance are claims that innovation exists at the root of all economic, social, technological and business developments (Birkenshaw et al, 2008) and is often indivisible from organisational success (Tidd & Bessant, 2009). Moreover, Drucker (1985) argues that innovation creates resources, and accordingly without innovation, Hart's resources of pollution prevention, product stewardship, clean technologies and base of the pyramid would not exist.

Thus, taking this study's four-resource perspective of the NRBV, synergies between each resource and innovation typologies are explored. Innovation overall benefits from some definition as to its capabilities throughout literature (e.g. Drucker, 1985; Soosay et al, 2008; Tidd & Bessant, 2008; Crossan & Apaydin, 2010; Berghman et al, 2012; Steiber & Alänge, 2013; de Medeiros et al, 2014; Jayaram et al, 2014), and as such this exploration results in identification of further implications for capabilities, depicted in table 2.7 at the end of this section. Pertinently, this is also advantageous to the topic of innovation, responding to calls for enhanced definition of innovation capabilities (Jayaram et al, 2014) according to innovation typologies which are commonly disregarded (Garcia & Calantone, 2002).

2.5.1 Pollution prevention & Innovation

As mentioned, since its conception pollution prevention has been directly linked with innovation and in particular topics of continuous innovation (Hart, 1995; Hart & Dowell, 2011; Vachon & Klassen, 2008; Golicic & Smith, 2013) and process innovation (Hart, 1995; Aragon-Correa & Sharma, 2003) emerge with significance. Consequently, this section reviews continuous and process innovation, identifying a number of pertinent capabilities.

Continuous Innovation

Continuous innovation, along with continuous improvement, features prominently in discussion of pollution prevention (Hart, 1995; Hart & Dowell, 2011; Vachon & Klassen, 2008; Golicic & Smith, 2013). Given that the fundamental principle of pollution prevention is to enhance operations to meet the demands of the natural environment (Aragon-Correa & Sharma, 2003; Menguc & Ozanne, 2005; Hart & Dowell, 2011) a reliance on innovation and improvement are easily understandable. However, it is the emphasis on continuous innovation that is interesting here. Continuous innovation is based upon the argument that in order to meet demand, in this case environmental demand, firms must continuously out-innovate competitors (Drucker, 1985; Christensen, 1997; Galunic & Rodan, 1998) and continuously innovate processes, products and capabilities (Shang et al, 2008). To put it more simply, Tidd & Bessant (2009) suggest that innovation is a 'moving target' based on the argument that

innovations may be imitated by competitors or become outdated and be replaced with new innovations. Taking this into consideration, it can be assumed that pollution prevention is a moving target that firms must constantly strive to be the best at, warranting links with dynamic capabilities (Crossans & Apaydin, 2010).

Literature somewhat struggles to define the capabilities of continuous innovation (Steiber & Alänge, 2013). This said, Sharma & Vredenburg (1998) offer implications for proactivity, higher order learning and technology, and Shang et al (2008) place a reliance on entrepreneurial leadership, foresight and insight and the reconfiguration of processes and technologies to allow for the integration of new information and knowledge. Adding some reinforcement, subsequent studies highlight the significance of organisational characteristics (Soosay et al, 2008; Steiber & Alänge, 2013) and managerial competencies (Crossans & Apaydin, 2010) in continuous innovation.

Process Innovation

According to Tidd & Bissant (2009, p6) process innovation allows you to '*make something that no one else can, or to do so in ways that are better than anyone else'*, offering a source of competitive advantage. It is the latter part of this statement in which comparisons can be drawn with pollution prevention, in that pollution prevention is intended to facilitate production that is superior to that of competitors: both environmentally via the elimination of waste, emissions and effluents and competitively via reduced costs and improved quality and efficiency (Hart, 1995; Hart & Dowell, 2011). Process innovation by its very definition is focused upon improvements in organisational structure, strategy and processes (Walker, 2014), and has been linked with cost reduction (Chenavaz, 2012), value creation (Utterback & Abernathy, 1975; Smith, 1994) and enhanced speed and efficiency. Moreover, Christmann (2000) argues that process-based best practices should exist as a pre-condition in the realisation of competitive and sustainable operations, adding strength to the role of process innovation in the realisation of pollution prevention.

Fortunately a recent study by Walker (2014) does offer some definition of process innovation capabilities, namely: new approaches to personnel including rewards and motivation; searching out new approaches and implementing new structures; modifying managerial processes; effective allocation of resources, organisational capacity; organisational learning in support of process innovation, adoption and implementation; and technological process innovations that are aimed at reducing costs and time and improving efficiency and

flexibility. The emphasis on technology (e.g. Utterback & Abernathy, 1975; Smith, 1994; Jayaram et al 2014) and significance of external influences (Jayaram et al, 2014) corresponds with further studies of process innovation.

2.5.2 Product Stewardship & Innovation

Links between product stewardship and innovation surround the modification of products and processes and the use of alternative materials (Hart, 1995; Hart & Dowell, 2011). In the most part, this has manifested in discussions of the need for innovation throughout the supply chain as a whole in an attempt to create wholly sustainable products and processes (Von Hippel, 1988; Soosay et al, 2008; Jumadi & Zailani, 2010; Ashby et al, 2012; Blome et al, 2012; Ageron et al, 2013; Golicic Smith, 2013; Johnsen et al, 2014). As such, this section reviews the emergent field of sustainable supply chain innovation, resulting in identification of further implications for product stewardship capabilities.

Sustainable Supply Chain Innovation

The dominant role of innovation in SSCM (Soosay, 2008; Vachon & Klassen, 2008; Abbasi & Nilsson, 2012; Ashby et al, 2012; Chen et al, 2012; Ageron et al, 2013; Jensen et al, 2013; Wu, 2013) has facilitated the evolution of sustainable supply chain innovation, which is defined as:

> *'Innovation that is concerned with sustainable, environmentally sound, closed-looped innovations in terms of business processes, network structure, and technology in a supply chain management context'.*
>
> Jensen et al (2013, p127)

Sustainable supply chain innovation is presented as a viable means by which to realise sustainability (Vachon & Klassen, 2008; Szekely & Strebel, 2013) in a competitive fashion (Berghman et al, 2012; Szekely & Strebel, 2013). The lifecycle focus of sustainable supply chain innovation, aimed at the sustainable enhancement of operations throughout the supply chain (Szekely & Strebel, 2013) corresponds with product stewardship. Pertinently, Pagel & Shevchenko (2014) heavily endorse sustainable supply chain innovation, predicting that it facilitates the modernisation of traditional supply chain management towards a sustainability-focused approach. Thus, its value in terms of the realisation of product stewardship is difficult to ignore.

As a relatively new academic field, sustainable supply chain innovation lacks comprehensive research and understanding and accordingly its capabilities are yet to be defined. This said, capabilities of research and development (Chakrabarty & Wang, 2012) and technology (Ageron et al, 2013; Boons et al, 2013; Jensen et al, 2013; Szekely & Strebel, 2013) are linked with product stewardship, but lack clarity or empiricism. Isaksson et al (2010) also render implications for change management, corporate social responsibility, stakeholder management and measurements such as KPIs and ISO 14001 in order to visualize and realise environmental improvements from a supply chain perspective.

2.5.3 Clean Technologies & Innovation

Out of all the NRBV resources, clean technologies places most obvious reliance on innovation, given that it is focused upon the creation of new, sustainable technologies and processes. In particular, the topic of technological innovation features in discussion of clean technologies (Hart, 1997; Hart & Dowell, 2011) and is explored in this section. Drawing on synergies with clean technologies, the topic of sustainable innovation also warrants discussion.

Technological Innovation

Technological innovation is linked with clean technologies in initial conceptualisation of the resource (Hart, 1997) and featured in the earlier analysis of clean technologies and SSCM synergies (Bell et al, 2012; Jensen et al, 2013). The topic also asserts dominance in innovation literature (Birkenshaw et al, 2008), with the common perception that technology is innovation (Drucker, 1985) often resulting in technological innovation serving as an inclusive title for innovation (Garcia & Calatone, 2002). This thesis contests this, instead adopting the view that technological innovations are 'technology based innovations' (Garcia & Calatone, 2002) that are intended to improve performance in the long-term (Christensen, 1997). From this perspective, synergies are easily identifiable with clean technologies, which encourages companies to '*plan for and invest in tomorrow's technologies'* (Hart, 1997, p3).

As a result of its prominence in literature, technological innovation benefits from extensive research and understanding, and in particular attention has been awarded to the capabilities of technological innovation. Fortunately, Yam et al's (2010) literature review refines this into seven core capabilities:

- learning capability in which knowledge is identified and exploited from the environment;
- R&D capability including R&D strategy, project implementation and expenditure;

- Resource allocation capability regarding capital, professionals and technology;
- Manufacturing capability in which R&D is transformed into marketable products;
- Marketing capability in which products are successfully target consumer markets;
- Organizing capability in which intra-firm departments work together;
- Strategic planning capability which is the ability to incorporate internal and external threats and opportunities into corporate vision.

Such capabilities, which demonstrate correspondence with the clean technologies capabilities identified earlier, further benefit from empirically reinforced links with performance improvement (Yam et al, 2010)

Sustainable Innovation (environmental)

Szekely & Strebel (2013, p468) draw direct links between clean technologies and sustainable innovation, defining it as:

> *'The development of something new, be it intentional or not, that improves performance in the three dimensions – i.e. environmental, economic and social – of sustainable development'*.

To maximise specificity with clean technologies, this section focuses upon the environmental element of sustainable innovation, and in doing so is inclusive of synonymous terms of eco-innovation, green innovation and environmental innovation. From this perspective, the purpose of sustainable innovation is to modify operations in response to increased ecological degradation (de Medeiros et al, 2014). In further correspondence with clean technologies, this is presented as a complex and high-risk strategy which requires further research (Christensen, 1997; Heimonen, 2012; de Medeiros et al, 2014). However, adding strength to its value in this study, Boons et al (2014) conclude that the positives of sustainable innovation, particularly in terms of financial gain, far out-weigh the negatives. Similarly, de Medieros et al (2014, p81) stress the competitive potential of sustainable innovations, suggesting that they:

> '*add value to a brand as they generate positive awareness towards the brand, as well as increased perceived quality and trust that may positively impact customer satisfaction'*.

With regards to capabilities, Andersson & Bateman (2000) stress the importance of the individual role of employees, suggesting that it is often one 'champion' who is able to interpret

and exploit opportunity for sustainable innovation. Implications are also made for system optimization (Quist & Tukker, 2010), proactivity and flexibility (de Medeiros et al, 2014) and eco-design (Quist & Tukker, 2010; Boons & Lüdeke-Freund, 2013). In addition, Cuerva et al's (2014) empirical study of the drivers of green innovation places an emphasis on quality management systems, product differentiation strategy and technological abilities. More recently, Lee & Min (2015) stress the need for green R&D, top management support and a long-term perspective to realise financial paybacks from sustainable innovations, pertinently using the NRBV to underpin their study and empirical analysis to support links with financial and environmental benefits.

2.5.4 Base of the pyramid & Innovation

The role of innovation in base of the pyramid is best demonstrated via the need for advanced market entry and the modification of products and processes to meet new market demands (Prahalad & Hart, 2002). However, base of the pyramid is also presented as a stimulant for innovation, in that emerging markets act as a safe environment for the creation and testing of new products or processes (Hart, 1997). It is suggested that for base of the pyramid to succeed, innovation must be embedded within a company (Hall & Vrendenburg, 2004; Hart & Dowell, 2011), rendering links with radical innovation (Hart & Christensen, 2002; Prahalad & Hart, 2002; Klassen & Vereeke, 2012) and disruptive innovation (Hart & Christensen, 2002; Hart et al, 2016) which are explored here, along with the social element of sustainable innovation.

Radical Innovation

Loosely described as the opposite of incremental innovations (Green & Cluley, 2014), radical innovations offer something entirely new (Story et al, 2011), and as such could be linked with both clean technologies and base of the pyramid. However, according to Prahalad & Hart (2002) radical innovation is a base of the pyramid capability, and this can be perhaps attributed to claims that it goes beyond the development of a new technology and is instead where that technology meets marketing (Garcia & Calantone, 2002). Given Hart & Christensen's (2002) argument that base of the pyramid markets often offer suitable markets for the launch and development of clean technologies this assumes logic. Highlighting further synergies is the suggestion that radical innovations create new markets as a result of their ability to create demand rather than respond to it (Garcia & Calantone, 2002).

The significance of capabilities is maximised in radical innovations due to the need for entirely new capabilities in terms of communication, infrastructure and the handling of information (Garcia & Calantone, 2002). However, Story et al (2011) suggest that firms still

struggle to develop capabilities, and link this with high levels of failure in radical innovations. This said, some implications for capabilities are identifiable, with particular reference to NPD technology which in turn produce what are considered the four competencies of radical innovation: discovery in which an opportunity for radical innovation is identified; incubation in which the radical innovation transforms into a business proposal; acceleration in which the innovation is prepared and produced for market; and commercialization in which the innovation is launched (Story et al, 2011). An emphasis also falls upon extensive collaboration and the individual roles of each party. Green & Cluley (2014) reinforce this, suggesting that radical innovations may emerge from employee entrepreneurial abilities, senior management or external interactions.

Disruptive Innovation

Disruptive innovation is also presented as a base of the pyramid capability (Hart & Christensen, 2002; Hart et al, 2016) on account of its divergence from current market strategies and penetration of completely new markets (Tidd & Bessant, 2009). More specifically, such innovations, which were first explored by Christensen & Bower (1995), commonly involve cheaper or simpler products that would fail in primary business markets but that suit the unsaturated nature of emerging markets (Christensen, 1997). Thus, as well as synergies with base of the pyramid, synergies are identifiable with radical innovations, but as is argued by Story et al (2011), all disruptive innovations are radical but not all radical innovations are disruptive.

As with radical innovations, the scarcity of resources in emerging markets and the pressure to develop something entirely new puts extra strain on capabilities (Brem & Wolfram, 2014). From a traditional perspective, Christensen (1997) suggest that disruptive innovation relies on organisational processes such as labour, materials, energy and investment, organisational culture such as employee and managerial decision making, and technology and the management of technological change. However, a more modern perception of disruptive innovations which incorporates the social principles of disruptive innovation has resulted in examination of more socially-specific capabilities (Christensen et al, 2006; Brem & Wolfram, 2006). That is, Christensen et al (2006) promote catalytic innovations as a '*subset of disruptive innovations, distinguished by their primary focus on social change, often on a national scale'*, arguing that companies must be able to think 'catalytically' and placing a reliance on five organisational abilities: scaling and replication to create systematic social change; the ability to meet new or over served needs; the ability to create less costly and simpler products that are

of value to specific consumers; the ability to generate resources from donations, grants, volunteers, or intellectual property; and the ability to serve markets that are deemed unattractive. Similarly, Brem & Wolfram (2014) identify frugal innovation and gandhian innovation as subsets of disruptive innovation that are of particular significance to base of the pyramid. Frugal innovation is a managerial approach that begins with targeting base of the pyramid markets and then adapts offerings to meet their needs in a low-cost fashion. Gandhian innovation focuses on the internal aspects of frugal innovation, with particular reference to the development of internal capabilities and technologies. Brem & Wolfram's literature review identifies frugal and gandhian innovation capabilities such as new product development, product or process customization, new technologies and business models, market insight and collaboration both within and out with the supply chain.

Sustainable Innovation (Social)

As is demonstrated in its earlier definition (Szekely & Strebel, 2013), sustainable innovation focuses upon enhancement of economic, environmental and social spheres, and as such is applicable to both clean technologies and base of the pyramid. Literature varies in its handling of this, but Quist & Tukker's (2010) perspective of sustainable innovation as a '*long-term focus on sustainable societal transformation [....] that leads to sustainable consumption and production'* presents a social based focus of sustainable innovation that corresponds with base of the pyramid (Boons & Lüdeke-Freund, 2013). Interestingly the social aspects of sustainable innovation, also referred to as social innovation (Baker & Abid, 2015) can be traced back to Schumpeter's (1934) Theory of Economic Development, however, it only is in more recent times that the topic has gained precedence in literature (Baker & Abid, 2015).

According to Quist & Tukker (2010), sustainable innovation is inseparable from organisational learning and collaboration. In correspondence with the earlier discussion of base of the pyramid, it is argued that firms must work with all stakeholders to combine knowledge and encourage positive changes (Boons & Lüdeke-Freund, 2013). Mutual engagement with such a broad perspective of stakeholders, ranging from supply chain intermediaries, competing firms, NGOs, governments and educational and health bodies, is believed to facilitate the realisation of shared goals (Quist & Tukker, 2010), or rather sustainable social development (Baker & Abid, 2015). Interestingly, this often involves radical or disruptive innovations (Szekely & Strebel, 2013). Further implications for capabilities can be identified from Baker & Abid's (2015) review of social innovation, namely individual

creativity, organisational structure, environmental context, social learning, technology, natural resource management, governance and fair trade.

Table 2.7 Implications for natural-resource-based view capabilities derived from innovation synergies

Pollution Prevention
➢ Managerial approaches (Crossans & Apaydin, 2010; Walker, 2014) ➢ Personnel management (Walker, 2014) ➢ Identification & implementation of new processes (Walker, 2014) ➢ Resource management (Walker, 2014) ➢ Organisational capacity (Walker, 2014) ➢ Organisational learning (Walker, 2014) ➢ Technology (Utterback & Abernathy, 1975; Smith, 1994; Sharma & Vredenburg, 1998; Jayaram et al, 2014; Walker, 2014) ➢ Consideration of externalities (Jayaram et al, 2014) ➢ Entrepreneurial leadership, foresight & insight (Shang et al, 2008) ➢ Information/ knowledge management (Shang et al, 2008) ➢ Reconfiguration of processes & technologies (Shang et al, 2008)
Product Stewardship
➢ Technology (Ageron et al, 2013; Boons et al, 2013; Jensen et al, 2013; Szekely & Strebel, 2013) ➢ R&D (Chakrabarty & Wang, 2012) ➢ Change management (Ikasson et al, 2010) ➢ Corporate social responsibility (Ikasson et al, 2010) ➢ Stakeholder management (Ikasson et al, 2010) ➢ Measurement (KPIS, ISO 14001) (Ikasson et al, 2010)
Clean Technologies
➢ Green R&D (Yam et al, 2010; Lee & Min, 2015) ➢ Resource Allocation (Yam et al, 2010) ➢ Manufacturing & Marketing (Yam et al, 2010) ➢ Strategic planning (Yam et al, 2010) ➢ Organisational capacity (Yam et al, 2010) ➢ Employee skills (Andersson & Bateman, 2000) ➢ Proactivity (de Medieros et al, 2013) ➢ Flexibility (de Medieros et al, 2013) ➢ Eco-design (Quist & Tukker, 2010; Boons & Lüdeke-Freund, 2013) ➢ Optimization (Quist & Tukker, 2010) ➢ Quality management systems (Cuerva et al, 2014) ➢ Product differentiation strategy (Cuerva et al, 2014) ➢ Technological abilities (Cuerva et al, 2014) ➢ Top management support (Lee & Min, 2015) ➢ Long term perspective (Lee & Min, 2015)
Base of the Pyramid
➢ Discovery of radical innovation opportunities (Story et al, 2011) ➢ Transforming innovation into business proposals (Story et al, 2011) ➢ Marketing & commercialisation (Story et al, 2011; Brem & Wolfram, 2014) ➢ External collaboration (Quist & Tukker, 2010; Story et al, 2011; Boons & Lüdeke-Freund, 2013; Brem & Wolfram, 2014; Green & Cluley, 2014) ➢ Entrepreneurial power of individuals (Story et al, 2011; Green & Cluley, 2014) ➢ Flexible approach to innovation (Green & Cluley, 2014) ➢ Shared organisational culture & decision making (Christensen, 1997; Quist & Tukker, 2010; Boons & Lüdeke-Freund, 2013) ➢ Management of technological change (Christensen, 1997; Brem & Wolfram, 2014; Baker & Abid, 2015) ➢ Scaling and replication to create systematic social change (Christensen et al, (2006) ➢ Meeting new or over served market needs (Christensen et al, 2006) ➢ Creating less costly and simpler products of value to specific consumers (Christensen et al, 2006) ➢ Generating resources (Christensen et al, 2006) ➢ Product or process customization (Brem & Wolfram, 2014) ➢ Inter -Organisational learning (Quist & Tukker, 2010; Boons & Lüdeke-Freund, 2013; Baker & Abid, 2015) ➢ Individual creativity (Baker & Abid, 2015) ➢ Fair trade (Baker & Abid, 2015)

2.6 Summary of Findings

The literature review demonstrates the strong presence of the NRBV in literature and its modern day relevance in industry. In some contrast, the NRBV's failure to overcome resource-based theory issues of impracticality, incorporate dynamic capabilities and the disregard for the theory's evolution from three resources to four is also exposed. As such, the need for the realisation of pollution prevention, product stewardship, clean technologies and base of the pyramid as the complex resources they were intended and explication and ellucidation of their dynamic capabilities in support of this is evidenced. This chapter's comprehensive review of seminal NRBV studies, NRBV theoretical extensions and developments and synergies between each resource and sustainable supply chain management and innovation offer some insight into potential capabilities. As detailed in the following chapter, this permits the construction of a dynamic framework of natural-resource-based view capabilities, offering a basis for overdue empirical investigation of the theory.

Table 2.8 Literature Review Findings

Literature Review Findings	
Pollution Prevention	➢ Dominant resource in literature, benefitting from extension & development ➢ Synergistic relationship with SSCM strategies of intra-organisational environmental practices, environmental management systems & lean supply chain management conceptualised ➢ Synergistic relationship with innovation sub-types of process innovation and continuous innovation conceptualised ➢ 45 conceptual capabilities identified
Product Stewardship	➢ Strong presence in literature, benefitting from extension & development ➢ Synergistic relationship with SSCM strategies of green purchasing, green distribution, design for the environment, sustainable supply chain collaboration & closed-loop supply chain management conceptualised ➢ Synergistic relationship with innovation sub-type of sustainable supply chain innovation conceptualised ➢ 60 conceptual capabilities identified
Clean Technologies	➢ Neglected in literature ➢ Synergistic relationship with SSCM strategies of environmental technologies in the supply chain, corporate environmental responsibility, closed-loop supply chain management & resource efficient supply chains conceptualised ➢ Synergistic relationship with innovation sub-types of technological innovation & sustainable innovation conceptualised ➢ 52 conceptual capabilities identified
Base of the Pyramid	➢ Neglected in literature ➢ Conflict surrounding global versus local social sustainability ➢ Synergistic relationship with SSCM strategies of socially responsible supply chains, external collaboration & supply chains in developing economies conceptualised ➢ Synergistic relationship with innovation sub-types of radical innovation disruptive innovation & sustainable innovation conceptualised ➢ 56 conceptual capabilities identified

3.0 Conceptual Definition of Dynamic Natural-Resource-Based View Capabilities

The preceding chapter stresses the need for investigation and operationalisation of the four natural-resource-based view resources. The natural-resource-based view's lack of practical applicability (Hart & Dowell, 2011) is to some extent inherited from its resource-based theory roots, where a lack of practical guidance is well noted (Grant, 1991; Lockett et al, 2009). In particular inattention of the capabilities required to support resources, both from a resource-based theory perspective and a natural-resource-based view perspective, emerges as a major theoretical flaw. Capabilities are believed to play a fundamental role in the operationalisation of resources (Penrose, 1959; Amit & Schoemaker, 1993; Christmann, 2000; Butler & Priem, 2001), but the specifics of this and their definition remains a research gap (Newbert, 2007; Rashidirad et al, 2015). The introduction of dynamic capabilities (Teece et al, 1997) adds further consequence, stressing the need for capabilities that support the continuous renewal of resources. However, subject to considerable criticism and misinterpretation, dynamic capabilities as a tool with which to guide and explain capabilities within resources has been widely overlooked (Teece, 2007). Thus, in absence of practical guidance and in conflict of its significance in modern business's pursuit of competitive and sustainable operations (Pagell & Shevchenko, 2014), a natural-resource-based view theory-practice gap emerges. In response, this study seeks empirical explication and elucidation of dynamic natural resource-based view capabilities in support of its overdue operationalisation.

Building on the results of the preceding literature review, this chapter offers conceptual defintion of dynamic natural-resource-based view capabilities. As depicted in figure 3.1. *(below)*, and discussed throughout this chapter, this involves the refinement of capabilities extracted from literature and their categorization according to dynamic capabilities and their internal or external focus. In doing so, this chapter resolves the second research objective:

- Categorize and refine capabilities into a dynamic capability framework.

This preliminary definition of capabilities provides a basis for the empirical study, supporting the empirical definition of dynamic natural-resource-based view capabilities.

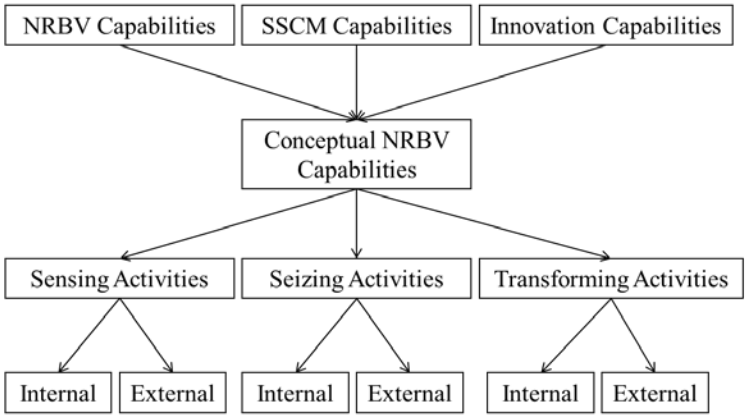

Figure 3.1 Process of Conceptual Capability Definition

3.1 Extraction & Refinement of Conceptual Capabilities

The initial identification of natural-resource-based view capabilities came from critical review of literature, as depicted in chapter 2. More specifically, review of natural-resource-based view seminal studies and theoretical extensions and developments resulted in the identification of implications for capabilities. Exploration of each natural-resource-based view resource and synergies with sustainable supply chain management strategies *(fig. 3.2)* and sub-types of innovation *(fig. 3.3)* then resulted in the identification of additional implications for capabilities.

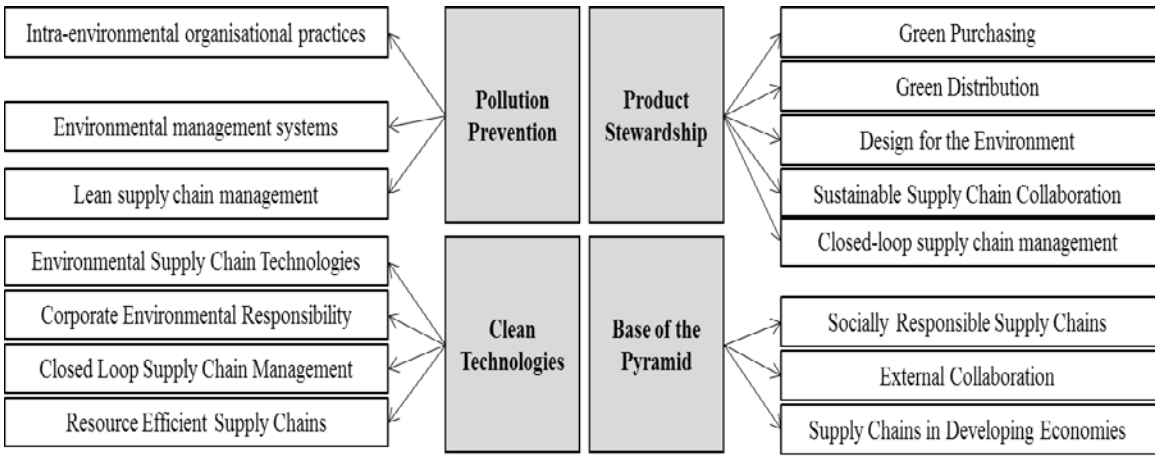

Figure 3.2 Natural-resource-based view & sustainable supply chain management synergies

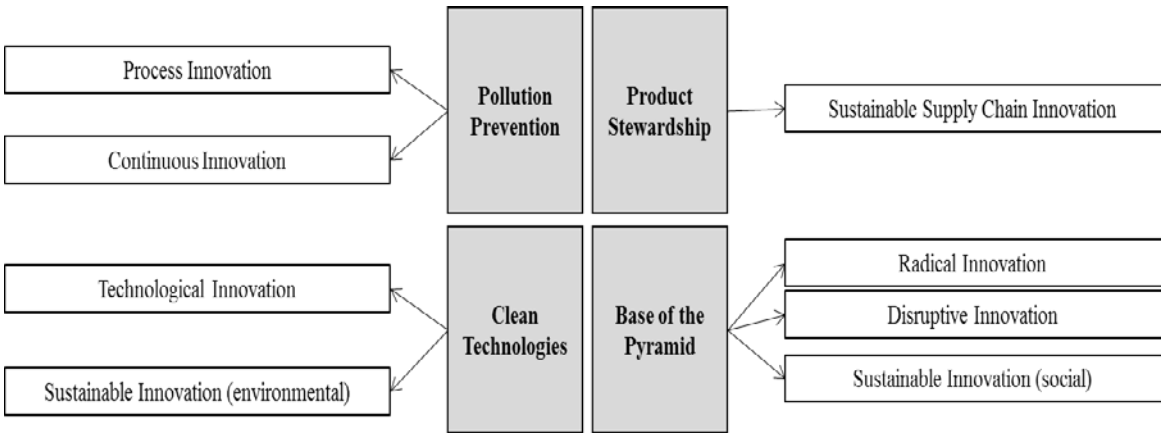

Figure 3.3 Natural-resource-based view & Innovation synergies

This resulted in the extraction of 213 capabilities: 45 for pollution prevention; 60 for product stewardship; 52 for clean technologies; and 56 for base of the pyramid. Whilst this provides valuable insights into conceptual natural-resource-based view capabilities, high levels of repetition create unnecessary confusion in that capabilities derived from seminal natural-resource-based view studies often re-emerged in theoretical extensions and sustainable supply chain management and innovation synergies. Adding further complexity are synonymous or similar capabilities such as total quality management, environmental total quality management and internal environmental management systems for pollution prevention. In the interests of promoting clarity the need for refinement emerges, encouraging the amalgamation of repeated, synonymous and similar capabilities. Thus, the initial 213 capabilities were reduced to 187 *(appendix 1)*: 35 pollution prevention capabilities; 48 product stewardship capabilities; 52 clean technologies capabilities; and 52 base of the pyramid capabilities. This reduction of 26 capabilities, albeit not substantial, supports the construction of a clearer and more approachable definition of conceptual natural-resource-based view capabilities.

3.2 Categorization of Conceptual Capabilities

Whilst the definition of capabilities is interesting, it is the explanation of their role in supporting resources that is important. Rashidirad et al (2015) offer a strong argument for the need to examine the complex relationships between capabilities and resources, which literature to date has neglected. As such, this study aims to go beyond the basic definition of natural-resource-based view capabilities to instead elucidate the specific relationship between a given capability and its corresponding resource. In particular, the role of such capabilities as dynamic

capabilities and the distinction between internal and external capabilities is prioritised. Accordingly, the 187 conceptual capabilities were categorized according to dynamic capabilities activities of sensing, seizing and transforming and their internal or external focus, permitting the construction of *dynamic* framework of natural- resource-based view capabilities.

Grbich (2007, p21) defines categorization as a process that allows data to be *'segregated, grouped, regrouped and relinked to consolidate meaning and explanation'*. As discussed in detail in chapter 6, such categorization was supported by qualitative content analysis and inter-coder reliability assessments. However, this was not a straightforward process of assigning capabilities to corresponding categories, but rather involved in-depth analysis, interpretation and discussion by three researchers. This was a lengthy and complex task, but advantageous in that as well as well as enhancing the conceptual definition of natural-resource-based view capabilities it significantly advanced the researchers' understandings of capabilities ahead of the empirical study. This is supported by the qualitative nature of this study which intentionally diverges from the positivistic dominance of existing resource-based theory research (Acedo et al, 2016) in pursuit of profound explanation of capabilities. An example of the refinement and categorization of a sensing internal pollution prevention capability is provided in figure 3.4 below.

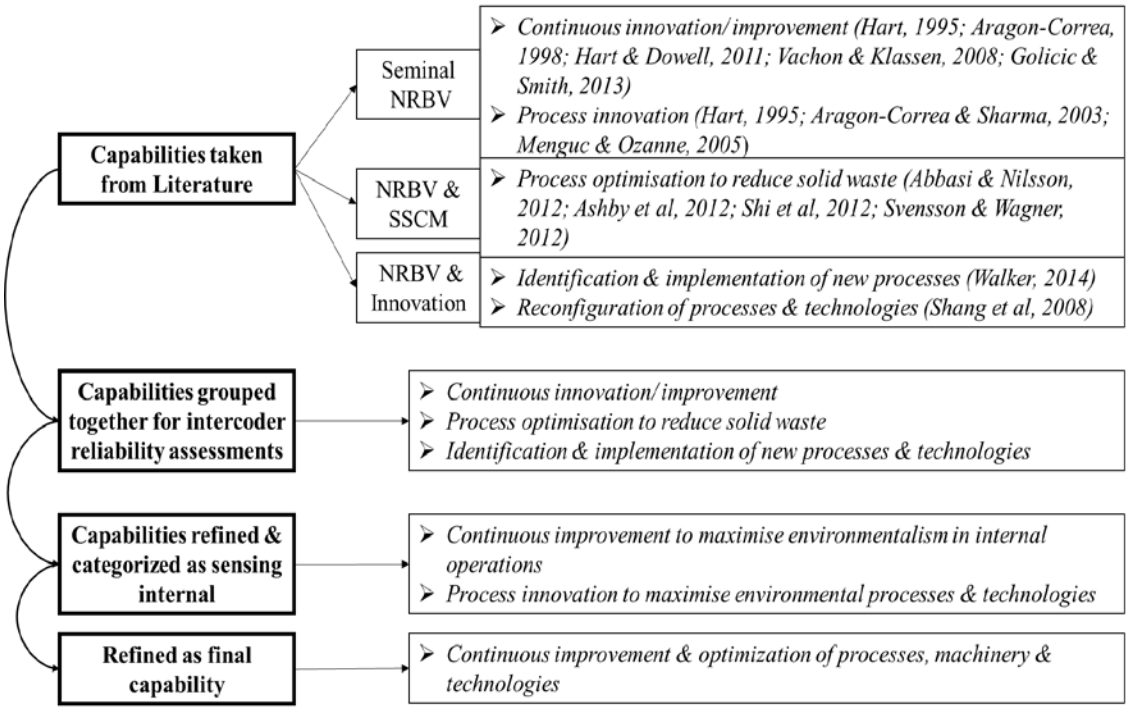

Figure 3.4 Refinement & categorization of sensing internal pollution prevention capability

3.2.1 Dynamic Capability Categorization

As discussed, dynamic capabilities emerges with significance in resource-based theory research (Teece et al, 1997; Lockett et al, 2009), and is particularly prominent in the natural-resource-based view (Johnson et al, 2014). That is, the unpredictability of environmental and social sustainability issues, from which natural-resource-based view resources are derived, may add to the implausibility of static competitiveness (Chakrabarty & Wang, 2012; Li & Lui, 2014), thus heightening the need for dynamic capabilities. However, whilst this need is well noted in literature, definition of dynamic natural-resource-based view capabilities is neglected. In addition, dynamic capability activities of sensing, seizing and transforming scarcely feature in literature, disregarding their role in guiding and explaining capabilities within resources (Teece, 2007). Given the purpose of this study, the categorization of conceptual capabilities as dynamic capabilities activities emerges with logic. Not only does this add lucidity to the role of a capability within a resource, but it corresponds with the derivation of conceptual capabilities from sustainable supply chain management and innovation synergies. More specifically, it is argued that sustainable supply chain capabilities are dynamic capabilities (Beske, 2012; Beske et al, 2014), whilst dynamic capabilities are believed to stimulate innovation (Crossans & Apaydin, 2010; Teece & Leih, 2016). Thus, dynamic capabilities activities and their sub-activities, as discussed in the literature review and depicted in table 3.1 below, were used to categorize the conceptual capabilities.

Table 3.1 Dynamic Capabilities Activities

Sensing	➢ Processes to direct internal R&D and select new technologies ➢ Processes to tap supplier and complementor innovation ➢ processes to tap developments in exogenous science and technology ➢ Processes to identify target market segments, changing customer needs and customer innovation
Seizing	➢ Delineating the customer solution and business model ➢ Selecting decision making protocols ➢ Selecting enterprise boundaries to manage compliments and control platform ➢ Building loyalty and commitment
Transforming	➢ Decentralisation and near decomposability ➢ Governance ➢ Cospecialization ➢ Knowledge management

Specifically, this involved three independent researchers assigning each conceptual capability to the appropriate sensing, seizing or transforming category and sub-category *(appendix 2)*. However, whilst satisfactory agreement was reached, a number of capabilities were applicable to more than one category and sub-category. In particular, it proved difficult to distinguish between the dynamic capability activity sub-categories and as such the decision was made to remove sub-categorization altogether. In an attempt to offer further clarity, the

capabilities where possible were specified according to their categorization by the three researchers. Nonetheless, as demonstrated in appendix 3, this resulted in a repetitive and somewhat unapproachable list of 205 capabilities, highlighting the need for further refinement and categorization.

3.2.2 Internal-External Categorization

As discussed throughout the literature review, resources assume both internal and external aspects (Lockett et al, 2009) and Hart (1995) attempts to exemplify this in his natural-resource-based view. More specifically, it is argued that resources are derived from both internal capacities (Penrose, 1959) and external opportunities and threats (Barney, 2001). Nonetheless, this is commonly overlooked, as demonstrated in the common misperception of pollution prevention and product stewardship as internal-external counterparts (e.g. Shi et al, 2012). In some consequence, Rashidirad et al (2015) claim that the need to distinguish between internal and external capabilities is lacking in resource-based theory literature. In particular, there appears a tendency to overlook the pertinence of externally focused capabilities, in some conflict to the exogenous nature of resources (Barney, 2001; Lockett et al, 2009). Adding strength to the pertinence of internal versus external categorization is the prominence of inbound and outbound activities in modern sustainable supply chain management. particularly with regards to supply chain flexibility (Malhorta & Mackelprang, 2012). Thus, further categorization of conceptual capabilities according to their internal or external focus also emerges with logic.

Again, this categorization was completed by the three researchers via extensive discussion. As well sub-categorizing the capabilities, their deeper analysis permitted further refinement and reduction. This resulted in conceptual definition of dynamic natural-resource-based view capabilities for each resource *(table 3.2; 3.3; 3.4; 3.5).* Whilst this is presented as a preliminary definition ahead of the empirical study, such tables add definition to the natural-resource-based view's four resources, incorporate the need for dynamic capabilities and refine over twenty years' worth of natural-resource-based view, sustainable supply chain management and innovation literature.

Notably, in order to prevent an inaccurate account of or discount of any conceptual capabilities, the inter-coder reliability results *(appendix 3)* were not discarded. Rather, as is commonly the case in abductive studies in which the researcher moves between varying strata to reach conclusions (Edwards et al, 2012), such results served as an additional point of reference where necessary in the empirical study.

Table 3.2 Conceptual definition of dynamic pollution prevention capabilities

Conceptual Pollution Prevention Capabilities		
	Internal	**External**
Sensing	➢ Environmental, operational and financial measures ➢ Continuous improvement & optimization of processes, machinery & technologies ➢ Cross-functional integration & learning towards environmental objectives ➢ Technological know-how	➢ Entrepreneurial foresight and insight of environmental issues ➢ Analysis of external environments, target markets and changing customer needs ➢ Identification of environmental opportunities from externalities
Seizing	➢ Interpretation of environmental issues as opportunities ➢ Capacity to implement & manage new environmental processes ➢ Environmental management systems ➢ Advanced prevention & safety measures ➢ Employee involvement, skills & expertise ➢ Entrepreneurial leadership ➢ Information and knowledge management	➢ Evidencing reputation of environmentally sound company
Transfor	➢ Organisational commitment to the environment ➢ Organisational capacity to create new environmental processes & technologies ➢ Creation of environmental policy & criteria ➢ Higher-order shared learning	➢ Political acumen surrounding environmental issues ➢ Concern for external environments & resources

Table 3.3 Conceptual definition of dynamic product stewardship capabilities

Conceptual Product Stewardship Capabilities		
	Internal	**External**
Sensing	➢ Employee awareness of environmental supply chain issues ➢ Lifecycle perspective & analysis of products & processes ➢ Incentive systems for environmental ideas	➢ Supply chain measurements & analysis ➢ Bringing together suppliers in the same industry to share problems & know-how ➢ Stakeholder integration to select new technologies & direct joint innovation ➢ Seeking the creation of sustainable products, processes & packaging ➢ Seeking out professional memberships
Seizing	➢ Corporate environmental responsibility assessments ➢ Employee training surrounding environmental behaviours ➢ Cross-functional integration ➢ Incentive systems for environmental behaviours ➢ Choice of suppliers by environmental criteria ➢ Management of uncertainty or change ➢ Top management support ➢ Risk taking	➢ Environmental, operational and financial supply chain measures ➢ Building relationships throughout the supply chain ➢ Cooperation with suppliers for environmental objectives & new, lower impact operations ➢ Assisting suppliers with environmental programmes ➢ Environmental audits for suppliers' internal management ➢ Capacity for resale, recycling or remanufacturing throughout supply chain ➢ Investment in cooperative resources and activities ➢ Eco-labelling
Transformin	➢ Creation of environmental supply chain policy ➢ Vertical integration ➢ Creation of recyclable or reusable products ➢ Cradle-to-cradle philosophy	➢ Entrepreneurship leadership in the supply chain ➢ Informing suppliers about the benefits of cleaner production & encouraging environmental action ➢ The construction of mutual goals throughout the supply chain ➢ Co-evolution with customers and suppliers

Table 3.4 Conceptual definition of dynamic clean technologies capabilities

Conceptual Clean Technologies Capabilities		
	Internal	**External**
Sensing	➢ Continuous assessment & improvement of environmental impact ➢ Resource impact assessment ➢ Environmental, financial and non-financial measures ➢ Green research and development ➢ Employee awareness of clean technologies	➢ Consumer & environmental consultation of new technologies & innovations ➢ Seeking the advanced reduction of energy & material consumption ➢ Supplier environmental impact audits
Seizing	➢ Organisational capacity to implement, manage & create clean technologies ➢ Technological & quality management system ➢ Environmental, & financial and measures ➢ Employee technological know-how & skills ➢ Investment in innovations of the future	➢ Supplier guidance surrounding clean technologies and positive impact operations ➢ Sharing & creating new technologies throughout the supply chain
Transforming	➢ Aptitude for disruptive change ➢ Strategic planning for the future ➢ A global, lifecycle perspective of operations ➢ Creating closed-loop systems ➢ Ecological leapfrogging ➢ Creating environmental & political regulations ➢ Eco-design	➢ Commercialization of clean technologies ➢ Political acumen surrounding clean technologies ➢ Knowledge transfer and capacity building throughout industry

Table 3.5 Conceptual definition of dynamic base of the pyramid capabilities

Conceptual Base of the Pyramid Capabilities		
	Internal	**External**
Sensing	➢ Integration of internal resources to direct R&D & identify new markets & technologies ➢ Employee awareness of social issues & social sustainability benefits	➢ Monitoring external environment to identify new markets & social issues ➢ Non-traditional collaboration & joint planning with stakeholders and externalities ➢ Customer consultation of social issues
Seizing	➢ Internal assessment & auditing of social practices & impact ➢ Fair trade certification & principles ➢ Supplier selection to meet social criteria ➢ Strategic market entry ➢ Capacity for new technologies and innovations ➢ Capacity for product & process customisation ➢ Entrepreneurial power of employees and individuals ➢ Translating innovations into business proposals	➢ Supplier assessment and auditing of social practices ➢ Supplier training & support of social practices ➢ Rewards and penalties for supplier social practice ➢ Third-party auditing ➢ Building loyal and committed relationships with externalities ➢ Use of social media to promote social practices and communicate with society ➢ Generating resources from donations, grants, volunteers or intellectual property
Transforming	➢ A global perspective of business & society ➢ Employee commitment & top management support for social improvement ➢ Access to information ➢ Vertical integration	➢ Promotion of social sustainability benefits ➢ Scaling and replication to create systematic social change ➢ Co-invention and spread of resources ➢ Awareness of regulatory framework in base of the pyramid markets ➢ Information transparency

3.3 Limitations

As discussed, this conceptual definition of dynamic natural-resource-based view capabilities serves only as a preliminary definition of capabilities to guide and support the empirical study. The extent to which relationships between capabilities can be fully understood or explained without empirical investigation is limited. The framework is further limited via the heavy reliance on assumed relationships between each resource and sustainable supply chain management and innovation, which lack empirical confirmation. It is for such reasons that empirical study of natural-resource-based view, sustainable supply chain management and innovation synergies, and thereafter empirical definition of dynamic natural-resource-based view capabilities is sought in this study. However, such empirical study is neither possible nor of value if the natural-resource-based view does not exist in industry, and as such exploration of the existence of pollution prevention, product stewardship, clean technologies and base of the pyramid is also called for.

4.0 Industry Review

As discussed, there is a distinct lack of empirical evidence of competitive resources literature contends that the natural-resource-based view does not exist in industry (Andersson & Bateman, 2000; Aragon-Correa & Sharma, 2003; Menguc & Ozanne, 2005; Hart & Dowell, 2011; Golicic & Smith, 2013). To some extent this can be attributed to the tacit nature of competitive resources (Lockett et al, 2009) which prevents their observation (Butler & Priem, 2001), particularly with regards to the positivistic dominance of resource-based theory. With support of a critical realist philosophical stance, this study seeks to explore this tacit existence, in turn empirically investigating links between the natural-resource-based view and sustainable supply chain management and innovation, and explicating and elucidating dynamic natural-resource-based view capabilities. Prior to such empirical investigation, the existence of the four natural-resource-based view resources in UK agri-food is assessed via a comprehensive industry review, as detailed throughout this chapter. Exploration of UK agri-food secondary data supports the existence and value of natural-resource-based view resources in industry, resolving the third research objective:

- Investigate the existence of the natural-resource-based view in UK agri-food.

Notably, whilst the purpose of the industry review was solely to resolve the above research objective, exploration of the natural-resource-based view in UK agri-food secondary data also revealed implications for sustainable supply chain management, innovation and specific organisational capabilities. Such implications add further strength to this study, and are also reported in this chapter.

4.1 The Natural-Resource-Based View in the UK Agri-Food Sector

Agri-food assumes a dominant position in the UK economy; valued at over £100bn and employing more than 10% of total UK workforce (DEFRA, 2014). Demand for sustainability throughout the sector is increasing (FHIS, 2013b; Mintel, 2013b), partly driven by a growing consumer interest in sustainable food (The Guardian, 2016), and increased media attention surrounding the negative impacts of food production, consumption and disposal (Gould, 2016). As well as responding to consumer demand, the appeal of sustainable food production for firms arises from associated benefits of cost-cutting, quality and efficiency which are

heavily promoted throughout the sector (e.g. DEFRA, 2015; 2016). From the government's perspective, advanced sustainability in agri-food practices is directly linked with the economic stability and development of the sector (Tassou et al, 2014; Environmental Sustainability KTN, 2015), and accordingly recent years have witnessed a vast array of sustainably driven legislation, policy and subsidies (Tassou et al, 2014; Harvey, 2016). Thus, overall sustainability emerges as a major opportunity in UK agri-food (Foresight, 2011; DEFRA; 2013; WRAP, 2015; McGill, 2016), suggesting that the promotion of competitive sustainable strategies such as the natural-resource-based view may be of great value.

Supporting this is clear similarities between the natural-resource-based view and its prioritisation of the natural environment as a competitive strategy (Hart, 1995) and discussions of the competitive value of sustainability in UK agri-food (e.g. Foresight, 2011; DEFRA, 2013; 2015; 2016). The natural-resource-based view attempts to address both ecological and social environments via its four resources, whilst the UK agri-food sector faces intense scrutiny surrounding its environmental (Foresight, 2011; Kniver, 2012; Jensen et al, 2013; Cuerva et al, 2014) and social impacts. Environmental scrutiny is a product of agri-food's dependence on natural-resources such as water, land and energy (Foresight, 2011; Kniver, 2012), whilst growing concerns surrounding the availability of food, poverty and malnutrition (Foresight, 2011; Tassou et al, 2014) invite social scrutiny. It is for such reasons that agri-food is presented as one of the most resource intensive sectors in need of enhanced sustainability (Cuerva et al, 2014), implying some significance to the application of natural-resource-based view resources.

Notably, Shi et al (2012) suggest that environmental and social sustainability pressures often encourage increased innovativeness, and in correspondence with this, agri-food is considered one of the most innovative manufacturing sectors in terms of sustainability (Cuerva et al, 2014). UK agri-food has invested heavily in sustainable innovations (Parliament UK, 2014; Department for Energy and Climate Change, 2016), and in particular has undertaken ground-breaking research in sustainable food chains (Parliament UK, 2014; Department for Energy and Climate Change, 2016). In fact, Tassou et al (2014) argue that UK agri-food is leading the way in sustainable innovations with potential to overcome issues of both environmental and social degradation, whilst the Department for Business and Innovation (2013) claim the sector is in the midst of a 'sustainability revolution'. Thus, the UK agri-food sector arguably possesses considerable expertise and knowledge of sustainable operations that

may be of great value to this study and the practical realisation the natural-resource-based view.

Thus, in demonstrating demand for and experience of sustainable operations in correspondence with the natural-resource-based view, the UK agri-food sector emerges as a relevant and worthy contextual setting for this study. This is discussed in greater detail in the following sections, which offer review of pollution prevention, product stewardship, clean technologies and base of the pyramid in UK agri-food. The coding framework below *(table 5.1)*, derived primarily from initial conceptualisation of each resource, was used as a guide to the collection, categorization and analysis of UK agri-food secondary data.

Table 4.1 Natural-resource-based view coding framework

Pollution Prevention
➢ The minimisation of waste & emissions via prevention rather than disposal ➢ Reduced emissions & capital expenditure = competitive cost cutting strategy ➢ Assumes an internal focus that over times shifts towards external
Product Stewardship
➢ Prioritisation of natural environment throughout entire lifecycle ➢ Creation of wholly sustainable products offers opportunities for differentiation ➢ Access to scarce resources via stakeholder integration ➢ Supply chain/ lifecycle focus
Clean Technologies
➢ Positive impact operations ➢ Technological innovations as alternatives to non-renewables ➢ Move away from traditional routines to re-create industry in a way which promotes sustainability with products, processes or services that create value or significantly reduce waste ➢ Energy technologies, transport technologies, water technologies and material technologies
Base of the Pyramid
➢ Alleviation of social ills on a global scale ➢ Stimulation of economic growth/ support of emerging markets at the base of the pyramid ➢ Access to scarce/ unsaturated markets = market growth ➢ Relationship with clean technologies and innovation

4.1.1 Pollution Prevention in UK Agri-Food

UK agri-food demonstrates obvious interests in prevention, both from a cost perspective (The Environment Agency, 2013; DEFRA, 2015) and from an environmental perspective (DEFRA, 2010; Foresight, 2011); the two of which appear indivisible (Vision 2020, 2013; WRAP, 2015; 2016). In fact, WRAP (2016) suggest that prevention has been a core focus in agri-food for over a decade and saves the sector millions of pounds each year. According to The Environmental Agency (2013) prevention reduces costs associated with operations, waste disposal and pollution clean-up, protects valuable materials and avoids fines and insurance premiums. Moreover, Vision 2020 (2013) argue that as well as cutting costs, preventing the

generation of waste is critical to ensuring sustainability and maximising value in the production of food. Thus, in line with Hart's (1995) conceptualisation of pollution prevention, prevention in UK agri-food is believed to provide companies with a demonstrable competitive advantage (The Environmental Agency, 2013). It is for such reasons that prevention is presented as the most effective means of managing waste and pollution in UK agri-food (WRAP, 2015), and presented a key competitive objective for the sector's continued development (Vision 2020, 2013).

With specific regard to preventing waste, an emphasis falls upon food waste (Visit Scotland, 2015; DEFRA, 2016; Gould, 2016), packaging waste (Vision 2020, 2013; DEFRA, 2015; WRAP, 2016) and process waste (Vision 2020, 2013). UK agri-food produces more than 15million tonnes of food waste every year (DEFRA., 2015) and WRAP (2016) believes that more than half of this is preventable. Calls for a national ban on food waste and increasing landfill taxes (Vision 2020, 2013) are intended to enforce the initial occurrence of food waste (Vision 2020, 2013), whilst initiatives such a Zero Waste support prevention focused strategies (Visit Scotland, 2014). UK agri-food also produces 3million tonnes of packaging waste each year (DEFRA, 2015), encouraging a growth in enhanced, recyclable or reusable packaging (Mintel, 2011; 2013a) which is again driven by the desire to avoid landfill (Vision 2020, 2013). With regards to process waste, the prevention of water waste assumes some dominance (DEFRA, 2010; 2012; The Environmental Agency, 2013) and accordingly the management of water and effluents is highly regulated (DEFRA, 2012a). Water management plans that prevent excess use of water and generation of effluents are heavily advocated and linked with efficiency and cost benefits for the firm (The Environmental Agency, 2013). Notably, whilst waste prevention undoubtedly assumes precedence over waste disposal (WRAP, 2015), disposal is still in some cases advocated (The Environmental Agency, 2013). That is, some forms of waste are unavoidable (Vision 2020, 2016) and their segregation, storage and collection for recycling or reuse is recommended. For example, the treatment and reuse of waste waters or farm sludge in internal operations is seen as an effective way to avoid unnecessary waste and create value (DEFRA, 2012a). This form of disposal assumes overall intentions of prevention and corresponds with the prioritisation of recyclability in Hart's (1995) pollution prevention.

A prevention approach is also advocated with regards to pollution (DEFRA, 2009; The Environmental Agency, 2013; The Carbon Trust, 2016), which often goes hand in hand with the prevention of waste. For example, the prevention of water waste is also seen as a way in

which to prevent polluted effluents from entering the natural water environment (DEFRA, 2012a), whilst the avoidance of landfills is linked with the prevention of carbon and greenhouse gas emissions (The Environmental Agency, 2013). Similarly, the use of fertilisers, pesticides and fossil fuels are not only presented as costly areas in which waste occurs, but are associated with harmful pollutants and consequently climate change (The Environmental Agency, 2013). As such, calls for crop and livestock management that reduces the need for farming aids (DEFRA, 2009), farming, manufacturing and land practices that prevent or capture run-offs (DEFRA, 2012a) and enhanced cleaning and maintenance to avoid spillages or error (DEFRA,2016) are common throughout UK agri-food. In addition, recent years have witnessed the emergence of technologies designed to identify problem areas before they develop (Hirsch, 2016; McGill, 2016) and to manage the application of farming or manufacturing aids only where necessary (DEFRA, 2010).

Thus, the UK agri-food sector demonstrates a clear shift from disposal to prevention and stresses associated opportunities for competitiveness and cost-cutting consistent with Hart's (1995) pollution prevention. In spite of its assumed tacit existence, the term 'pollution prevention' features explicitly in secondary data (e.g. DEFRA, 2009; 2010; 2016; The Environmental Agency, 2013), and pertinently is presented as a best practice internal approach for sustainability (The Environmental Agency, 2013; Vision 2020, 2013). Moreover, UK agri-food's declining levels of waste to landfill, reduced use of water and fossil fuels, declining in CO2 emissions and increasing recycling levels (DEFRA, 2014) imply that prevention is successfully being realised throughout the sector. Therefore, secondary data supports the existence, applicability and value of pollution prevention in industry.

4.1.2 Product Stewardship in UK Agri-Food

As with pollution prevention, product stewardship is easily identifiable in UK agri-food, in that a stewardship approach is linked with the creation of sustainable products and manufacturing processes throughout the sector (DEFRA, 2009; Vision 2020, 2013; WRAP, 2016). More specifically, DEFRA (2009) argues that stewardship offers an effective way to incorporate environmental principles into agri-food production, which in turn welcomes both environmental and competitive benefits. In addition, both Vision 2020 (2013) and the Carbon Trust (2016) directly link stewardship in food chains with conservation and accessibility to scare resources, whilst economic and efficiency benefits are heavily promoted (Vision, 2020, 2013; WRAP, 2016). Opportunities for differentiation can also be recognised via the argument that stewardship appeals to the growing number of consumers who believe the food chain

should not impact negatively on the environment (The Guardian, 2016). Supporting the move towards a stewardship approach are government funded initiatives such as Environmental Stewardship land management scheme, Entry Level Stewardship scheme and High level stewardship scheme which are solely aimed at encouraging sustainability in agriculture (Natural England, 2012).

In correspondence with Hart's (1995) conceptualisation of the natural-resource-based view, there exist similarities between prevention and stewardship in UK agri-food, with the latter appearing as an advancement of the former. More specifically, a focus remains on waste (Vision 2020, 2013) and pollution (Kniver, 2012) and the protection of natural resources (DEFRA, 2009), but from an external, supply chain perspective (The Carbon Trust, 2016) rather than an internal perspective. A 'farm-to-fork' philosophy is heavily promoted (The Department for Business and Innovation, 2012) in order to create an inclusive supply chain approach to sustainability. At the supplier or grower end this manifests in accreditations and audits that support sustainable behaviours (McGill, 2016). At the consumer end considerable efforts are made to encourage responsible consumption and disposal behaviours (Mintel, 2011; Gould, 2016) via packaging designed to maximise portion control, freshness and recyclability (Mintel, 2013a) and technologies that match consumers with unwanted food to local bodies or charities (Gould, 2016). A circular economy approach is also advocated in attempt to encourage the reuse of valuable supply chain waste and by-products in a way which maximises efficiency, financial returns and environmentalism throughout the food chain (Vision 2020, 2013). Accordingly WRAP (2015) suggests that around 2million tonnes of food waste or animal product is redistributed and reused within the food chain as animal feed each year, preventing waste and creating value (FHIS, 2013a).

Whilst the term 'product stewardship' does not feature explicitly, secondary data still supports the existence, applicability and value of product stewardship in UK agri-food. That is, discussions of stewardship as a means by which to create wholly sustainable agri-food products and processes (e.g. DEFRA, 2009; Vision 2020, 2013; WRAP, 2016) and realise competitive rewards (e.g. Vison 2020, 2013; The Guardian, 2016) are consistent with Hart's (1995) product stewardship.

4.1.3 Clean Technologies in UK Agri-Food

Agricultural demand is expected to increase around 140% over the next 20 years (Visser, 2014), and in recognition of the environmental impact of this, there is increasing call for *'innovative solutions for the future'* (Foresight, 2011, p5). In particular, increasing calls for agricultural production to be managed in a way which contributes to the mitigation of climate change and supports global ecosystems and biodiversity are notable (Foresight, 2011; Visser, 2014). Parliament UK (2014) state that '*UK agriculture must embrace new technologies* [....] *meeting criteria of both economic and environmental sustainability if it is to meet the challenges of the future'.* Accordingly, technological innovations are increasingly being used as alternatives to non-renewables (The Department for Energy and Climate Change, 2016) and a process focus that considers the whole food chain is employed (Tassou et al, 2014). Within this parallels with clean technologies are easily identifiable. More specifically the need to move away from traditional routines and to promote advanced sustainability with products, processes or services (e.g. Department for Business and Innovation, 2013; Department for Energy and Climate Change, 2016) and seek positive environmental impacts (e.g. Foresight, 2011; Tassou et al, 2014; Visser, 2014) is clearly evidenced. Alongside environmental benefits, competitive benefits such as reduced costs (The Carbon Trust, 2016; The Department for Energy and Climate Change, 2016), enhanced efficiency and quality (Tassou et al, 2014) and sector-wide improvements surrounding resilience and productivity (Department for Business and Innovation, 2013) are heavily promoted.

Reinforcing the existence of clean technologies in UK agri-food, is the sectors representation of all four of Pernick & Wilder's (2007) clean technologies categories: energy technologies, transport technologies, water technologies and material technologies. With regards to energy technologies, The Department for Energy and Climate Change (2016) state that low carbon energy and renewable energy is at an all-time high, making specific reference to bioenergy, onshore and offshore wind power, solar power, hydro power and shoreline wave or tidal power. Similarly, Tassou et al (2014) discuss the use of decentralised or high efficiency boilers, building insulation, heat pumps, intelligent temperature and humidity controls, natural ventilation, combined heat and power systems, efficient lighting and higher efficiency motors and stress environmental and cost benefits. Moving on to transport technologies, the focus falls upon fuel efficiency, electric or low carbon vehicles and refrigeration technologies used in distribution (Tassou et al, 2014). Electric vehicles emerge with particular significance, presented as means by which to dramatically reduce CO2 and harmful pollutants associated with both logistical and refrigeration emissions and reduce fuel costs (Prynn, 2016). With

regards to water technologies, references are made to technologies that recirculate, purify and treat water (DEFRA, 2009; Visser, 2014), whilst enhanced irrigation technologies and rainwater harvesting (Parliament UK, 2014) are heavily promoted. Of some notability is the recent emergence vertical farming (BBSRC , 2016a), in which crops are grown in a tower of trays to allow water to be sprayed on the top and collected at the bottom after having filtered through each level, collecting valuable nutrients on the way to support its reuse. Finally, material technologies are represented by advances in biological, chemical and environmental sciences aimed at agriculture (Department for Business and Innovation, 2013). In particular, green buildings and facilities have benefitted from considerable technological advancements such as enhanced refrigeration, LED lighting and anaerobic digestion (Tassou et al, 2014). Agricultural robotics are also increasingly common (Department for Business and Innovation, 2013; Parliament UK, 2014) and are expected to play a major role in the 'farm of the future' with specific regards to precision farming, satellite driven tractors, drones used in spraying and planting, and the measurement and monitoring of crops from handheld devices and apps (BBSRC , 2016a). DNA technologies in crops (Parliament UK, 2014), informatics (Department for Business and Innovation, 2013), biotechnologies (Visser, 2014), nanotechnologies, genetic modification and animal cloning (Foresight, 2011) also feature in discussions of material technologies. Thus, UK agri-food appears to possess considerable experience in clean technologies, and according to The Department for Business and Innovation (2013), is leading the way in agricultural science, research and technology. Supporting this is the recent increase in government initiatives and legislation (Department for Business and Innovation, 2013; Tassou et al, 2014) intended to drive the creation and adoption of clean agri-food technologies.

As with product stewardship, the term 'clean technologies' is not explicitly used in UK agri-food secondary data, but there again appears support for the existence, applicability and value of clean technologies in industry. This is demonstrated via both parallels with Hart's (1997) conceptualisation of clean technologies and Pernick & Wilder's (2007) categorisation of clean technologies. Notably, the strong presence of clean technologies in UK agri-food is somewhat conflictive of its negligence in literature (e.g. Menguc & Ozanne, 2005; Shi et al, 2012; Matapolous et al, 2014; Miemczyk et al, 2016), implying that empirical investigation of the resource may be of great benefit to academia.

4.1.4 Base of the Pyramid in UK Agri-Food

The UK agri-food sector does to some extent assume a global perspective of social sustainability (e.g. Vision 2020, 2013) and demonstrates some consideration of its role in emerging markets (GFS, 2010; 2012). Issues such as growing global populations, world hunger, health and malnutrition are discussed throughout the sector (GFS, 2010; Vision 2020, 2013). In addition, given that 3 out of 4 people in emerging markets rely on agriculture for an income (GFS, 2010), agricultural inefficiencies are also linked with economic decline, poverty, unemployment and political uprisings (GFS, 2012). Thus, the need for enhanced social sustainability (Foresight, 2011) to overcome issues of volatility, resource scarcity and affordability that impact heavily on '*the world's poorest'* (Foresight, 2011, p5) is clearly pronounced. In line with Prahalad & Hart's (2002) base of the pyramid, the UK agri-food sector's attention to emerging markets does feature competitive merits and links with innovation. For example, UK Trade and Investment (2016) suggest that innovative agri-food products and technologies aimed at the development of emerging economies render economic benefits for the sector as a whole by increasing export opportunities. Similarly, entry into emerging markets is seen as a way to escape the volatility and competitiveness of the domestic market (NFU, 2014), whilst DEFRA (2012b) suggest that agri-food companies who enter such markets benefit from increased levels of growth, productivity, profitability and innovativeness.

It is perhaps for such reasons that there exists growing pressure on UK agri-food companies to enter emerging markets (UK Trade and Investment, 2016). A particular emphasis falls upon SMEs and their potential to both assist emerging markets and benefit from emerging markets that are believed to be in possession of considerable growth potential (DEFRA, 2012b), such as Africa and China (NFU, 2014). In support of this, there exists a £70m government fund offering specialised training and guidance in agri-food in emerging markets (UK Trade & Investment, 2016) and SMEs are heavily encouraged to exhibit products and test markets at international trade events and showcases (DEFRA, 2012b). A further £1.5bn of government funding has been allocated to research aimed at alleviating agricultural issues in emerging markets (BBSRC, 2016b) in response to the need for improved, innovative agricultural practices and technologies in such markets (Foresight, 2011; Department for Business and Innovation, 2013). More specifically, such research focuses on improved crop varieties that combat disease and support resilience, veterinary medicines and advancement in pest control tailored to support specific emerging markets (Wheeler, 2015). In addition, technologies that support the sustainable use of land, water and energy are presented as a means by which to alleviate social ills in areas of the world which suffer from extreme resource scarcity (UK

Trade and Investment, 2016) and assist economic development in emerging markets (The Carbon Trust, 2016). A dependency is therefore placed on clean technologies, corresponding with the hierarchal nature of the natural-resource-based view (Hart & Dowell, 2011) and the interconnectedness of clean technologies and base of the pyramid (Hart, 1997).

However, in spite of such promotion and support, DEFRA (2012b) suggest that the vast majority of UK agri-food SMEs are disinterested in emerging markets and remain focused on the dominant European export markets that benefit from close geographical and cultural proximity. It is also notable that the presence of base of the pyramid in secondary data is considerably less than that of the other three resources, somewhat mirroring its inattention in literature (Hart & Dowell, 2011). This raises some concern as to the extent to which base of the pyramid is realised in UK agri-food, making it difficult to confirm its existence in industry. This said, discussions of the need to enter emerging markets to maximise social sustainability (e.g. GFS, 2010; Foresight, 2011; GFS 2012) and links with competitive benefits (e.g. DEFRA, 2012b; NFU, 2014; UK Trade and Investment, 2016) do imply considerable demand for and stress the value of base of the pyramid.

4.2 Implications for Sustainable Supply Chain Management & Innovation

As well as demonstrating the existence, applicability and value of the natural-resource-based view resources, albeit to varying extents, UK agri-food secondary data also reveals implications for sustainable supply chain management and innovation. Whilst this was not the purpose of the industry review, it offers some support for links between the natural-resource-based view and sustainable supply chain management and innovation, and as such warrants discussion.

Clear implications for sustainable supply chain management in pollution prevention UK agri-food secondary data are identifiable in references to the need for a collaborative and lean supply chain approach that prevents the generation of waste (Vision 2020, 2013; Gould, 2016; WRAP, 2016). More specifically, it is argued that firms should assume a ‘whole-chain resource efficiency’ approach (WRAP, 2016, p4) in which access to supplier and customer information supports forecasting to prevent the generation of waste. Reinforcing this, Visit Scotland (2015) suggest that working closely with suppliers can help to reduce or promote reuse of packaging and therefore prevent packaging waste (Visit Scotland, 2015). Links

between pollution prevention and innovation are also notable, with WRAP (2016) stressing that medium term innovations are crucial in food waste prevention, placing an emphasis on food processing technologies to improve yields and reduce waste. DEFRA (2010) also discuss the need for innovation in the prevention of pollution, stressing the value of technologies that manage the application of fertiliser, water or pesticides and the enhanced design of sites to prevent or capture run-offs. More recently, Hirsch (2016) explores the potential of emergent data technologies in identifying issues with soil and water quality and climatic changes in order to prevent the development of internal problem areas, and accordingly prevent waste and pollution.

Corresponding with literature, discussions of product stewardship in UK agri-food are somewhat inseparable from supply chain management. Broadly speaking this is demonstrated via stewardship assumptions that sustainability is the responsibility of the supply chain as a whole rather than a firm in isolation (DEFRA, 2009). From this perspective supply chains seen as *'multipliers of energy cost and carbon risk, as well as commodity and resource risks'* (The Carbon Trust, 2016). In addition, discussions of supply chain audits and measurements (McGill, 2016), the promotion of a circular supply chain approach (Vision 2020, 2013) and growing attention on suppliers and distributors (DEFRA, 2009; Vision 2020, 2013) place clear dependencies on supply chain management and strategies. Implications for innovation feature to a lesser extent but are nonetheless identifiable in discussions of packaging enhancements (Mintel, 2013a), lifecycle technologies (Gould, 2016) and the reuse of waste in the supply chain as stockfeed or landspread (Gould, 2016), which in itself is presented as a best practice environmental innovation (DEFRA, 2016; WRAP, 2016).

Implications for sustainable supply chain management in clean technologies are evidenced in the UK agri-food sector's promotion of a '*farm to fork through agri-food supply chain'* approach (Department for Business and Innovation, 2013, p10) that requires a collaborative supply chain in support of the development of technologies (Tassou et al, 2014). The Carbon Trust (2016) reinforce this, suggesting that mitigating environmental impacts is dependent on resource efficiency in the supply chain. Implications for innovation in clean technologies feature prominently, with Foresight (2011) claiming that environmental solutions and new technologies for future food is wholly dependent on innovation. Similarly, Visser (2014) suggests that energy technologies are big opportunities for innovation, whilst Tassou et al (2014) call for enhanced innovativeness surrounding energy and renewables in food production. In addition, the Department for Business and Innovation (2013) suggest that the

UK agri-food sector is undergoing a technological revolution via innovations surrounding genetics, informatics, satellite imaging, remote sensing, precision farming and low impact farming.

Despite its indeterminate existence, implications for both sustainable supply chain management and innovation in base of the pyramid UK agri-food secondary data can be identified. With regards to sustainable supply chain management, the provision of food in emerging markets is considered a supply chain issue (GFS, 2012), whilst NFU (2014) argue that social degradation in emerging markets is often the result of supply chain inefficiencies surrounding waste and ineffective distribution. Implications for innovation in base of the pyramid UK agri-food secondary data manifest in discussions of the need for and application of new systems, processes and technologies. For example, UK Trade and Investment (2016) suggest that it is UK agri-food's expertise in such systems, process and technology innovations that will assist with the sector's growing presence in emerging markets. Moreover, DEFRA (2012b) suggest that the action of entering a new, especially emerging, market itself is presented as both an innovative activity and a way to stimulate greater innovativeness.

4.3 Emergent Capabilities

Along with implications for sustainable supply chain management and innovation, the industry review also revealed implications for specific capabilities in relation to each resource. In the most part, such implications are somewhat vague but demonstrate correspondence with capabilities identified in the literature review. For example, references to lean in pollution prevention (WRAP, 2016) or supply chain audits and measurement in product stewardship (The Carbon Trust, 2016). However, of greater interest are implications for capabilities that up to this point had not been linked with natural-resource-based view resources. These emergent capabilities are discussed here, and in line with the abductive nature of this study, are further investigated in the empirical study.

Two new pollution prevention capabilities emerge from UK agri-food secondary data: internal waste segregation and demand forecasting. Vision 2020 (2013) suggest internal waste segregation supports advanced recyclability, avoids landfills and prevents pollution, whilst WRAP (2016) present demand forecasting as a means by which to prevent the occurrence of waste. Carbon measurement emerges as a new product stewardship capability, presented as a means by which to facilitate a stewardship approach to the protection of natural resources

throughout the supply chain (DEFRA, 2013; The Carbon Trust, 2016). With regards to clean technologies, external partnerships emerge as a new capability. That is, collaboration with external companies is believed to support the identification and creation of new clean technologies (Visser, 2014). No emergent capabilities were uncovered in relation to base of the pyramid.

4.4 Summary of Findings

The industry review evidences the existence, applicability and value of pollution prevention, product stewardship and clean technologies in UK agri-food, thus contesting claims of a theory-practice gap (Hart & Dowell, 2011). Whilst the existence of base of the pyramid cannot be confirmed, demand for and the value of the resource is demonstrated, warranting its further investigation. In addition to this, the industry review also supports the links between the natural-resource-based view, sustainable supply chain management and innovation and identifies emergent capabilities for pollution prevention, product stewardship and clean technologies. Thus, in its completion the industry review reinforces the value of this study and serves as a supportive base for empirical investigation of the natural-resource-based view and its capabilities.

Table 4.2 Industry Review Findings

Industry Review Findings	
Pollution Prevention	➢ Existence industry confirmed ➢ Competitive value reinforced ➢ Relationship with sustainable supply chain management & innovation reinforced ➢ Internal waste segregation and demand forecasting identified as new capabilities
Product Stewardship	➢ Existence industry confirmed ➢ Competitive value reinforced ➢ Relationship with sustainable supply chain management & innovation reinforced ➢ Carbon measurement and management emerge as new capability
Clean Technologies	➢ Existence industry confirmed ➢ Competitive value reinforced ➢ Relationship with sustainable supply chain management & innovation reinforced ➢ External partnerships emerge as new capability
Base of the Pyramid	➢ Unconfirmed presence in industry ➢ Demand for resource and associations with competitiveness demonstrated ➢ Relationship with sustainable supply chain management & innovation

5.0 Research Philosophy

Before empirical investigation of the natural-resource-based view and its capabilities could be undertaken, the research philosophy underpinning this study must be defined and its influences explained. According to Saunders et al (2012, p127), a research philosophy is concerned with the '*development of knowledge and the nature of that knowledge'* and as such plays a critical role in research. More specifically, the way in which a researcher views, handles and creates knowledge contributes to the object of study, the collection and analysis of data and the interpretation of results (Johnston, 2014). Research philosophy consists of three components: ontology which is our philosophical assumptions about reality; epistemology which is our assumptions about the best ways to inquire the nature of the world; and methodology which is the combination of techniques used to enquire a situation (Easterby-Smith et al, 2008). Or to put it more simply, Fleetwood (2005, p197) states *'the way we think the world is (ontology) influences: what we think can be known about it (epistemology)* [and] *how we think it can be investigated (methodology and research techniques)'*. This chapter discusses the critical realist philosophy guiding this study, detailing ontological, epistemological and methodological influences.

5.1 Critical Realism

Whilst this study assumes a critical realist stance, there exist a vast array of research philosophies; the most common in business research including positivism, interpretivism, realism, objectivism and constructionism (Bryman & Bell, 2011) *(table 6.1)*. Notably, it is positivism and interpretivism that are considered the dominant research paradigms (Zikmund et al, 2010) and believed to exist in opposition of one another (Johnson & Duberly, 2000). That is, positivists are typically associated with quantitative, statistical analysis of tangible or measurable realities, whilst interpretivists are associated with qualitative or discursive analysis of what they believe to be the 'real world' (Edwards et al, 2014). The former is praised for its robust and hard science but criticised for its 'closed' approach which can be difficult to relate to real life, whilst the latter is often presented as real-life applicable science but criticised for its soft, unreliable or immeasurable approach (Edwards et al, 2014). Critical realism is often presented as a 'middle-of-the-road' approach between the extremes of positivism and interpretivism (Mingers, 2006) in that it appreciates both the positivistic view that the world

can be measured, and the interpretivist view that the word exists outside of our measurements (Edwards et al, 2014).

Table 5.1 Philosophy Definitions

Philosophy	Definition
Positivism	Advocates the application of the methods of the natural sciences to the study of social reality. Only phenomena confirmed by senses can be warranted by knowledge and the purpose of theory is to generate hypothesis to allow explanation of laws by the gathering of facts.
Interpretivism	A contrasting orthodoxy to positivism based on the view that a strategy is required that respects the differences between people and the objects of the natural sciences and therefore requires the social scientist to grasp the subjective meaning of social action.
Realism	Believes that the natural and the social sciences should apply the same approaches to data collection and explanation, and a view that there is an external reality to which scientists direct their attention.
Objectivism	Asserts that social phenomena and their meanings have an existence that is independent of social actors, implying that social phenomena and the categories we use in everyday life have an existence that is independent or separate from actors.
Constructionism	Asserts that social phenomena and their meanings are continually being accomplished by their social actors, implying that social phenomena and their categories are not only produced through social interaction but are in a constant state of revision.
Critical realism	Recognises the reality of the natural order and the events and discourses of the social world. These structures are not spontaneously apparent in the observable pattern of events, but identified through the practical and theoretical work of the social sciences.

Adapted from Bryman & Bell (2011)

However, critical realism is not an amalgamation of positivism and interpretivism, but rather is a robust philosophy in its own right that has confidently challenged existing understandings of research and knowledge (Bhaskar & Lawson, 1998). Conceived of by Roy Bhaskar some thirty years ago, it is in fact a sub-type of realism (Fleetwood, 2005), with an appreciation for constructionism (Archer et al, 1998; Easton, 2010). Ackroyd (2004) suggests that it is such influences along with an awareness of existing philosophical limitations which gives critical realism one of its greatest strengths: escaping the extremes of methodological imperialism to encourage the construction of research designs based solely on the nature of phenomena under study (Sayer, 2004).

Although it has been suggested that critical realism remains in developmental stages (Easton, 2010; Edwards et al, 2014), the philosophy is of growing importance in the study of business (Fleetwood, 2004; Ryan et al, 2012). In particular, Easton et al (2010) suggest that critical realism supports direct study of the organisational processes, structures and behaviours which exist at the core of business research. Moreover, Ryan et al (2012) argue that the

philosophy is particularly useful in marketing research, and pertinently, in the explanation of business structures, mechanisms and capabilities. As discussed, research surrounding resource-based theories, including the natural-resource-based view (Acedo et al, 2006), is dominated by positivism which struggles to explore the complex, tacit nature of resources (Butler & Priem, 2001; Lockett et al, 2009) and the implicit, inherent nature of capabilities (Newbert, 2007; Lockett et al, 2009). As such, critical realism perhaps offers an alternative perspective with which to study the natural-resource-based view, with potential to resolve existing research gaps, particularly those surrounding capabilities. This is demonstrated with strength throughout discussion of the ontological, epistemological and methodological assumptions made in this study.

5.2 Ontological Assumptions

As discussed, ontological assumptions deal with the researcher's perceptions of reality (Easterby-Smith et al, 2008) and play a fundamental role in the creation and direction of a research project (Fleetwood, 2005; Edwards et al, 2014). Our perceptions of reality may be derived from personal preferences, past experiences and expectations (Johnston, 2014), and accordingly differ from person to person. As such, the researcher's ontology is not purposefully selected and cannot be separated from the research project (Johnston, 2014). According to Ryan et al (2012), the critical realist's ontology, in comparison to that of the founding philosophies, is difficult to apply on account of its obscure nature and stratified perception of reality. However, such complexities are unavoidable given the unconscious nature of research ontology, and moreover, formed assumptions surrounding the existence of the natural-resource-based view and the feasibility of observing and empirically explicating its capabilities upon which this study is reliant.

5.2.1 A Critical Realist Reality

The critical realist believes the world exists as its own entity, acting independently outside of our awareness or influence (Fleetwood, 2004; Edwards et al, 2014). From this perspective, reality is a social construct (Archer et al, 1998; Easton, 2010) and consequently cannot be predicted or generalised (Sayer, 2004). This said, to the critical realist, reality is not entirely socially constructed, but also made up of physical elements (Bhaskar & Lawson, 1998; Easton, 2010). Thus, the critical realist adopts a stratified ontology (Sayer, 2004), accepting that both physical and social units constitute reality, and it is through the deep exploration of both that reality can be explained (Edwards et al, 2014).

Within the context of this study, this ontology manifests in the assumption that the natural-resource-based view can and does exist in industry, albeit outside of our awareness. It exists as a social construct in that it is dependent on human activity and knowledge, but it also possesses physical elements such as technologies and tools and the materialisation of ecological and competitive gains. This was demonstrated in the earlier industry review, in which the tacit existence of the natural-resource-based view was demonstrated via explication of social constructs and physical elements surrounding each resource in UK agri-food. This critical realist view of reality as entities is a fundamental part of critical realism, setting the philosophy apart from alternatives (Fleetwood, 2005). To offer some contrast, the inability to physically observe, quantify or generalise natural-resource-based view resources in UK agri-food would render them non-existent from a positivistic ontology. It is perhaps for such reasons that existing studies suggest the natural-resource-based view suffers from a theory-practice gap (Hart & Dowell, 2011), whilst this study argues that the theory does exist in industry as its own entity, or more specifically, a socially real entity.

5.2.2 Socially Real Entities

It is the natural-resource-based view's existence as a socially real entity that permits its conceptualization and discussion (Fleetwood, 2005). There are two fundamental components of socially real entities that must be understood: the socially real aspect and causal efficacy. The socially real aspect, as mentioned, is derived from the belief that entities are socially constructed (Sayer, 1992) and consequently dependent upon some form of human interaction (Fleetwood, 2004); in this case, capabilities possessed and deployed by managers and employees. Causal efficacy is a fundamental component of critical realism (Archer et al, 1998; Easton, 2010) and refers to the belief that something is real if it has an effect or makes a difference (Sayer, 2004); in this case the natural-resource-based view's materialisation in ecological and competitive improvements. Causality often exists at the very root of critical realist research in that the research is often concerned with explicating 'causes' (Ryan et al, 2012).

Consequently, socially real entities are rarely the object of study, but rather provide *'the basic theoretical building blocks'* (Easton, 2010, p120) that influence our explanation of reality and from with which we derive research topics. The critical realist researcher is more concerned in 'events' within entities (Easton, 2010), which also exist out-with our knowledge (Fleetwood, 2005), requiring explication by the researcher. It is arguably the critical realists stratified ontology that forces the researcher to go beyond the definition of reality to instead

focus on phenomena at work across various levels of that reality (Sayer, 2004). Giving nod to the significance of 'socially real' and causal efficacy, this commonly involves the conceptualization of processes, structures, behaviours and activities that have an effect (Easton, 2010).

Accordingly, this study is not concerned with the proof or falsification of the natural-resource-based view for its existence as an entity is already implicit and serves as the 'theoretical building block' within which this study is conducted, corresponding with the argument that theory is heavily embedded in ontology (Edwards et al, 2012; Johnstone, 2014). Rather, it is the explication of capabilities that support that reality which this study is interested in, as detailed in the research question guiding this study: *what are the organisational capabilities that support the four natural-resource-based view resources in practice?*

5.3 Epistemological Assumptions

Epistemological assumptions direct the means by which to assess the world (Easterby-Smith et al, 2008) and are directly influenced by ontological assumptions (Edwards et al, 2014). Epistemological assumptions are the '*pre-understandings which influence how we make things intelligible*' (Johnson & Duberly, 2000, p1), or rather, the way in which knowledge or data is interpreted. As with ontology, epistemology differs from person to person (Johnston, 2014), and accordingly what is accepted as knowledge by one person may be rejected by another (Johnson & Duberly, 2000; Johnston, 2014). This said, critical realists adopt a non-contradictory synthesis (Sayer, 2004) which accepts all knowledge as fallible (Jepsen, 2005; Mingers, 2006). They believe that the creation of knowledge itself is a social process that is dependent on human interpretations of concepts, theories and data (Sayer, 1992; Johnson & Duberly, 2000; Ryan et al, 2012), and consequently falsification is implausible (Sayer, 1994; 2004; Easton, 2010). Thus, ontological assumptions surrounding the existence of the natural-resource-based view directs the nature by which definition and explanation of capabilities is undertaken and manifests in the adoption of an abductive approach to data collection.

5.3.1 An Abductive Approach

There are two dominant approaches to the creation of knowledge: the deductive approach in which theory is tested via observation and the inductive approach in which theory is created via observation (Johnston, 2014). In recent years, the lines between these two approaches have become blurred, stimulating increased application of the abductive approach in which the

researcher moves back and forth between theory and observation (Saunders et al, 2012). An abductive approach is typical of critical realist research (Ryan et al, 2012), stimulated by the belief that that theory and data should exist as a point of reference for one another and a need for dynamism between the two (Edwards et al, 2014). From this perspective, the value of theory is maximised via the belief that it offers a basis for empirical investigation (Ackroyd, 2004; Johnston, 2014), but this should not be at the expense of restricting data or overpowering real-life phenomena (Edwards et al, 2014). This approach is neither theory-testing nor theory-building (Edwards et al, 2014), but rather is employed where existing theory is to be explained (Saunders et al, 2012) and is effective in the explication of routine or tacit knowledge (Easton, 2010).

With regards to this study, the pertinent role of theory is demonstrated in the review and linking of natural-resource-based view, sustainable supply chain management and innovation literature in chapter 2, the application of dynamic capabilities in chapter 3 and the construction of the conceptual frameworks in chapter 4. The industry review in chapter 5 and the empirical studies discussed later in chapters 8 and 9 maximise the value of real-life phenomena via exploration of the natural-resource-based view in UK agri-food and the identification of new avenues of interest and emergent capabilities and findings. The researcher moves between both domains, using theory to re-describe reality and reality to re-describe theory. The overall results are therefore dependent upon both interpretations derived from extant research and interpretations derived from real-life phenomena and the ways in which the two interrelate.

5.4 Research Methodology

Both ontological and epistemological assumptions influence the methodological approach of a given study, which in turn influences the methods employed to answer the research question (Edwards et al, 2014). There are two fundamental decisions to be made with regards to methodology: quantitative or qualitative data; and cross-sectional or longitudinal timeframes (Saunders et al, 2012). In this study the ontological significance of social realness and causal efficacy and the epistemological significance of descriptive, explanatory data have encouraged the employment of a qualitative multi-method cross-sectional study, as is discussed below.

5.4.1 A Qualitative Multi-Method Approach

There are two dominant forms of data collection: quantitative data collection and qualitative data collection. The two were traditionally believed to be in opposition of one another

(Fleetwood & Ackroyd, 2004); the former associated with positivism and the latter with interpretivism. However, quantitative and qualitative approaches are now often considered mutually supportive of one another in that their conjoint applications add robustness to research results (Bryman & Bell, 2011). Critical realism recognises the value of both quantitative and qualitative approaches and supports their application either in isolation or conjunction to suit the specifics of a given study (Ackroyd, 2004). This said, Ryan et al (2012) suggest that critical realism, with its rejection of the positivistic need for statistical justification and measurable regularities, is better suited to qualitative data.

This is true of this study, in which the ontological pertinence of socially real entities and the epistemological belief that the creation of knowledge is a social process encourages collection of only qualitative data, in some contrast to existing efforts at studying resource-based capabilities (Newbert, 2007; Lockett et al, 2009). Qualitative data's facilitation of descriptive and detailed discussions corresponds with the critical realists' dependency on discourse and causal language to explicate tacit knowledge and explain phenomena (Eason, 2010). This said, given the critical realist's stratified ontology and abductive epistemology, discourse alone is rarely enough. Rather the desire to explore phenomena at various levels and from various perspectives calls for more than one approach (Bhaskar & Lawson, 1998; Easton, 2010). With specific regards to this study, secondary data is collected from the literature and industry reviews, qualitative discursive data is collected from interviews and qualitative observational data is collected from observations, as is discussed in detail later in this thesis. Pertinently, the employment of a multi-method approach (Saunders et al, 2012) promotes robustness and reliability of the results (Bryman & Bell, 2011).

5.4.2 Cross-Sectional Research

There are also two time scales in which research can be conducted: cross-sectional in which data is taken from a particular moment in time; and longitudinal in which data is collected over a long period of time (Saunders et al, 2012). Longitudinal research is often applied where research is particularly interested in developments or progression, whilst cross-sectional research offers a 'snap-shot' of phenomena (Saunders et al, 2012). In line with the critical realist stance that *'events take place at the domain of the actual'* (Ryan et al, 2012, 306) cross sectional research seems appropriate for this study. This study was set a three-year time frame, from October 2013 to October 2016. The collection of empirical data was undertaken between October 2014 and June 2016.

5.5 Influences of Critical Realism in Existing Literature

One of the strengths of this study is the analysis of the natural-resource-based view from a critical realist perspective, as opposed to the dominant positivistic approach that renders the theory non-existent in a practical sense. However, as mentioned, critical realism is of growing importance in the study of business (Fleetwood, 2004), particularly in the study of business processes, structures and activities (Ryan et al, 2014). In some consequence, the philosophy is beginning to establish a presence in resource-based theory literature (Acedo et al, 2006). In fact, Acedo et al (2006) argue that whilst literature surrounding resource-based theories remains dominantly positivistic, as the theory evolves it is growing more inclusive of alternative philosophical and methodological stances. This is perhaps in response to calls for greater understanding of how resources can be obtained and managed and causality within resource-based theories, which in turn is inspiring the collection of qualitative, descriptive data (Priem & Butler, 2001). Moreover, Adamides et al (2011) note the growing application of a critical realist perspective in the study of supply chains, stressing the value of critical realism in understanding the way in which modern supply chains operate. Reinforcing this is Ashby et al (2012), who via systematic review of supply chain sustainability literature evidence a deference away from positivistic, deductive studies and a dominance of qualitative studies that allow the supply chain to be observed and described.

Notably, whilst there are no explicit references to critical realism in the studies reviewed earlier, ontological, epistemological and methodological implications demonstrate some correspondence with assumptions made in this study. For example, Jensen et al's (2013) study presents a closed-loop food chain as its own entity that is explored within its real-life context and conceptualised using descriptive data. Miemczyk et al (2016) employ the natural-resource-based view as a theoretical lens and use dynamic capabilities to conceptualize the management of closed-loop supply chain via an abductive, qualitative empirical study. Goffin et al (2006) criticise the value of statistical analysis in understanding complex supply chain relationships, and instead use in-depth, exploratory interviews to gather descriptive, discursive data. Ageron et al (2013) examine innovative supply chain practices from a qualitative perspective that prioritises discursive analysis and causal relationships, whilst Klassen & Vereeke's (2012) study of social issues in the supply chain is also dependent on the analysis of rich, qualitative data. Similarly, using resource-based theory, Gold et al (2010) base their empirical study of inter-organisational resources in sustainable supply chain management on the interpretation of causal language, whilst Galeazzo et al (2013) adopt a qualitative, abductive approach to

examine pollution prevention strategies. Such studies demonstrate the suitability and strengths of the ontological, epistemological and methodological approaches undertaken in this study.

6.0 Research Methods

As mentioned, research philosophy directly influences the research methods employed in a given study (Johnston, 2014). According to Edwards et al (2014), research methods are, for the critical realist, tools by which the real world can be connected with the theoretical world. Critical realism appreciates the value of a wide-range of research methods (Fleetwood & Ackroyd, 2004; Edwards et al, 2014) and tends to incorporate more than one form of data and to adapt methods throughout the course of research (Ryan et al, 2012). Not only is this complementary of an abductive approach, but it maximises the potential to address research objectives and welcomes new avenues of interest (Bryman & Bell, 2011). As discussed throughout this chapter, the research methods employed in this study are purposefully selected to resolve the following research objectives:

- Identify natural-resource-based view capabilities from a review of seminal studies and exploration of sustainable supply chain management and innovation synergies;
- Categorize and refine capabilities into a dynamic capability framework;
- Investigate the existence of the natural-resource-based view in UK agri-food;
- Empirically investigate links between the natural-resource-based view, sustainable supply chain management and innovation;
- Empirically define dynamic natural-resource-based view capabilities

6.1 Literature Review

A literature review is a common starting point for critical realist researchers (Edwards et al, 2014), and is in the most part used to define the object of study (Barratt et al, 2011) and generate a research question (Saunders et al, 2012). This normally involves exploration of the history of a topic, the identification of a research gap and the generation of ideas as to the way in which such a gap may be addressed and the value of doing so (Edwards et al, 2012). As depicted in chapter 2, this was the case in this study, in that review of resource-based theory and natural-resource-based view literature highlighted the modern-day resonance of the theory and the need for enhanced practical applicability via definition of dynamic capabilities. This form of literature review is described as a standard literature review (Edwards et al, 2012) and often serves as preliminary research (Zikmund et al, 2010; Saunders et al, 2012). From this perspective, the literature review is considered a ‘scholarly contribution’ (Seuring & Gold,

2012, p544) in that it permits the refinement, mapping and development of theory surrounding a given research topic (Tranfield et al, 2003). However, this study's ontological, epistemological and methodological prioritisation of theory calls for a more in-depth review of literature, otherwise known as a critical literature review.

6.1.1 A Critical Literature Review

According to Seuring & Gold (2012), the expansive scope and conflictive nature of modern literature has driven the need for critical literature reviews, which allow the researcher to go beyond a general synthesis of existing knowledge. By probing deeper into existing literature, the researcher develops a greater understanding of the research topic than is possible with a standard literature review (Bryman & Bell, 2011). In doing so the researcher can analyse relationships between existing theories and concepts (Saunders et al, 2012) which can then be conceptualised into a theoretical framework (Seuring & Gold, 2012). Whilst this often serves as one of the first stages of a research project (Saunders et al, 2012), it may be revisited throughout the research process (Tranfield et al, 2003). More specifically, the researcher may return to the literature to seek further explanation or reinforcement of empirical findings (Seuring & Gold, 2012), corresponding with an abductive approach.

In this case, a critical literature review was employed to explore synergies between each natural-resource-based view resource and sustainable supply chain management and innovation, and in turn identify implications for capabilities. As depicted in figure 6.1 below, this began with a review of natural-resource-based view literature, and as such literature searches for the natural-resource-based view, pollution prevention, product stewardship, clean technologies and base of the pyramid. Within this, papers that featured sustainable supply chain management or innovation were prioritised. Having identified links between a resource and a given sustainable supply chain management strategy or innovation sub-type, such strategies and sub-types were then searched out-with a natural-resource-based view context. This deep exploration of literature and identification of synergistic relationships, which pertinently is reminiscent of the critical realist's stratified ontology and causal efficacy (Sayer, 1992), addressed the first research objective:

- Identify natural-resource-based view capabilities from a review of seminal studies and exploration of sustainable supply chain management and innovation synergies.

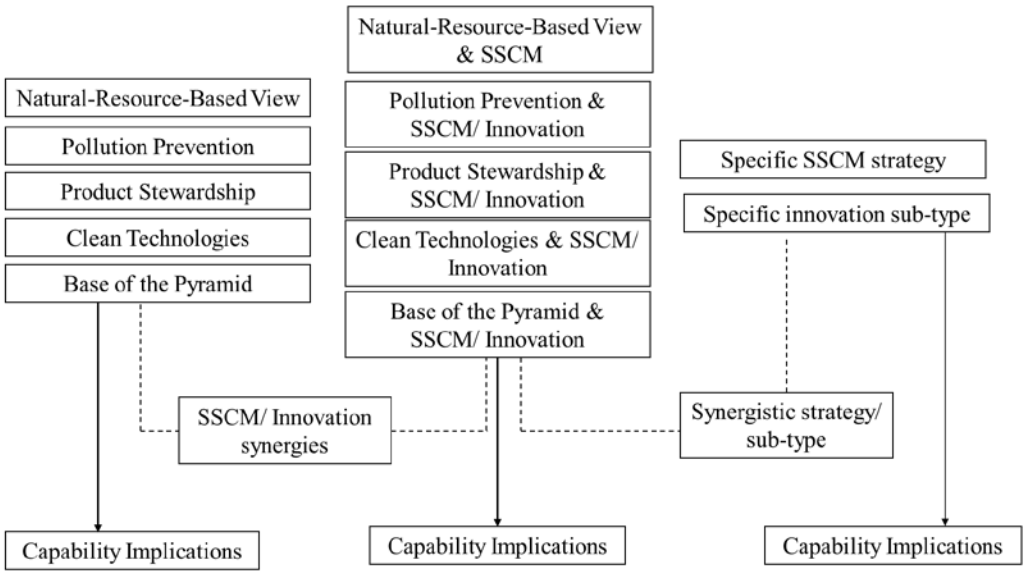

Figure 6.1 Literature search process

Notably, in line with the abductive nature of this study, the review of literature was an on-going process throughout the course of study. As well as referring back to literature, emergent findings in the industry review or empirical study occasionally encouraged the collection and review of additional literature. In addition, in reference to the standard literature review, literature searchers of resource-based theory, competitive resources, capabilities and dynamic capabilities preceded the comprehensive literature review, allowing the researcher to identify a research gap and develop an understanding of the research topic.

6.1.2 Qualitative Directed Content Analysis

Whilst conducting a critical literature review is a relatively straight forward process, the researcher's interpretation and analysis of data gathered from such a review is more complex (Saunders et al, 2012). Content analysis, which has long been used as a method for analysing data and deriving meaning from text (Burla et al, 2008; Elo et al, 2014), is presented as an effective tool in the analysis of critical literature reviews (Tranfield et al, 2003; Seuring & Gold, 2012). Employed in both qualitative and quantitative studies, content analysis permits the systematic interpretation and description of data (Burla et al, 2008) and is perhaps most commonly used to statistically reinforce data (Hseih & Shannon, 2005). However, the critical realist underpinnings of this study do not call for statistics or quantification of theory, but as is commonly the case in critical realism (Ryan et al, 2012), is more concerned with the identification of patterns are regularities. As such, *qualitative directed content analysis* was employed throughout the critical literature review.

Qualitative directed content analysis is used to analyse secondary data, permitting the researcher to *'extend conceptually a theoretical framework of theory* [....] *to provide predictions about the variables of interest or about the relationships among variables, helping to determine the initial coding scheme'* (Hsieh & Shannon, 2005, p1281). In this case the natural-resource-based view is the theory being conceptually extended, and the directed content analysis of natural-resource-based view, sustainable supply chain management and innovation literature provides predictions about the capabilities required to support the natural-resource-based view. As detailed in chapter 3, following categorization of data according to each natural-resource-based view resource, capabilities were then coded and categorized according to Teece's (2007) dynamic capabilities activities of sensing, seizing and transforming, before being further categorized according to an internal or external focus. Whilst this is often seen as a deductive form of content analysis (Elo et al, 2014), directed content analysis permits the researcher to revisit and revise codes to adapt to newly identified themes (Hsieh & Shannon, 2005), supporting the abductive nature of this study.

6.1.3 Intercoder Reliability Assessments

Notably, content analysis of any sort can be a long and complex process, involving several stages of preparation, organisation and reporting (Elo et al, 2014). Qualitative content analysis in particular is questioned for its validity and rigour, despite benefitting from some reinforcement from its theoretical underpinnings (Elo et al, 2014). In response to this, intercoder reliability, which involves analysis by more than one researcher, is often employed to prevent bias in the coding of data (Burla et al, 2008). More specifically, intercoder reliability measures *'the extent to which independent coders evaluate a characteristic of a message or artefact and reach the same conclusion'* (Lombard et al, 2002, p589).

Given the extensive scope of data involved in the extraction of natural-resource-based view capabilities from literature, initial identification of capabilities for each resource was undertaken by the primary researcher. In line with Elo et al's (2014) recommendations, this was then carefully followed up on by two additional researchers, allowing for the discussion and resolution of any disagreements. The three researchers then independently assigned capabilities derived directly from literature to dynamic capabilities activities of sensing, seizing and transforming *(appendix 2),* and seeking percentage agreement of 75% which is commonly considered reliable in exploratory research (Lombard et al, 2002), were categorized into conceptual frameworks *(appendix 3).* Significant levels of repetition and synonymous terminologies made this a laborious process, requiring categorization according to internally

or externally focused capabilities and further reduction and refinement, resulting in a final dynamic frameworks of natural-resource-based view capabilities *(tables 3.2; 3.2; 3.4; 3.5).* Given the argument that '*without adequate conceptualization it is impossible to make observations*' (Ackroyd, 2004, p143), this process was unavoidable and of fundamental importance. Moreover, it resolved the second research objective:

- Categorize and refine these capabilities into a dynamic framework.

6.2 Industry Review

The exploration of theory in industry is a common pursuit of business research (Bryman & Bell, 2011), and is often undertaken via collection and review of secondary data (Zikmund et al, 2010). Review of secondary data provides a deep understanding of phenomena within a contextual setting, and offers high accessibility whilst avoiding the obtrusiveness and costs of primary data (Saunders et al, 2012). As such, Cowton (1998) stresses that secondary data offers a rich data source that should not be overlooked. In particular, Cowton suggests that governments and regulatory bodies offer important, often statistical or census data, private companies offer descriptions of operations, business insight and financial data, and the media offers timely and pertinent discussions of current issues; all of which could not plausibly be gathered by the researcher alone. Moreover, such an exploration of phenomena from a variety of sources can be considered supportive of the critical realist's stratified ontology, which encourages the collection of data from multiple sources (Ryan et al, 2012).

As detailed in chapter 4, this study undertook industry review of the natural-resource-based view in UK agri-food. This involved the collection and analysis of secondary data in order to explore each natural-resource-based view resource in UK agri-food. In particular, data from governmental sources and regulatory bodies surrounding food and sustainability, such as The Department for Environment, Food & Rural Affairs (DEFRA), The Waste & Resources Action Plan (WRAP) and The Department for Business & Innovation and was prioritised. Relevant media sources, including UK newspapers such as The Telegraph and The Guardian and broadcaster's websites such as the BBC offered further sources of secondary data, whilst marketing data was gathered from sources such as Mintel. In its completion, this resolved the third research objective:

- Investigate the existence of the natural-resource-based view in UK agri-food.

6.2.1 UK Agri-Food as a Contextual Setting

Selecting a contextual setting is of great importance (Bryman & Bell, 2011), and in this case the UK agri-food sector was selected for both theoretical and practical reasons. Theoretically speaking, there exist correspondences between Hart's conceptualisation of the natural-resource-based view and agri-food's dependency on natural resources and prioritisation of sustainability as a competitive advantage. Moreover, agri-food features in several prominent papers included in the critical literature review (e.g. Jensen et al, 2013; Cuerva et al, 2014; Matapolous et al, 2014), where pertinently it is argued that the resources, tools and methods required for sustainable agri-food chains remain understudied and ill-defined (Matapolous et al, 2014). Practically speaking, UK agri-food food assumes considerable expertise in innovative sustainable operations (Jensen et al, 2013; Cuerva et al, 2014; Tassou et al, 2014; Parliament UK, 2014; Department for Energy and Climate Change, 2016), and as such agri-food companies may possess tacit knowledge relevant to this study. In addition, the natural-resource-based view arguably offers a means by which to address demand for enhanced competitiveness and sustainability throughout UK agri-food (DEFRA, 2014; Environmental Sustainability KTN, 2015).

6.2.2 Qualitative Content Analysis

Pertinently, one of the fundamental concerns of secondary data is its reliability (Saunders et al, 2012), and as such only trusted secondary sources were included in the industry review. However, Cowton (1998) suggests that reliability can be further advanced via qualitative content analysis, and as such this was again employed in the industry review. The approach used was relatively similar to the directed content analysis used throughout the literature review, but it was publicly available data being coded rather than academic literature. A coding framework of natural-resource-based view resources *(table 4.1)* was employed to categorize industry review data according to each resource, focusing on common themes and regularities. The results were continuously compared to that of the literature review, encouraging the researcher to move back and forth between theory and practice as is often the case in critical realist, abductive studies (Ackroyd, 2004; Saunders et al, 2012). As Burla et al (2008) discuss, the purpose of this is to assess meanings and relationships between various texts in order to reach conclusions, in this case, surrounding the existence, value and applicability of each natural-resource-based view resource. Given the vast amount of data involved in this process, coding was again undertaken by the primary researcher and then carefully reviewed by two independent researchers, in line with Elo et al's (2014) recommendations.

Notably, whilst the purpose of the industry review remained focused on exploring the existence of the natural-resource-based view, analysis of secondary data also revealed implications for sustainable supply chain management, innovation and specific capabilities. In line with the abductive nature of this study, these were also reported in chapter 4 and where appropriate, taken into consideration throughout the empirical study.

6.3 Empirical Study – *Phase 1*

It is commonly the case in business research that secondary data serves as a compliment to primary data (Zikmund et al, 2010; Bryman & Bell, 2011). More specifically, primary data is often sought to seek clarification of ideas generated from review of secondary data (Saunders et al, 2012). In this case, primary data is gathered from seven in-depth telephone interviews with purposefully selected UK agri-food experts to investigate ideas generated in the literature review and reinforced in the industry review surrounding links between the natural-resource-based view, sustainable supply chain management and innovation. This exploratory analysis (Saunders et al, 2012) is considered phase 1 of the empirical study, and as detailed in the chapter 7, resolves the fourth research objective:

- Explore links between each resource and sustainable supply chain management and innovation in UK agri-food.

6.3.1 In-depth Interviews

In-depth interviews are considered particularly useful in the investigation of general topics of interest (Saunders et al, 2012), and as such their application in in exploratory analysis has become commonplace (Goffin et al, 2006). Such interviews provide an informal form of interaction with relevant parties, avoiding direct questioning in to ensure data maximises the interviewee's perspective (Srivastava & Thomson, 2009). Therefore, in-depth interviews often result in detailed descriptions of phenomena (Saunders et al, 2012) which corresponds with the critical realist's prioritisation of discursive data (Edwards et al, 2012).

In-depth interviews begin with a holistic question (Srivastava & Thomson, 2009), and in this case respondents were asked to describe their experiences, knowledge and opinions of sustainable operations in UK agri-food. Whilst open-ended questions were used to further probe avenues of particular interest, interviewees were at no point questioned directly about the natural-resource-based view, sustainable supply chain management or innovation and all

related terminology was avoided. This relaxed approach encouraged the interviewee to lead the interview, so that any discussions of natural-resource-based view resources and associations with sustainable supply chain management or innovation can be considered free from bias or leading.

6.3.2 Non-Probability Critical Case Sampling & Recruitment

With regards to the selection of interviewees, non-probability sampling was used to identify suitable industry experts for interview. Non -probability sampling allows the researcher to exercise judgement (Saunders et al, 2012), using theoretical parameters to select the most relevant organisations (Dul & Hak, 2008). In this case, the four resources of the natural-resource-based view served as theoretical parameters to identify organisations that possessed tacit knowledge or experience of the natural-resource-based view. For example, specific aspects signified potential experience of a given resource: advanced interests in waste and pollution or environmental accreditations for pollution prevention; discussions of sustainable or organic food chains, provenance or a lifecycle, circular approach for product stewardship; patented technologies or systems or innovation awards within a sustainability context for clean technologies; and concern for social issues, presence in emerging markets or interests in fair trade for base of the pyramid. Moreover, in line with the resource-based roots of the natural-resource-based view the competitiveness of such sustainability merits were sought, and Barney's (2001) discussions of value, rarity, inimitability and non-substitutability were also taken into consideration. The identification of suitable interviewees was supported to some extent by the earlier industry review in which prominent organisations were revealed, whilst online searches identified additional organisations of relevance. Those selected, which can be thought of as 'critical cases' (Saunders et al, 2012), included 36 privately owned companies, regulatory bodies, government bodies and research bodies. Where possible, individuals within these organisations were targeted on account of their knowledge of or proximity to natural-resource-based view resources. Such individuals varied in their professional position, however Edwards et al (2014) suggest critical realists tend to view all practitioners as experts as a result of their first-hand experience of phenomena.

Selected organisations or individuals were contacted via email and asked for interview. In order to overcome time and location restraints whilst maintaining conversational dialogues (Saunders et al, 2012), telephone interviews were requested. Of the 36 organisations or individuals contacted, seven agreed to participate, the details of which are depicted in table 6.2 below. Pertinently, the informal nature of exploratory and qualitative analysis does not

stipulate required sample sizes (Zikmund et al, 2010), instead advocating the continued collection of data until a point of saturation is reached (Saunders et al, 2012). In this case, the seven in-depth interviews, which typically lasted around an hour each, provided sufficient evidence and descriptions of the natural-resource-based view's relationship with sustainable supply chain management and innovation, and in doing so, empirically supported their synergies.

Table 6.1 Phase 1 Interview Participants

Participant	Organisation Type	Organisation Description	Interviewee	Geographical presence
1	Privately owned company	Food Production (fruit & vegetables)	Environment & Energy Efficiency Officer	International
2	Privately owned company	Food Production (dairy)	Head of Corporate Communications	International
3	Public Body	Levy Board (meat)	Development Manager	England & Wales
4	Cooperative	Farming (all)	Manager	Scotland
5	Privately owned company	Food Production (fruit & vegetables)	Head of Agronomy	UK wide
6	Privately owned company	Food Production (meat)	Sustainability Director	UK wide
7	Privately owned company	Food Production (baked goods)	Corporate Responsibility Director	UK wide

6.3.3 Qualitative Content Analysis

Again, qualitative content analysis similar to that used in the critical literature review and industry review was undertaken to analyse phase 1 results. This began with the categorisation of interview data, which was recorded and transcribed, according to each natural-resource-based view resource. These categories were then further analysed using a coding framework of sustainable supply chain management and innovation synergies *(table 7.1.)*. This focused on detailed descriptions of each resource and within that causal language implicating sustainable supply chain management and innovation. The critical realist's causal efficacy (Sayer, 1992) is pertinent here, in that it stimulates the assumption that sustainable supply chain management and innovation serve as contributory causes in the practical realisation of the natural-resource-based view. The critical realist abductive nature of this study is also of significance, encouraging phase 1 results to be continuously compared to secondary data from the literature review and industry review, thus empirically reinforcing theoretical synergies (Ackroyd, 2004) and theoretically reinforcing 'observed realities' (Saunders et al, 2012). In addition, to maximise validity and rigour, intercoder reliability was again undertaken in which coding was undertaken by the primary researcher and then carefully reviewed by two independent researchers.

Notably, whilst the purpose of phase 1 was to empirically explore links between the natural-resource-based view, sustainable supply chain management and innovation, analysis of phase 1 results also revealed implications for organisational capabilities. In line with the abductive nature of this study, such capabilities were reported as emergent capabilities in chapter 7, and incorporated in to the empirical study for further investigation. In support of this is the suggestion that exploratory interviews often serve as an effective means with which to refine research topics (Zikmund et al, 2010; Saunders et al, 2012).

6.4 Empirical Study – *Phase 2*

Phase 2 of the empirical study returns attention back to the research question guiding this study: *what are the organisational capabilities that support the four natural-resource-based view resources in practice?* Using the conceptual frameworks defined in chapter 3 as a guide *(tables 3.1; 3.2; 3.3; 3.4),* semi-structured interviews and participant observation was undertaken to explicate the capabilities in support of pollution prevention, product stewardship, clean technologies and base of the pyramid. This was considered phase 2 of the empirical study, and as detailed in chapter 9, resolved the fifth and final research objective:

- Empirically define dynamic natural-resource-based view capabilities.

6.4.1. Semi-Structured Interviews

As detailed in discussion of phase 1's in-depth interviews, interviews lend themselves well in critical realist qualitative research, providing the descriptive data which the critical realist prioritises (Edwards et al, 2012). It is often through interviews that theory and real-life interact and serve as points of reference for one another (Ackroyd, 2004; Edwards et al, 2012). Both the researcher and the interviewees play fundamental roles: the researcher considered an expert on account of their knowledge of existing theory and the interviewee an expert on account of their first-hand experience of phenomena (Edwards et al, 2012). It is engagement between the two 'experts' in which final conclusions can be drawn and ideas conceptualized (Ackroyd, 2004; Edwards et al, 2012). However, whilst this was achieved via in-depth interviews in phase 1, semi-structured interviews were used in phase 2.

Semi-structured interviews strike a balance between in-depth and structured interviews (Srivastava & Thomson, 2009) in that they still facilitate detailed, descriptive data (Saunders et al, 2012) but do so in way which ensures key themes can be covered (Bryman & Bell, 2011).

Whilst there are some key questions which remain the same, interviews are still conversational and can be adapted throughout the course of data collection to suit new themes or topics (Saunders et al, 2012), supporting an abductive approach. Consequently, data collected varies from interview to interview and is dependent on the nature of the interviewee and the context under study (Srivastava & Thomson, 2009). Key questions and prompts to guide the researcher throughout the interview are derived from ideas generated in the literature review (Zikmund et al, 2010; Saunders et al, 2012), thus maximising the value of theory. However, the conversational nature of semi-structured interviews allows interviewees to stray from key questions and themes, permitting the emergence of new topics of interest (Bryman & Bell, 2011), and maximising the value of real-life data. This approach corresponds with the critical realist's prioritisation of causal language and discourse (Easton, 2010) and ensures that data collected portrays the research topic from the perspective of the interviewee (King, 1992).

Key questions in this study were intended to facilitate discussion of the operationalisation of each natural-resource-based view resource, from with which to explicate capabilities, without using natural-resource-based view terminology. The avoidance of such terminology was necessary in order to prevent researcher bias, which presents a considerable issue in qualitative interviews (Saunders et al, 2012). The four key questions were derived primarily from a summary of the resources taken from literature, as demonstrated in table 6.2 below.

Table 6.2 Derivation of key questions

Objective	Literature Summary	Question
Encourage discussion of pollution prevention operationalisation	Preventing the initial occurrence of waste and emissions throughout operations (Hart, 1995; Russo & Fouts, 1997; Aragon-Correa & Sharma, 2003)	Can you tell me about the company's approach to waste management?
Encourage discussion of product stewardship operationalisation	Prioritisation of the natural-environment throughout each stage of the life-cycle (Hart, 1995; Hart & Dowell, 2011)	How do you manage sustainability throughout the food chain?
Encourage discussion of clean technologies operationalisation	Investing in the technologies of the future in pursuit of environmentally sustainable operations (Hart, 1997; Pernick & Wilder, 2007)	How does technology play a role in sustainability in the company?
Encourage discussion of base of the pyramid operationalisation	The alleviation of social ills via simulation of development at the base of the economic pyramid (Hart & Christensen, 2002)	Can you tell me about the company's approach to social sustainability?

However, in consideration of contextualities and to maximise interviewer-interviewee dialogue, aspects of the industry review and phase 1 of the empirical study also influenced the key questions. For example, whilst literature discusses both waste and emissions in pollution prevention, both the industry review and phase 1 suggest that the food sector considers

emissions to be waste, and accordingly only the term ‘waste’ was used. Discussions of specific wastes and pollutions, which did feature prominently in phase 2 interviews, were therefore implicated by the interviewee alone. Similarly, to mirror food industry terminology the term ‘food chain’ was used in place of lifecycle in product stewardship, and accordingly any discussions of lifecycle management or analysis was not influenced by the researcher.

Of particular notability is the construction of the base of the pyramid question, which asks about social sustainability generally rather than including specifics surrounding emerging markets. This was in response to the absence of base of the pyramid in either the industry review or phase 1 of the empirical study, the decision not to falsify the resource and the emerging theme of social sustainability out-with a base of the pyramid context. Thus, the question was intended to facilitate a broader discussion of social sustainability, in which base of the pyramid was not excluded. Supporting this were further questions and prompts derived from Hart & Christensen’s (2002) initial conceptualisation of base of the pyramid, surrounding emerging markets, global sustainability initiatives and market entry *(appendix 4).*

Prompts for all resources were primarily derived from the conceptual frameworks of capabilities to guide the researcher to probe any implications of capabilities in discussion of each resource *(Appendix 4).* Again this involved open ended questions that avoided direct reference to or questioning of specific capabilities to prevent researcher bias. The purpose of this was to explicate and thus empirically validate specific capabilities from interviewee’s tacit knowledge.

6.4.2 Non-Probability Theoretical Sampling and Recruitment

As with phase 1 interviews, non-purposive sampling was employed to select companies for interview. The success of the in-depth interviews in phase 1 meant that the sampling frame remained the same; UK agri-food companies that demonstrated some, albeit tacit, experience of the natural-resource-based view resources. Again, this involved looking for things like advanced interests in waste and pollution, accreditations, a circular food chain approach, patented technologies, sustainable innovation awards, fair trade or a presence in emerging markets with a competitive context. Given the lack of references to company specifics in natural-resource-based view or corresponding sustainable supply chain management and innovation literature, sub-sector, company size, location or operational function did not feature in selection criteria. However, in order to explicate capabilities, phase 2 interviews required a more directed approach than the critical case sampling used in phase 1, and as such theoretical

sampling was employed. Whilst both begin with a theoretically influenced idea of the required sample, theoretical sampling allows the researcher to be more specific and to modify the sampling frame to suit emergent themes (Saunders et al, 2012). For example, family run businesses were prioritised for interview after family business principles emerged as recurring theme, whilst repeated references to genetically modified crops encouraged a breeding company with expertise of genetic modification to be sought for interview. Such an approach works well with the abductive nature of this study, in that whilst theory and existing knowledge offered a starting point, unexpected avenues of interest were welcomed and explored. Specifically, selection began with identification of companies with high sustainability expertise, which was narrowed down according to correspondence with the natural-resource-based view, and then if required, further narrowed down to specific themes. In the most part, suitable companies were generated from online searches, but the preceding exploratory analysis and attendance at agri-food and sustainability conferences also led to the identification of suitable companies and recruitment of interviewees.

As with phase 1 interviewees, interviewees themselves were targeted on account of their proximity to the natural-resource-based view resources and included managers, CEOs, agronomists, environmental officers and commercial directors, each of which the critical realist considers an expert on account of their first-hand experience (Edwards et al, 2012). This said, although it was preferable, interviewees did not need to possess experience of all four natural-resource-based view resources and accordingly some can be considered experts in pollution prevention whilst other experts in clean technologies. To maximise responses and value, interviews where possible involved more than one interviewee.

Saunders et al (2012) recommend that the location of interviews should be decided upon the convenience of the respondent, and accordingly respondents were offered the choice of face-to-face interviews on company premises, telephone interviews or Skype interviews. To minimise interviewee bias, the amount of information about the study made available to interviewees was restricted, and as such respondents were told the interview explored different approaches to sustainability in the UK agri-food sector only. In an attempt to encourage a high response rate, interviewees were offered anonymity and access to the anonymised results upon completion of the study. The final data set included 20 UK agri-food companies, the details of which are depicted in table 6.3 below.

Table 6.3 Phase 2 Interview Participants

FC*	Sub-sector(s)	Stage(s) in food chain	Size**	Geographical Presence	Interviewee(s)
1	Fruit & Vegetables	Grower; Processor; Packer	Large	International	Environment & Energy Efficiency Officer
2	Fruit & Vegetables	Grower; Packer	Large	UK	Head of Agronomy
3	Fruit & Vegetables	Breeder	Small	International	Chief Executive
4	Dairy	Grower; Processor; Packer	Small	UK	Marketing Director; Finance Director
5	Seafood	Grower; Processor; Packer	Micro	UK	CEO; Marketing Executive; Collaborator
6	Fruit & Vegetables	Grower; Packer; Retailer	Small	UK	CEO; Health, Safety & Environmental Officer
7	Dairy	Wholesaler	Micro	UK	Director
8	Cereal	Processor; Packer; Retailer	Medium	International	CEO
9	Fruit & Vegetables	Breeder	Large	International	Executive Director
10	Baked Goods	Grower; Processor; Packer	Large	International	Agricultural & Sustainability Manager
11	Dairy; Fruit & Vegetables	Grower	Micro	UK	Farm Director
12	Baked Goods	Processor; Packer	Large	UK	Corporate Responsibility Director
13	Fruit & Vegetables	Grower; Packer	Medium	UK	Commercial Director
14	Fruit & Vegetables	Grower; Packer	Medium	UK	Commercial Manager
15	Animal Feeds	Wholesaler	Micro	UK	CEO
16	Meat	Processor; Packer	Large	UK	Environmental & Sustainability Manager
17	Seafood	Wholesaler; Retailer	Micro	UK	Co-founder
18	Fruit & Vegetables; Seafood	Grower; Wholesaler; Retailer	Micro	UK	Co-founder
19	Fruit & Vegetables	Grower	Large	UK	Farm Assurance Manager
20	Seafood; Meat; Fruit & Vegetables	Services	Large	International	Operations Manager

**FC = Food Company*
***Micro = maximum 10 employees & £2m turnover; Small = maximum 50 employees & £6.5m turnover; Medium = maximum 250 employees & £13m turnover; Large = 250+ employees & £13m+ turnover.*

6.4.3 Response Rate

In spite of efforts made, this study suffered from a relatively low response rate, in that of the 107 companies asked for interview between June 2015 and June 2016, only the 20 companies detailed above chose to participate, totalling to a response rate of 18.6%. There were several prominent reasons for this. First, many agri-food companies, particularly in the earlier stages

of the food chain, did not have publicly available contact details and thus were difficult to recruit and tended to avoid speaking with unknown externals. Second, the word 'sustainability' appeared to deter companies, with interviewee 3 from Phase 1 stating:

> *'I think it's the word sustainability that farmers tend to avoid or ignore, it is not a word they like, not because they aren't sustainable but because it is management speak and they don't have the time to sit at their computers and look into sustainability'.*

Such was the detrimental impact of the word 'sustainability' in recruitment that it was later replaced with 'competitively rewarding sustainability' which proved more successful. Thirdly, a number of companies agreed to participate but could not commit time for interview and therefore cancelled; something which Zikmund et al (2010) suggests is a common issue in business research. Finally, taking into consideration resource-based theory's founding argument that resources should be scarce and not readily available (Wernerfeldt, 1984), finding companies with experience of natural-resource-based view resources was difficult to begin with, thus limiting scope.

Notably, whilst sample size is of fundamental importance (King, 1994) with regards to reliability (Saunders et al, 2015), the critical realist is perhaps afforded some flexibility. That is, the critical realist does not seek generalised rules about the world (Sayer, 2004) and such the need for statistically relevant samples is diminished (Ryan et al, 2012). Rather, the critical realist is interested in the contingent and situational factors that may evidence phenomena (Ryan et al, 2012). Accordingly, this study is not about quantifying natural-resource-based view capabilities, but explicating them and elucidating their role in supporting their corresponding resource in UK agri-food. This diverges from the quantifiable justifications that have dominated existing studies of capabilities in resource-based theory (Newbert et al, 2007; Lockett et al, 2009), to maximise discourse and contextualities. Reinforcing this is Rashidirad et al (2015) who stress the need for the investigation of the complex relationship between resources and capabilities and consideration of contextual variance in resource-based theory research.

Pertinently whilst this thesis refers to '20 interviews' it is notable that such interviews often involved more than one interviewee, and were lengthy and deep discussions. In some cases, such interviews also incorporated secondary data, via demonstration and discussion of reports, sustainability policy, training materials and certifications and were complimented by 6

participant observations. This was intended to ensure that such interviews were not based upon the isolated opinions of 20 individuals. Moreover, as discussed below, the interviewed companies commonly operated in more than one agri-food sub-sector and at one stage in the food chain, maximising the representivity of each of these sub-sectors and stages. In total, the 20 interviews undertaken in this study produced around 40 hours or 190 pages of rich data. From this is was possible to derive detailed descriptions of natural-resource-based view resources in UK agri-food and explicate their dynamic capabilities.

6.4.4 Representivity

As demonstrated in table 6.3 above, the final sample included micro, small, medium and large enterprises, each of which operates in one or more UK agri-food sub sector and at one or more stages in the food chain. This is due to the sampling frame's focus on natural-resource-based view resources as opposed to company specifics, and maximises representivity of the UK agri-food sector. That is it is commonly the case that UK agri-food companies operate in more than one sub-sector and at more the one stage of the food chain. For example, Food Company 18 began as a seafood wholesaler, before expanding into retail and growing their own fruit and vegetables to sell alongside their seafood. Thus, a study investigating the natural-resource-based view in a specific sub-sector or food chain stage would be of limited value. Moreover, the prominence of the supply chain in this study, and the lifecycle in the natural-resource-based view for that matter, calls for the investigation of the food chain as a whole. Adding further reinforcement is the lack of company specifics such as size in natural-resource-based view or corresponding sustainable supply chain management and innovation literature. As such, as depicted in figures 6.2 and 6.3 below, the sample represents all 7 subsectors and all 8 stages of the food chain as taken from DEFRA's (2013) definition of UK agri-food.

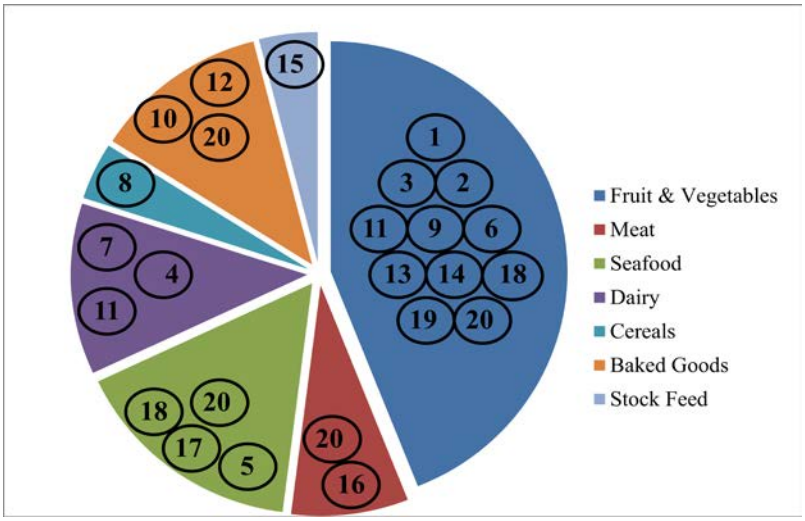

Figure 6.2 Sample Saturation of UK Agri-Food Sector

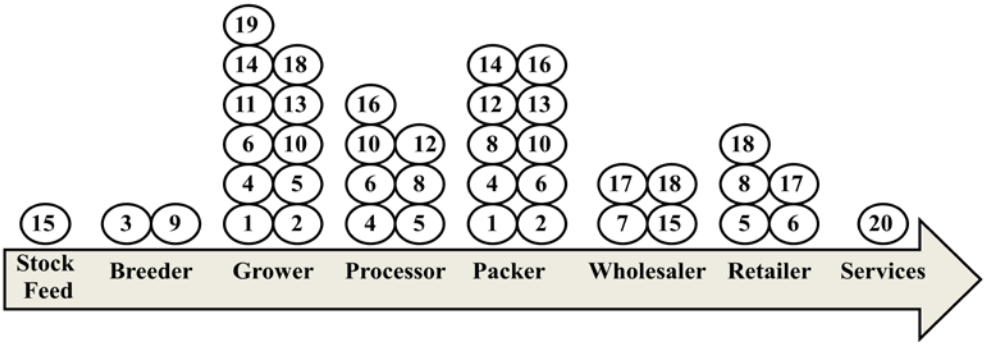

Figure 6.3 Sample Saturation of UK Agri-Food Chain

However, given that the sample only includes companies with experience of the natural-resource-based view resources, it does not represent every UK agri-food company. Rather, it represents only those that have successfully exploited sustainability for competitive gain in line with the natural-resource-based view resources. Taking into consideration the heterogeneity and rarity that surrounds such competitive resources (Wernerfeldt, 1984; Barney, 2001; Lockett et al, 2009), this is an important distinction to make. The sample therefore can be considered representative of leaders in competitive sustainability in UK agri-food, and it is from them that dynamic natural-resource-based view capabilities can be explicated.

6.4.5 Participant Observation

As discussed, the critical realist's stratified ontology is interested in phenomena from varying perspectives (Ryan et al, 2012) and accordingly researchers tend to go beyond discursive

analysis (Easton, 2010) and use more than one research method at a time (Edwards et al, 2012). Data derived from observations commonly serves a compliment to discursive data, allowing the researcher to gain a deeper understanding of the contextual setting and validate interview results (Kawulich, 2005). This can be particularly useful in identifying phenomena that the interviewee is not aware of or cannot verbalise (Kawulich, 2005). Accordingly, participant observation was undertaken in this study to support interview results and the explication of tacit knowledge and capabilities.

Participant observation involves the researcher physically observing phenomena of interest within its real-life setting (Bryman & Bell, 2011) and providing detailed descriptions of activities observed (Kawulich, 2005). More specifically, assuming the role of 'complete observer' (Saunders et al, 2012), the researcher toured interviewed company premises to observe day-to-day operations. During the tour, the interviewee was asked to highlight and discuss any activities that they felt related to sustainability, whilst the researcher undertook no interaction or participation. This is considered *focused observation,* and in maximising the interviewee's insights (Kawulich, 2005), supports the critical realist belief that practitioners are experts (Edwards et al, 2014). This said, the researcher's own observations of processes, systems, technologies and communications also permitted comparison with and added tangibility to natural-resource-based view and associated theory and capabilities. As such, both the researcher and the interviewee assume important roles in observational data collection (Bryman & Bell, 2011), and again theory and practice interrelate and serve as points of reference for one another.

There are several complexities with observation that must be considered: maintaining objectivity (Kawulich, 2005); observer error and influence (Saunders et al, 2012); and ethical constraints and access (Saunders et al, 2012). The researcher's role as complete observer rather than participating observer minimised the risk of becoming too involved in the data and losing objectivity. Observer error, or rather unfamiliarity or misinterpretation of the setting, was minimised by the interviewee's descriptions of activities observed. Researcher influence, which in this case could have encouraged modifications of operations or behaviours to appear more sustainable, resulting in social desirability bias, was minimised by restricting the data made available to interviewees and ensuring observed third parties were unaware of the researcher's intentions. Access was the biggest issue in this study, in that location of interviews, time and on-site health and safety and privacy regulations meant that observation was not possible with every company. Given the recruitment complexities discussed earlier,

companies were asked to participate in observation only after having agreed to an on-site interview. Diversity also played some role in this, in that observations of different operational activities within the UK agri-food were sought. As detailed in table 6.4 below, 6 companies participated, permitting observation of operations ranging from the very beginning of the food chain with breeding and stock-feed up to the very end with retail. This provided the retailer with valuable insight into the operation of a UK agri-food chain, and added some tangibility to the existence of natural-resource-based view resources within this.

Table 6.4 Observation Details

FC	Setting	Activities observed
1	Pack house	Packing process; storage & distribution processes; water treatment facilities; biodiversity site; back-of-house operations
2	Farm	Harvesting; farm machinery; back-of-house operations
3	Farm	Crop treatment processes; tasting processes; back-of-house operations
4	Farm & Processing Plant	Milking process; renewable energy site; biodiversity site; back-of-house operations
6	Farm & Shop	Harvesting; back-of-house; retail process
15	Head Office	Back-of-house operations; sales pitch

Pertinently, it is notable that observations in this study served primarily as a verification tool for discursive interview results, and could be compared findings from the literature review, industry review and phase 1 results, and as such participation from every company was unnecessary. Rather, observations can be considered an extension of interviews, providing an additional 23 pages of rich data and supporting the explication of 14 of the 72 final dynamic natural-resource-based view capabilities defined in chapter 9. This adds both tangibility and robustness to the results. Reinforcing this is Kaulwich (2005) who claims that observation is commonly used for triangulation, and Zikimund et al (2010) who suggests that the difficulties of accessing companies for business research calls for a flexible approach. It is further notable that those observed were not aware of the researcher's intents, thus minimising social desirability bias.

6.4.6 Qualitative Content Analysis

As is commonly the case in qualitative studies (Saunders et al, 2012), data analysis was an ongoing process throughout data collection to facilitate the modification of the sampling frame and the exploration of new themes. This involved the categorization and coding of data, the comparison of results with existing theory and the identification of new themes or capabilities. In support of this, qualitative content analysis was used throughout the analysis of both the interviews and observations.

With regards to interviews, analysis began with the transcription of interviews, which in resulting in a vast amount of written data, can often be daunting for the researcher (Sayer, 2011). Qualitative content analysis and coding helps with this, allowing the researcher to systematically organise and reduce data into more approachable categories (Bryman & Bell, 2011). In this first instance, interview transcripts were categorized according to each natural-resource-based view resource, using the coding framework detailed in chapter 4 *(table 4.1).* As is commonly the case in semi-structured interviews (Bryman & Bell, 2011), direct quotes were then extracted from each category and coded according to the corresponding conceptual frameworks of dynamic natural-resource-based view capabilities detailed in chapter 3 *(table 3.2; 3.3; 3.4; 3.5)* and emergent capabilities from the industry review and phase 1 results. This permitted empirical verification of such capabilities, whilst any pertinent quotes that could not be assigned to a predetermined coded capability were considered newly emergent capabilities and, where appropriate, were included in the final definition of empirical natural-resource-based view capabilities *(tables 8.4; 8.8; 8.12).* The same process was used for analysis of observations, in that field notes were transcribed and coded according to each natural-resource-based view resource. In line with Kaluwich's (2005) recommendations, such field notes included records of informal conversations and descriptions of activities observed in the order that they occurred, and were transcribed as soon after observation as possible in an attempt to maximise accuracy. Such informal conversations and descriptions were then coded according to conceptual and emergent capabilities, primarily serving to reinforce the empirical verification of capabilities. Notably, intercoder reliability assessments were also undertaken in the analysis of interview and observation results, again involving two independent researchers checking up on the initial coding conducted by the primary researcher.

Pertinently analysis of phase 2 was a long and complex process, and involved much more than ticking off capabilities from a framework. Qualitative content analysis also supported the interpretation of interview and observation data (King, 1994; Burla et al, 2008), which is typical of critical realist research (Easton, 2010) and in correspondence with the critical realist's causal efficacy (Sayer, 1992), focused on analysis of discursive, causal language. More specifically, interview and observation data was continuously compared to literature review, industry review and phase 1 results, facilitating the re-wording of capabilities to maximise clarity and applicability according to both theoretical and UK agri-food underpinnings. In addition, reflection of the results permitted definition of common natural-resource-based view capabilities *(table 8.13),* again supported by inter-coder reliability

assessments. This moving back and forth between theory and real-life is demonstrative of the critical realist abductive approach (Sayer, 1992) and epistemology that the creation of knowledge is a social process (Sayer, 1992), involving the interrelations of both the researcher and the interviewee (Edwards et al, 2012). The critical realist researcher is very much engaged in the data (Ryan et al, 2012), and their prior understanding of theory undoubtedly yields unavoidable influences (Johnson & Duberly, 2000; Easton, 2010). This said, the interviewee's perspective is also accurately represented and not manipulated to suit theoretical assumptions or predictions, thus protecting the valuable first-hand accounts of phenomena derived from interviews (Bryman & Bell, 2011). According to the critical realist, it is within these two perspectives that reality can be observed and explained and conclusions drawn (Easton, 2010).

The critical realist non-contradictory synthesis and fallibility of knowledge (Sayer, 1992) also warrants significance in data analysis. That is, whilst capabilities were empirically defined they were not generalised to suggest that they will support the practical realisation of the natural-resource-based view in every context, nor were theoretical capabilities that did not feature in data falsified.

7.0 Empirical Study Results – *Phase 1*

As discussed, phase 1 of the empirical study involved seven in-depth telephone interviews with UK agri-food experts *(table 6.1)*, intended to seek empirical validation of the links between the natural-resource-based view, sustainable supply chain management and innovation. Interviewees were asked about and provided detailed discussion of their experiences of sustainability in UK agri-food. Such discussions were coded according to natural-resource-based view resources *(table 4.1)*, consequently explicating real-life, albeit tacit, descriptions of pollution prevention, product stewardship and clean technologies and supporting their existence in industry. These descriptions were in turn coded according to synergies between each resource and sustainable supply chain management and innovation, depicted in table 7.1 below, and compared back to literature in line with this study's critical realist abductive approach. Given that all pollution prevention, product stewardship and clean technologies synergies featured in interview discussions this resulted in empirical verification of the natural-resource-based view, sustainable supply chain management and innovation links discussed in literature. Notably, the same was not possible with base of the pyramid, in that the resource did not feature in any of the seven interviews, preventing empirical investigation of its sustainable supply chain management and innovation synergies. Nonetheless, as depicted throughout this chapter, the successful completion of phase 1 resolved the fourth research objective:

- Explore links between each resource and sustainable supply chain management and innovation in UK agri-food.

Table 7.1 Sustainable Supply Chain Management & Innovation Coding Framework

	SSCM Synergies	Innovation Synergies
Pollution Prevention	➢ Intra-organisational environmental practices ➢ Environmental management systems ➢ Lean supply chain management	➢ Process innovation ➢ Continuous innovation
Product Stewardship	➢ Green Purchasing ➢ Green distribution ➢ Design for the environment ➢ Sustainable supply chain collaboration ➢ Closed-loop supply chain management	➢ Sustainable supply chain innovation
Clean Technologies	➢ Environmental supply chain technologies ➢ Corporate environmental responsibility ➢ Closed-loop supply chain management ➢ Resource efficient supply chains	➢ Technological innovation ➢ Sustainable innovation (environmental)
Base of the Pyramid	➢ Socially responsible supply chains ➢ External collaboration ➢ Supply chains in developing economies	➢ Radical innovation Disruptive innovation ➢ Sustainable innovation (social)

7.1 Pollution Prevention Results

Pollution prevention featured the most prominently of the natural-resource-based view resources in interviews, corresponding with its dominance in literature and its explicit presence in the industry review. Interviewees discussed waste at length, making specific reference to the prevention of internal waste such as cardboards, plastics, metals, unusable or commercially unviable produce, water and soil. The prevention of pollutions featured to a lesser extent but were nonetheless notable in all seven interviews and surrounded discussion of water pollution, soil pollution, carbon emissions, emissions from transport and machinery and emissions from pesticides and fertiliser. Such discussions, as demonstrated throughout the following sections, entailed repeated references to competitive benefits of reduced costs and improved efficiency, corresponding with Hart's (1995) pollution prevention.

7.1.1 Pollution Prevention & Sustainable Supply Chain Management

Whilst interviewee's were not directly questioned about the supply chain, sustainable supply chain management featured prominently in discussion of pollution prevention. More importantly, to varying extents, all the pollution prevention and sustainable supply chain management synergies derived from the literature review *(table 7.1)* featured in interview discussions: intra-organisational environmental practices; environmental management systems; and lean supply chain management.

Intra-Organisational Environmental Practices

Intra-organisational environmental practices of environmental policy, use of environmentally friendly materials, substitution of questionable materials, process optimisation to reduce solid waste, internal recycling and advanced prevention and safety methods featured in interviewee discussions of pollution prevention. With regards to environmental policy, Interviewee 5 claimed they have a *'lot of targets and KPIs that we need to meet'*, whilst Interviewee 7 made reference to corporate responsibility policies in pollution prevention. Moreover, Interviewees 1, 5 and 6 all suggested that internal zero waste policies drove the prevention of solid waste and delivered competitive benefits of via improved efficiency and reduced costs via the avoidance of landfill costs. With regards to the use of environmentally friendly materials and substitution of questionable materials, Interviewee 3 discussed replacing unrecyclable plastics used in cleaning and storage processes to prevent waste, whilst Interviewee 4 discussed the use of Ad Blue in tractors to prevent emissions and pollution and improve efficiency. The avoidance of farm aids also featured prominently here and enjoyed links with cost-cutting, with Interviewee 5 stating *'farmers only use pesticides when we absolutely have to* [....] *and the most obvious way to prove that is that pesticides and fertilisers are really expensive*'. The same can be said for the prevention of carbon emissions, with Interviewee 4 stating '*I'm going to be trying to reduce carbon because I want to cut my costs*'. With regards to process optimization, interviewee 1 claimed it allowed them to '*identify any issues that are building up waste, like problems with machinery or whatever, and once those problems are fixed we improve efficiency*'. With regards to internal recycling, Interviewee 5 claimed to *'have massively increased our focus on recyclability'*, Interviewee 1 claimed to '*make money from selling on our waste cardboards'* and Interviewee 4 stated *'even our scrap metals are worth money so we're obviously going to sell them on'*. Finally, with regards to advanced prevention and safety methods, Interviewee 5 claimed to use health and safety system ISO 18001 *'to keep on top of our environmental strategy'*.

Such discussions add empirical reinforcement to Shi et al's (2012) conceptual natural-resource based model of green supply chain management, verifying that intra-organisational green supply chain practices do play some role in pollution prevention. Moreover, interviewee references to competitiveness stress the value of such practices in pollution prevention. This said, not all of Shi et al's intra-organisational practices featured in phase 1 interviews, in that consideration of environmental criteria, environmental total quality management and internal environmental management procedures were not identified. Nonetheless, such practices have

been incorporated into the conceptual definition of pollution prevention capabilities and will be further investigated in phase 2.

Environmental Management Systems

Environmental management systems, with particular reference to ISO systems, also featured prominently in interviewee discussions of pollution prevention, and rendered links with cost-cutting. For example, Interviewee 1 stated *'ISO 14001 is definitely a core capability'* in support of pollution prevention, whilst Interviewee 4 stated *'we have ISO 14001 and 9001 on site* [....] *it has a lot to do with waste, but again we see that as economics not sustainability'*. Interviewees 5 and 7 also explicitly linked ISO 14001 with the prevention of internal waste, and drew links with financial and efficiency benefits.

The prominent presence of environmental management systems in interviewee discussions of pollution prevention corresponds with their repeated occurrence in seminal natural-resource-based view studies (Hart, 1995; Russo & Fouts, 1997) and extensions and developments (Aragon-Correa & Sharma, 2003; Shi et al, 2012). Whilst most commonly this refers to total quality management, more recent studies have placed an emphasis on ISO systems (Shi et al, 2012; Hajmohammad et al, 2012) in pollution prevention. Moreover, interviewee references to the financial and efficiency benefits of environmental management systems correspond with the presentation of environmental management systems in sustainable supply chain management literature as a means by which to reduce cost and boost performance and competitiveness (Seuring & Müller, 2008), and add strength to their value in pollution prevention. Thus, phase 1 interviews verify a relationship between pollution prevention and environmental management systems.

Lean Supply Chain Management

Whilst none of the seven interviewees made explicit reference to lean supply chain management, some interviewee discussions did imply a lean approach. That is, in line with the definition of lean (Hajmohammad et al, 2013), interviewees made implications for interrelated bundles aimed at reducing waste in the value chain, whilst interviewee discussions of environmental policy, environmental criteria, internal environmental management procedures and ISO systems all correspond with a lean approach. Lean's emphasis on stakeholder integration and continuous improvement (Dües et al, 2013) can also be identified in interview discussions, with references to competitors, the government, NGOs, employees, supply chain partners and customers featuring prominently in discussions of pollution prevention.

7.1.2 Pollution Prevention & Innovation

As with sustainable supply chain management, interviewees were not questioned directly about innovation, but nonetheless innovation featured explicitly in discussions of pollution prevention. For example, Interviewee 1 stressed the need to find and implement new innovations in the prevention of waste and pollution, whilst Interviewee 2 spoke of the need for innovation and research surrounding land use. In addition, Interviewee 5 claimed that innovation and environmentalism '*goes hand in hand'*, and added '*we've got new farmers coming up with this big realisation that sustainability brings financial returns'*, encouraging innovation. In spite of this, pollution prevention and innovation synergies of process innovation and continuous innovation did not feature explicitly in interviews. Nonetheless, as discussed below, implications for process innovation and continuous innovation were still notable.

Process Innovation

Implications for process innovation can be identified in discussions of the reuse of waste in internal operations, which featured prominently in discussions, with Interviewee 1 stating *'I think turning waste products into something else is a good opportunity'*. More specifically, Interviewees 2 and 4 stressed the value of using solid waste products as fertiliser or feeds, whilst Interviewees 1 and 5 discussed the reuse of waste waters. As well as supporting prevention and cutting costs, interviewees suggested that such activities rendered additional benefits, with Interviewee 1 stating that reused water *'pushes soil and mud down to the bottom and from there it can be extracted and spread over our fields because it is full of nitrogen and it's great for our product'*. Both Interviewee 1 and Interviewee 5 described such processes as closed systems and presented them as forms of process innovation, with Interviewee 1 claiming that is this that '*puts us apart from our competitors'*.

Such discussions correspond with Tidd & Bissant's (2009, p6) claim that process innovation allows you to *'make something that no one else can, or to do so in ways that are better than anyone else'*, whilst links with cost reduction (Chenavaz, 2012) and value creation (Utterback & Abernathy, 1975; Smith, 1994) can also be identified in interviews. As such, a relationship between pollution prevention and process innovation is empirically verified, largely surrounding the argument that process innovation supports the reuse or responsible disposal of internal waste which prevents waste or pollutants.

Continuous Innovation

Taking the description of continuous innovation as continuously out-innovating competitors to meet demand (Drucker, 1985; Christensen, 1997; Galunic & Rodan, 1998) into consideration, there does appear some minor implications for continuous innovation in interview transcripts. For example, Interviewee 7 suggested their corporate responsibility approach *'has opportunities for innovation'* that allow them to continuously develop their approach to the prevention of waste and maximisation of internal environmentalism, whilst interviewee 4 claimed to continuously seek out new ways to prevent waste and link this with differentiation.

This offers some reinforcement for the earlier proposition that pollution prevention is a moving target that firms must constantly strive to be the best at, instigated by discussions in literature that innovations may be imitated by competitors or become outdated and be replaced with new innovations (Tidd & Bessant, 2009). Thus, interviews support the the assumption that continuous innovation play some role in the practical realisation of pollution prevention, with particular reference to competitiveness.

7.2 Product Stewardship Results

Product Stewardship was also discussed at length, featuring to varying extents in all seven interviews. As with pollution prevention, interviewees were not questioned directly about product stewardship and the term did not feature explicitly. However, a product stewardship approach was identifiable in statements such as *'from our point of view we are not just selling a product* [....] *we want to think about the performance of that product throughout production right up until it is cooked at eaten* [and] *sustainability plays a big part in this'* (Interviewee 6). Interviewees discussed working on and encouraging sustainability throughout the lifecycle, and as detailed below, placed a heavy reliance on the supply chain. In addition, competitive benefits were discussed, with Interviewee 3 suggesting that stewardship allows them to tell *'a good meat story'* that differentiates them from competitors, and Interviewee 5 referencing efficiency and cost benefits.

7.2.1 Product Stewardship & Sustainable Supply Chain Management

The relationship between product stewardship and sustainable supply chain management featured more prominently than that of pollution prevention. That is, every interviewee made repeated and direct reference to the supply chain throughout discussions of product

stewardship. More importantly, all product stewardship and sustainable supply chain management synergies derived from literature were empirically validated *(table 7.1)*: green purchasing; green distribution; design for the environment; sustainable supply chain collaboration; and closed-loop supply chain management

Green Purchasing

Discussions of green purchasing tended to surround the selection of suppliers and sourcing of sustainable products to assist in the creation of wholly sustainable products. For example, Interviewee 1 claimed to be *'looking for accreditation from all our suppliers'* to ensure that sustainability was maximised, whilst Interviewee 4 stressed that they had to obtain accreditations in order to attract customers and '*meet their standards*' of sustainability. ISO systems again emerged with significance, with Interviewees 1, 3 and 5 all suggesting that IS0 14001 supports the selection of suppliers in a way which maximises sustainability, and linking this with increased competitiveness. Some references to the acquisition of products that reduce environmental impact were also notable, with Interviewee 3 claiming to source only grass fed, responsibly reared cows to reduce '*environmental footprint*', and Interviewee 6 sourcing only recyclable or reusable packaging to prevent waste at the end of the lifecycle.

Again, this adds empirical reinforcement to Shi et al's (2012) conceptual natural-resource-based green supply chain management model, suggesting that inter-organisational supply chain practices do support the practical realisation of product stewardship. More specifically, Shi et al's emphasis on the choice of suppliers by environmental criteria and suppliers ISO 14001 certification as product stewardship practices are corroborated by interview discussions. References to recyclable or reusable packaging also correspond with Min & Galle's (2001) prioritisation of recycled or reused materials in green purchasing. As such, a relationship between product stewardship and green purchasing is empirically verified.

Green Distribution

Interviewee discussions of product stewardship included considerable references to environmentally friendly transport and logistics, thus reinforcing links with product stewardship. For example, Interviewee 7 claimed logistics is as a *'big part of supply chain strategizing* [....] *finding the most efficient ways to distribute* [...] *so we are reducing waste'*, whilst Interviewee 1 claimed their distribution strategy acted as a source of competitiveness in that it permitted reduced costs and reduced environmental impacts. More specifically, Interviewee 5 stressed the need for transport vehicles to be up to date *'because that is where*

the environmental benefits are', whilst Interviewee 4 spoke of using Ad Blue in logistics to prevent emissions and cut costs throughout the supply chain. As well as logistics and distribution, storage featured in interviewee discussions of product stewardship with Interviewee 7 discussing the need for storage technologies that promote freshness to prevent food waste, and Interviewee 3 discussing the need for environmentally friendly refrigeration systems. Packaging was also discussed here, in that interviewees referred to packaging that supports freshness throughout distribution and to the end of the lifecycle.

Notably, three of Jumadi & Zailani's (2010) five activities of green distribution can be identified in such discussions: green transportation; green storage; and green packaging. In addition, references to competitiveness and waste reduction correspond both with product stewardship and the presentation of green distribution in sustainable supply chain management literature (Markley & Davis, 2007; Jumadi & Zailani, 2010; Langella & Zanoni, 2011; Perotti et al, 2011). Thus, another of Shi et al's (2012) inter-organisational practices is empirically verified: a relationship between product stewardship and green distribution

Design for the Environment

The idea that design processes should be modified to prioritise environmental factors featured prominently in interviews, supporting links between product stewardship and design for the environment. That is, Interviewee 1 spoke of designing products and processes *'to help reduce fuel consumption, electricity use and so on*' throughout the supply chain, whilst Interviewee 3 spoke of new production sites specifically designed to maximise sustainability. Whilst the intention of such processes remained on enhanced environmentalism, Interviewee 6 suggests that *'this in turn improves the quality of the end product*', again demonstrating competitive benefits.

Thus, the third of Shi et al's (2012) inter-organisational practices is empirically reinforced, supporting a relationship between product stewardship and design for the environment. Notably, references to design for environment also feature in initial conceptualisation of product stewardship (Hart, 1995) and Markley & Davis's (2007) discussion of product stewardship.

Sustainable Supply Chain Collaboration

Sustainable supply chain collaboration emerged with some dominance in interviewee discussions of product stewardship. Interviewee 2 stressed that *'there really is a need for*

collaboration' with suppliers to maximise sustainability, whilst Interviewee 7 stated '*of course things like supply chain relationships matter, we are aware we can't do this on our own'*. In most cases, Interviewee's demonstrated direct involvement throughout the supply chain with both suppliers and customers to joint plan for environmental objectives and solutions. For example, Interviewee 6 claimed to be '*working with our retailers to encourage full cleaning and sterilisation'* in order to reduce waste, whilst both Interviewees 1 and 3 discussed designing packaging with retailers and the associated impact on recycling. Vertical integration emerged with significance here, with Interviewee 1 claiming that owning their own farms allowed them to '*manage sustainability and quality, and we can closely monitor things like soil quality'*, and Interviewee 6 suggesting owning their own cows '*improves the quality of the end product*'. Reinforcing this, Interviewee 3 claimed their vertically integrated approach created better, more responsible products that can be easily differentiated from competitors.

Such discussions corroborate the argument that the realisation of environmental objectives or strategies require input from each supply chain member (Vachon, 2007; Seuring & Müller, 2008; Abbasi & Nilsson, 2012 Giminez & Tachizawa, 2012; Miemczyk et al, 2012; Jensen et al, 2013). Notably, references to collaboration in product stewardship feature in initial conceptualisation of the resource (Hart, 1995) and are later picked up on by Shi et al (2012) and their presentation of awareness seminars for suppliers, bringing together suppliers to share know-how and problems and cooperation with suppliers for environmental objectives as product stewardship activities. Thus, interview discussions add empiricism and clarity to the role of collaboration in product stewardship.

Closed-Loop Supply Chain Management

Interviewees made explicit reference to closed-loop supply chain management in discussion of product stewardship, with Interviewee 2 claiming '*we have this closed-loop thing going on'* with regards to the reduction of waste throughout the lifecycle, and Interviewee 7 claiming to be *'promoting the circular economy'* throughout the supply chain. Stressing the value of this in product stewardship, Interviewee 7 claimed that closed-loop supply chain management allowed them to '*look at resale and packaging and the best ways to segregate waste and decide what to do with it',* whilst Interviewee 3 claimed their closed-loop approach involves the redistribution and reuse of by-products to supply chain partners, resulting in reduced costs via the avoidance of landfill and enhanced value via the creation of rich landspreads.

Such explicit discussions of closed-loop supply chain management add strength and empiricism to Miemczyk et al's (2016) argument that a closed-loop approach drives successful sustainable stewardship throughout the supply chain and stakeholders. Interviewee references to waste reduction and value creation also correspond with existing literature (Ashby et al, 2012; Bell et al, 2012; Garg et al, 2015; Govindan et al, 2015) and stress the value of closed-loop supply chain management in product stewardship.

7.2.2 Product Stewardship & Innovation

Unlike pollution prevention, there were no explicit references to innovation within interviewee discussions of product stewardship. Nonetheless, minor references to innovation were identifiable, suggesting that it does play some role in the practical realisation of product stewardship. Moreover, such references, as discussed below, demonstrate correspondence with sustainable supply chain innovation and therefore verify its synergistic relationship with product stewardship.

Sustainable Supply Chain Innovation

Both interviewee discussions of product stewardship and sustainable supply chain innovation place a focus on environmentally focused innovation, with particular attention rendered to circular processes, structure and technologies. Take for example discussions of vertical integration and closed-loop supply chain management in interviews, in which modifications to network structure are clearly intended to maximise environmental sustainability throughout the lifecycle. Moreover, a dependency falls upon innovative environmental technologies with references to cleaning technologies (Interviewee 6), disposal technologies (Interviewee 7) and transport technologies (Interviewee 5; 7) within the supply chain featuring in such discussions.

Thus, taking the definition of sustainable supply chain innovation as '*sustainable, environmentally sound, closed-looped innovations in terms of business processes, network structure, and technology*' (Jensen et al, 2013, p127), interviewee discussions empirically validate a relationship between clean technologies and sustainable supply chain innovation. This adds strength to existing arguments that sustainable supply chain innovation exists as a viable means by which to realise sustainability (Vachon & Klassen, 2008; Szekely & Strebel, 2013) in a competitive fashion (Berghman et al, 2012; Szekely & Strebel, 2013).

7.3 Clean Technologies Results

Conflicting the negligence of the topic in literature but corresponding with the results of the industry review, interviews results suggest that clean technologies assumes a prominent role in industry. The need for positive impact operations was easily identifiable in that Interviewee 7 claimed to have a *'genuine desire to achieve sustainability in the long term'*, whilst Interviewee 4 stated *'instead of asking how can we become more sustainable, maybe we need to be asking how can we protect the future'*. Pernick and Wilder's (2007) categories of clean technologies were also identifiable, with clear references to energy technologies, transport technologies, water technologies and material technologies throughout interviewee discussions. So too were competitive benefits, with Interviewee 5 stating that clean technologies are *'morally the right thing to do for the environment, but of course that is not to say there aren't financial gains because there are, you get big reductions'*.

7.3.1 Clean Technologies & Sustainable Supply Chain Management

Interviewee discussions of clean technologies did place a reliance on sustainable supply chain management. For example, Interviewee 7 claims that it is within the supply chain that *'opportunities for innovation that make good business'* with regards to long term sustainability can be found. More importantly, as discussed below, all clean technologies and sustainable supply chain management synergies derived from literature were empirically validated *(table 8.1)*: environmental supply chain technologies; corporate environmental responsibility; closed-loop supply chain management; resource efficient supply chains.

Environmental Supply Chain Technologies

Environmental supply chain technologies featured prominently throughout interviews. For example, both Interviewees 2 and 3 discussed growing opportunities surrounding biofuels in meat, with the former discussing innovative technologies to create value from animal blood and the latter technologies supporting the reuse of animal fat. Similarly, Interviewee 6 claimed to have invested heavily in animal fuels, allowing them to become *'a self-sufficient stand-alone company that puts us in a very unique position, actually outweighing our CO2 emissions'*. In addition, Interviewee 1 spoke of electricity technologies such as sensor-controlled lights, describing them as *'best practice innovations*', whilst Interviewee 5 claimed to have *'invested £120,000 in drying systems because traditional ways chew up so much electricity'*. Interviewee 3 also spoke of energy recovery from refrigeration technologies, whilst Interviewee 6 spoke of *'energy efficiency, heat recovery and optimization of*

refrigeration processes'. Communication technologies also featured in interviews, with Interviewee 2 referencing collaborative communication technologies such as online forums in which they can *'see what is demanded of us, see new technologies that might interest us and share best practice to find innovations'* throughout the supply chain.

In the most part, technologies discussed in interviews demonstrate correspondence with literature's presentation of environmental supply chain technologies as those that can boost performance and support a less damaging approach to production (Schrettle et al, 2014). Interviewee discussions of biotechnologies correspond with initial conceptualisation of clean technologies (Hart, 1997), whilst references to heating, drying and refrigeration processes correspond with the dominance of energy technologies in sustainable supply chain management literature (Weinberger et al, 2012). Thus, a synergistic relationship between clean technologies and environmental supply chain technologies is empirically verified.

Corporate Environmental Responsibility

Corporate environmental responsibility was explicitly linked with clean technologies, with Interviewee 7 stating *'we had this corporate responsibility report because it is just what you do these days, but we quickly realised that this is something which is good for us* [and] *we had to make that transition from CR reporting to actual sustainability to become more responsible, at the end of the day it is the right thing to do'*. Implying a corporate environmental responsibility approach, Interviewee 3 stressed the need for sustainability to go beyond legislation, whilst Interviewee 4 suggested that a company's own sustainability measures tend to exceed government expectations. In addition, Interviewee's 1, 5, and 6 discussed the measurement and reporting of environmental technologies with supply chain partners.

Interviewees implied a clear desire to use technologies to go beyond what is expected of them economically or legally to instead make a difference in environmental spheres, thus demonstrating correspondence with corporate environmental responsibility (Kovács, 2008; Kogg & Mont, 2011) and clean technologies, empirically supporting a relationship between the two. This offers some reinforcement to Maloni & Brown's (2006) claim that corporate social responsibility may add approachability to clean technologies. Furthermore, this also offers an advancement and adds clarity to Menguc & Ozanne's (2005) natural-environment orientation which draws links between the natural-resource-based view's sustainable development and corporate social responsibility.

Closed-Loop Supply Chain Management

As discussed, links between product stewardship and closed-loop supply chain management were empirically validated by interviews. However, so too are links between closed-loop supply chain management and clean technologies, albeit with some variances. That is, the closed-loop approach discussed in relation to product stewardship focused on the reuse of waste and thus reduction of negative environmental impacts, whilst the closed-loop approach discussed in relation to clean technologies appeared to support positive environmental impacts. For example, Interviewee 6 discussed the collection of oil from supply chain partners that not only offset their own 197,000 CO2 footprint, but created an additional 147,000 CO2 in biofuels that were distributed throughout the supply chain, resulting in positive rather than negative CO2 emissions. According to interviewee 6, this facilitated the creation of a renewables division that put them *'head and shoulders ahead of everyone else'*. Interviewees 1 and 5 also discussed closed-loop water systems intended to render positive environmental impacts, with Interviewee 1 claiming their water system collects 500 cubic metres of water a week, which having been reused several times filters into a purpose-built pond intended to promote biodiversity.

Such discussions empirically support this study's argument that closed-loop supply chain management is of relevance in clean technologies as it is in product stewardship. That is, interviewee discussions correspond both with clean technologies need for the advanced development of new, lower impact products and processes (Hart, 1997) and closed-loop supply chain's facilitation of extensive waste reduction, increased conservation and creation of renewable energies (Jensen et al, 2013).

Resource Efficient Supply Chains

References to resource efficient supply chains were also identifiable in interviewee discussions of clean technologies. That is, the fundamental activities of resource efficient supply chains of resource awareness, resource sparing, resource sensitivity and resource responsiveness, as defined by Matapolous et al (2014), featured in interviews. Resource awareness was demonstrated in interviewee discussions of concern for the use of water, electricity, fossil fuels and land, and the need to measure and manage the use of such resources throughout the supply chain. More specifically, Interviewee 3 presents resource mapping as an opportunity with which to maximise sustainability. Interviewee discussions of reusability and closed-loop initiatives render implications for resource sparing, whilst resource sensitivity featured in discussions of external environmental issues such as flooding, climate change, disease

outbreaks, deforestation and international trade issues. Implying resource responsiveness, Interviewee 7 claimed that such issues encouraged them to seek out and develop new clean technologies.

Notably, as well as corresponding with Matapolous et al's (2014) depiction of resource efficient supply chains, interviewee discussions of clean technologies correspond with clean technologies concern for global population growth, mineral shortages, water and food scarcity and agricultural pressures (Hart, 1997) and the need for sustainable supply chain management practices to maximise the planets natural resources (Bell et al, 2012; Shi et al, 2012). Thus, a relationship between clean technologies and resource efficient supply chains is empirically verified.

7.3.2 Clean Technologies & Innovation

In line with the literature review and the industry review, clean technologies in interviews demonstrated the strongest relationship with innovation, with the word innovation featuring explicitly in 5 of 7 interview discussions of clean technologies (Interviewee 1; 4; 5; 6; 7). However, the same cannot be said for clean technologies and innovation synergies of technological innovation or environmental sustainable innovation, in that neither was directly referenced in any interview. This said, as discussed below, implications for both technological innovation and environmental sustainable innovation are identifiable in interview discussions of clean technologies, supporting synergies.

Technological Innovation

Interviewees spoke at length of innovative technologies, such as the aforementioned biotechnologies, renewables and closed-loop technologies. Such technologies render clear environmental benefits, and according to Interviewee 6 also results in a *'competitive edge'*, supporting links between clean technologies and technological innovation. Moreover, such clean technologies discussed in interviews correspond with clean technologies need to '*plan for and invest in tomorrow's technologies'* (Hart, 1997, p3).

Thus, a relationship between clean technologies and technological innovation is empirically verified. Adding strength to this are links between clean technologies and technological innovation in initial conceptualisation of the resource (Hart, 1997) and sustainable supply chain management synergies (Bell et al, 2012; Jensen et al, 2013).

Sustainable Innovation (Environmental)

Given that technological innovations are intended to deliver environmental improvements in the long term, they also demonstrate correspondence with environmental sustainable innovation. Environmental sustainable innovation's focus on long term positive impacts is evidenced in interviewee discussion of genetics. That is, Interviewee 6 discussed investing in genetics research to dictate the sex of a calf, resulting in *'super-efficient'* operations that reduce emissions associated with animal rearing and thus mitigate climate change. Similarly, Interviewee 5 discussed genetics in terms of seed breeding, implying a focus on crops that prevent disease outbreaks and survive extenuating environmental conditions.

Such discussions again demonstrate correspondence with clean technologies' need for innovations in support of positive environmental impacts and verify a relationship between environmental sustainable innovation and clean technologies. This adds clarity and expands on Szekely & Strebel's (2013) linking of sustainable innovation and clean technologies.

7.4 Base of the Pyramid Results

In spite of references to global social sustainability on the interviewed company websites, none of the 7 interviewees spoke of base of the pyramid. That is, interviewees did not discuss the alleviation of social ills on a global scale, nor did they discuss entrance into or interest in emerging markets and associated opportunities for innovation. This adds to the negligence of the topic in existing literature (Hart & Dowell, 2011) and corresponds with claims discussed in the industry review that UK agri-food companies are disinterested in emerging markets (DEFRA, 2012b). Thus, again, the existence of base of the pyramid in UK agri-food remains unsubstantiated, and consequently synergies with sustainable supply chain management and innovation could not be empirically corroborated.

Notably, whilst the existence of base of the pyramid and its relationship with sustainable supply chain management and innovation could not be empirically verified, the resource is not falsified. In part, this is due to the non-contradictory synthesis of the critical realist philosophical stance underpinning this study which rejects falsification, but also takes into consideration the limitations of the contextual setting and sampling. That is, the absence of base of the pyramid may be sectorially specific, and thus its falsification may undermine its value in other sectors. Similarly, it may undermine the intended scarcity and complexity of natural-resource-based view resources (Hart, 1995) which Hart et al (2016) claim is

maximised in base of the pyramid. It is for such reasons, along with the demand for the resource as demonstrated in the industry review, that base of the pyramid was not excluded from phase 2 of the empirical study. However, to some extent its investigation was undertaken from a broader social sustainability stance, as discussed earlier in chapter 6.

7.5 Emergent Capabilities

Whilst the focus on phase 1 interviews fell upon exploration of natural-resource-based view, sustainable supply chain management and innovation synergies, implications for capabilities were notable throughout interviewee discussions. As with those derived from the industry review, such implications were somewhat vague but in large part demonstrated correspondence with the conceptual natural-resource-based view capabilities defined in chapter 4. Such correspondence is of little surprise given that conceptual capabilities were derived from the same synergies investigated in phase 1 interviews. However, of greater interest are implications for emergent capabilities, that other than in phase 1 interviews, had not been linked to natural-resource-based view resources. In line with abductive nature of this study, emergent capabilities are reported here and further investigated in phase 2. Given the absence of base of the pyramid in phase 1 interviews, no emergent base of the pyramid capabilities were uncovered.

7.5.1 Emergent Pollution Prevention Capabilities

Interview discussions of pollution prevention implicated four new capabilities: a zero waste philosophy; family management principles in decision making; farming and land qualifications; and financial capacity to invest in environmental practices. With regards to zero waste, Interviewees 1, 5 and 6 all claimed an internal zero waste philosophy drove the prevention of solid waste and rendered benefits for the firm via improved efficiency and reduced costs. Family management principles emerged as a pollution prevention capability in Interviewee 4's claim that '*farms are often different to other businesses; they often have that long term perspective or family values that encourage them to do the right thing'*, and Interviewee 7's claim that their '*focus on environmental responsibility comes a lot from us being a family based company'*. Family and land qualifications were linked with pollution prevention in Interviewee 5's claim that *'the thought process of every decision is really important* [....] *at the very forefront they need to be based on an understanding of the natural environment, and that comes from getting your BASIS qualifications'*. Finally, Interviewee 6 stressed the need for financial capacity to invest in environmental practices, claiming

'sustainability can only come from a successful business, you need money to begin a sustainability strategy and in turn it will start to pay for itself'.

7.5.2 Emergent Product Stewardship Capabilities

Interviews identified three new product stewardship capabilities: external partnerships; the measurement of energy and carbon throughout each stage of production to identify areas for improvement; and geographical location of sites to reduce environmental impact. With regards to external partnerships, Interviewee 5 claimed their partnership with an external researcher facilitated the creation of sustainable food products, whilst Interviewee 7 suggested their partnership with an external company that redistributes unsold goods for human consumption prevented supply chain waste. Interviewee 1 claimed the measurement of energy use at each stage of production throughout the supply chain allowed them to identify problem areas, whilst Interviewee 4 stressed the need to measure fuel and electricity throughout the supply chain. Finally, Interviewee 1 rendered implications for location in product stewardship, arguing *'location is also a big thing, and being close to the markets we serve'* allows them to minimise the environmental impact of distribution practices.

7.5.3 Emergent Clean Technologies Capabilities

Emergent capabilities for clean technologies include the use of online forums to identify new technologies and innovations; industry conferences to identify new technologies and innovations; offsetting environmental impacts; and family management principles in decision making. Linking online forums with product stewardship, Interviewee 1 spoke of their presence in an online industry forum in which companies can see what is demanded of them, find new technologies of interest and discover new innovations. Implying a similar approach with industry conferences, Interviewees 2 and 3 claimed to attend conferences to identify new innovations, specifically those focused on renewables and reusable waste. With regards to environmental offsetting, interviewee 6 spoke at length of offsetting carbon emissions via their creation of bio-fuels in discussion of product stewardship. Family management principles were implicated via Interviewee 7's claim that the *'genuine desire to achieve sustainability in the long term'* comes from being in the fifth generation, and that for the sixth generation they *'need to have sustainability at our core if there is going to be a successful business for them to grow in to',*

7.6 Summary of Findings

Phase 1 of the empirical study is considered exploratory analysis, which is often employed in order to seek clarification of a given idea (Saunders et al, 2012). In this case, the *idea* was that the natural-resource-based view assumed synergistic relationships with sustainable supply chain management and innovation. The results of the interview support this idea, and thus resolves the fourth research objective in empirically validating links between the natural-resource-based view, sustainable supply chain management and innovation. In doing so, phase 1 offers a substantial basis for phase 2 of the empirical study. That is, as summarized in table 7.2 below, phase 1 interviews reinforces the existence of pollution prevention, product stewardship and clean technologies in UK agri-food, and in verifying synergies with corresponding sustainable supply chain management strategies and innovation sub-types, add strength to derivation of conceptual capabilities. Adding further strength are implications for emergent capabilities from phase 1 interviews, which support the feasibility of explicating natural-resource-based view capabilities from the analysis of discourse and tacit knowledge.

Pertinently, whilst base of the pyramid did not feature in interviews, and thus cannot be empirically linked with sustainable supply chain management or innovation, the resource is not falsified and still warrants investigation in phase 2.

Table 7.2 Phase 1 Findings

	Finding	Evidence	Sample Data
Pollution Prevention	Existence in UK agri-food empirically reinforced	Lengthy discussions of advanced minimisation of waste and pollutants in internal operations, with clear links to competitiveness.	*'I believe we are the most efficient in the business, certainly when it comes to reducing waste and energy use and making the most of reusables and recyclables* [….] *that is how we keep our costs low and our environmentalism high'* (6)*
	Sustainable supply chain management synergies verified	Discussions of internal targets & KPIs (5), Zero Waste (1,5,6), CSR policies (7), internal recycling (3,4) and avoidance of harmful materials (4,5) correspond with Shi et al's (2012) **intra-organisational environmental practices.**	*'We have various KPIs that we need to meet if we want to realise our waste goals, and we really do want to realise them so we can beneft'* (5).
		Environmental management systems of ISO 14001 (1,4,5,7), ISO 18001 (5) & ISO 9001 (4) discussed.	*'ISO 14001 was a big help* [with reducing waste], *it took us from nought to 100 in terms of where we were environmentally'.*
		Lean approach implied in 3 interviews (1,4,6), via discussion of internal procedures to maximise quality and efficiency and the sustainable consequences.	*'Our internal strategy is designed to meet targets in terms of finance, efficiency, quality and sustainability – all goes hand in hand'* (6).
	Innovation synergies verified	**Process innovation** implied in discussions of internal systems (1,5) that permit the reuse of effluents & by-products (1,2,4,5)	*'It's a closed system* [that] *'pushes soil and mud down to the bottom and from there it can be extracted and spread over our fields because it is full of nitrogen and it's great for our product'.*
		Continuous innovation implied in discussions of long-term sustainability goals (4,7)	*'If the farmer is in it for the long haul* [….] *he's probably going to keep trying to improve'* (4).
Product Stewardship	Existence in UK agri-food empirically reinforced	Discussed in all 7 interviews, surrounding topics of sustainability from a lifecycle perspective with clear links to competitive benefits.	*'From our point of view we are not just selling a product* [...] *we want to think about the performance of that product throughout production right up until it is cooked at eaten, sustainability plays a big part in this'* (6)
	Sustainable supply chain management synergies verified	**Green purchasing** evidenced in discussions of sourcing suppliers with environmental accreditations (1,3,5) and motivations (4,5)	*'We tell a good meat story* […] *we're talking grass-fed, high quality cows and that's where we differ from the rest of the cattle market'* (3)
		Green distribution evidenced in discussions of reducing environmental impact of transport (4,5) and storage (3,7).	*'We are always working to be finding the most efficient ways to distribute* [...] *so we are reducing waste that way'* (7)
		Design for the environment evidenced in discussions of purpose built sites and systems (1,3,6)	*'These were specifically put in place to 'reduce fuel consumption, energy use and so on'* (1)
		Sustainable supply chain collaboration evidenced in discussions of working with suppliers for environmental targets (1,3,6), vertical integration (3,6), explicit references to collaboration (2,7).	*'You know, supply chain relationships matter, we are aware we can't do this on our own'* (7)

Table 7.2 cont.

	Finding	Evidence	Sample Data
		Closed-loop supply chain management explicitly referenced in product stewardship discussions (2;7)	*'We are actively promoting the circular economy, looking at resale and packaging, the best ways to segregate waste and then decide what to do with it'* (7)
	Innovation synergies verified	**Sustainable supply chain innovation** implied in environmentally maximised network design (1,2,3,6,7) and references to cleaning (6), disposal (7) and transport technologies (5,7).	***'**There's all sorts of things going on all the time, we're all trying to get to that point where we know we should be, In part that's about working together'* (7)
Clean Technologies	Existence in UK agri-food empirically reinforced	Featured in all 7 interviews, surrounding discussions of positive impact operations and long-term sustainability within a competitive context. Implications for energy, transport, water and material technologies also featured.	*'Instead of asking how can we become more sustainable, maybe we need to be asking how can we protect the future'* (4)
	Sustainable supply chain management synergies verified	**Environmental supply chain technologies** of bio-fuels (2,3,6), sensor controlled lights (1), drying systems (5), energy recovery (3,6) and communication technologies (2) discussed.	*'We wanted to invest in that tech so we could become a self-sufficient stand-alone company that puts us in a very unique position, actually outweighing our CO2 emissions'* (6).
		Corporate environmental responsibility explicitly discussed (7) & implied in discussions of going beyond legislation (4), and environmental measurement and reporting throughout the supply chain (1,5,6).	*'We had this corporate responsibility report because it is just what you do these days, but we quickly realised that this is something which is good for us* [and] *we had to make that transition from CR reporting to actual sustainability to become more responsible, at the end of the day it is the right thing to do'* (7)
		A closed-loop supply chain approach featured in discussions of the collection and reuse of waste from supply chain partners to facilitate renewables (1,5,6)	*'What we do is we collect that oil from them, and already we're offsetting our own CO2 footprint. But we're actually able to create biofuels, so positive CO2 that we can then distribute back into the supply chain. We basically created a whole renewables division from that that put us head and shoulders ahead of everyone else'* (6).
		Resource efficient supply chains evidenced in discussions of the conservation of water (1,2,3,4,7), fossil fuels (1,3,4,5,6) and land (6)	***'**We started* [resource mapping] *purely because we seen what was happening to that resource and we didn't want to be a part of it* (3).
	Innovation synergies verified	**Technological innovation** implied in discussions of biotechnologies (2,3,6), renewables (1,5,6) and closed-loop technologies (1,5,6)	*'It's those best practice innovations we're looking for, and where we want to put our money*' (1).
		Sustainable innovation (environmental) implied in discussions of new products and processes designed to maximise sustainability in the long term (4,5,6,7).	*'What we can now, its honestly amazing. Essentially we can start to manage sustainability years in advance, from the breeding end of things. That makes a big difference'* (5)

8.0 Empirical Study Results – *Phase 2*

Phase 1 of the empirical study reinforced the existence of the natural-resource-based view in industry and confirmed relationships with sustainable supply chain management and innovation. Building upon this, phase 2 of the empirical study investigated the capabilities in support of pollution prevention, product stewardship, clean technologies, and in spite of its absence in phase 1, base of the pyramid. As discussed, such investigation involved twenty semi-structured interviews and six participant observations. Following transcription, both interviews and observations were coded according to the natural-resource-based view coding framework *(table 4.1)*, allowing for the categorization of data according to each resource. Each section was then coded according to the corresponding conceptual framework of capabilities detailed in chapter 3 *(tables 3.2; 3.3; 3.4; 3.5)*, and further coded according to emergent capabilities derived from the industry review and phase 1 of the empirical study. In addition, the analysis of phase 2 data supported explication of newly emergent capabilities. Thus, as depicted in figure 8.1 below, the final empirical definition of natural-resource-based view capabilities is made up of three divisions: empirical validation of conceptual capabilities; empirical validation of emergent capabilities from the industry review and phase 1; and explication of newly emergent capabilities from phase 2 interviews and observations.

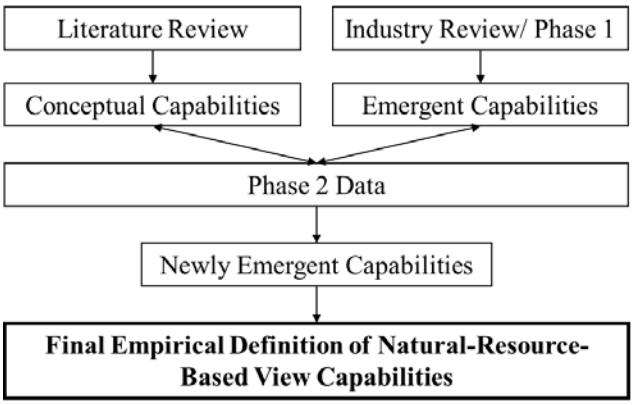

Figure 8.1 Process of defining natural-resource-based view capabilities

Notably, the critical realist abductive nature of this study, in which the researcher moves back and forth between theory and observation (Saunders et al, 2012) and examines phenomena through various strata (Sayer, 1992), meant that final definition of capabilities took into account existing literature, industry review and phase 1 results and theoretical

influences. In some cases this resulted in the re-wording of capabilities to reflect the detailed descriptions of each capability in interviews or observation and pre-understandings of the capability from literature, industry or theory. Thus, as well as adding empiricism to existing studies and conceptual natural-resource-based capabilities, phase 2 of the empirical study also adds clarity and definition to the relationship between each capability and its corresponding resource. This responds to calls for the explanation of the complex relationship between capabilities and resources (Rashidirad et al, 2015) and diverges from the positivistic tendency to rely on statistical quantification to define resource-based capabilities (Newbert, 2007; Lockett et al, 2009)

In addition, final capabilities remain segregated according to Teece's (2007) dynamic capabilities. This is based on the argument that dynamic capabilities activities of sensing, seizing and transforming should be used to guide and explain resource-based capabilities. As detailed in chapter 3 *(table 3.1)*, sensing activities are those that identify opportunities and threats, and according to Gebauer (2011), are undertaken frequently to encourage market-searching efforts and anticipate market developments and customer requirements. Seizing activities follow on from sensing by responding to opportunities, often involving the creation and adoption of new business models and effective decision making (Teece, 2007). Transforming activities are those which reconfigure firm assets to support organisational evolution (Teece, 2007) and create organisational routines (Gebauer, 2011). In an attempt to offer further clarity, capabilities are further divided into internally-focused and externally-focused capabilities.

Thus, using the results of the literature review, industry review, phase 1 and phase 2 of the empirical study, adopting an abductive approach, and using dynamic capabilities to categorize results, this chapter resolves the final research objective:

- Empirically define dynamic natural-resource-based view capabilities

Notably, as well as offering the research question by providing defining the dynamic capabilities in support of pollution prevention, product stewardship and clean technologies, this chapter also offers definition of common natural-resource-based view capabilities *(table 8.13)*. This is in attempt to provide a comprehensive depiction of capabilities that support the operationalisation of the natural-resource-based view, but does not detract from the specificity of pollution prevention, product stewardship or clean technologies capabilities.

8.1 Pollution Prevention Results

In line with the results of the literature review, industry review and phase 1 of the empirical study, pollution prevention featured prominently in interviews. That is, pollution prevention was identified in all 20 interviews, 17 of which provided detailed discussions of the resource. Whilst the term 'pollution prevention' was not explicitly used, a prevention focus was easily identifiable. For example, Food Company 18 (FC18) claimed to '*remove waste wherever possible, or really prevent it'*, whilst FC20 stated *'waste is a big issue for us, we realise it costs us money and it impacts on the environment so of course we want to take measures to prevent it'*. The most common forms of waste discussed included food waste and packaging waste, whilst discussions of pollutions mainly surrounded water pollutants and carbon or greenhouse gas emissions. Competitive associations were also easily identifiable, with particular regards to financial and efficiency benefits. That is, FC3 claimed prevention is undertaken *'principally to save money*' whilst FC4 claimed that extra money generated from prevention strategies *'allowed us to make a profit to compete with the big boys'*. Financial benefits were directly linked with efficiency benefits, with FC1 stating *'if it improves efficiency then it is linked to money'* and FC4 claiming '*people forget that being green is the most cost-conscious route, especially for efficiency'*.

However, the purpose of phase 2 was to explicate specific pollution prevention capabilities from interviewee discussions and participant observations. As shown in table 8.1 below, there was strong correspondence between literature results and phase 2 results in that 15 of the 21 conceptual capabilities were empirically validated. These capabilities are discussed throughout this section and a final, empirical definition of pollution prevention capabilities is presented in table 8.4.

Table 8.1 Phase 2 coding results of pollution prevention conceptual capabilities

Pollution Prevention Results				
	Conceptual Capability	**Presence in Data**	**Food Company**	**Sample Data**
Sensing Internal	Environmental, operational & financial measures	13 Interviews	1; 2; 3; 4; 6; 8; 10; 12; 13; 16; 18; 19	*'We measure all utilities with a big focus on electricity and gas'* (FC12)
	Continuous improvement & optimization of processes, machinery & technologies	7 Interviews	1; 3; 4; 10; 14; 18; 19	*'We are always looking for ways to optimise our operations, you know, reinventing parts of the business so we can reduce waste further. We seek out the best solution for our business and we constantly revisit that to make sure it is the best solution'* (FC18)
	Cross-functional integration & learning towards environmental objectives	8 Interviews	1; 2; 4; 5; 6; 14; 16; 19	*'Key people from engineering, environment, sustainability, health and safety get together and look at their metrics from the previous month and discuss where the water is, where the waste is and discuss projects they have underway to try and meet new targets'* (FC16)
	Technological know-how	0		
Sensing External	Entrepreneurial foresight & insight of environmental issues	5 Interviews	3; 4; 10; 11; 19	'*Because we know we're in a nitrate vulnerable zone we know we have to be really careful'* (FC3)
	Analysis of external environments, target markets & changing customer needs	13 Interviews	1; 4; 6; 8; 9; 10; 11; 12; 13; 16; 18; 19; 20	*'From looking outward I know we are in a good position when it comes to waste* [....] *in comparison to more traditional producers'* (FC19)
	Identification of environmental opportunities from externalities	0		
Seizing Internal	Interpretation of environmental issues as opportunities	0		
	Capacity to implement & manage new environmental processes	11 Interviews 1 Observation	1; 2; 4; 6; 8; 9; 12; 14; 16; 19; 20	*'For us it was important to have a system in place to support prevention. We've been installing all sorts of controls'* (FC16)
	Environmental management systems	8 Interviews	1; 2; 4; 6; 9; 10; 12; 19	*'ISO 26001 makes us measure and manage sustainability, giving us a strong grasp on waste in all its various definitions'* (FC9)
	Advanced prevention & safety measures	3 Interviews 1 Observation	1; 2; 10	*'We full maintenance records of every bit of kit* [….] *environmentalism and health and safety are closely linked'* (FC1)

Table 8.1 cont.

	Conceptual Capability	Presence in Data	Food Company	Sample Data
	Employee involvement, skills & expertise	15 Interviews 2 Observations	1; 2; 4; 5; 6; 8; 9; 10; 12; 14; 16; 17; 18; 19; 20	*'We want the right people and so we want to nurture experience over time and get the profession right'* (FC9)
	Entrepreneurial leadership	6 Interviews	1; 6; 9; 12; 14; 16	*'Some of the guys are given specific areas that they look after so they almost become the grower for that sector of the crop'* (FC1)
	Information & knowledge management	7 Interviews 4 Observations	1; 2; 4; 6; 12; 16; 19; 20	*'We do a lot of sessions from production managers explaining why environmental stuff needs to be done'* (FC19)
Seizing External	Evidencing reputation of environmentally sound company	9 Interviews	1; 2; 4; 6; 9; 10; 12; 17; 18	*Once people know you are determined and passionate and you know what is right* [....] *they start to listen* [….] *our internal sustainability programme is the external tangible evidence of our values'* (FC12)
Transforming Internal	Organisational commitment to the environment	9 Interviews	2; 5; 7; 10; 11; 12; 18; 19; 20	*'The environment is at the core of our business values, it has always been something that is really important to us* [….] *it's part of the ethos of our business'* (FC18)
	Organisational capacity to create new environmental processes & technologies	13 Interviews 1 Observation	1; 2; 4; 5; 8; 9; 10; 11; 12; 13; 16; 18; 19	*'We now have low water usage because we're in a closed-loop and we're reusing that water and creating value from it'* (FC18)
	Creation of environmental policy & criteria	7 Interviews	1; 2; 9; 10; 11; 16; 19	*'We have an internal charter, with our 'doing more for less', which is a resource efficiency programme that acts as a roadmap'* (FC16)
	Higher-order shared learning	0		
Transforming External	Political acumen surrounding environmental issues	0		
	Concern for external environments & resources	0		

8.1.1 Sensing Internal Capabilities

Environmental, Operational & Financial Measures

Environmental, operational & financial measures was the most prominent pollution prevention sensing internal capability, featuring in 13 interviews. Discussions of environmental measures surrounded the measurement of waste, recycling levels, carbon measurement and environmental impact assessments from an intra-organisational perspective. Demonstrating

links with pollution prevention, FC16 claimed that incorporating such environmental measures into their *'measuring and management programme'* allowed them to identify areas in which opportunities exist to prevent waste. Discussions of operational measurement surrounded the measurement of throughputs such as fuel, fertilizer, power and water. More specifically, FC12 claimed their water measurements allowed them to identify opportunities to '*reduce water*' used in internal operations and '*avoid the amount of run-off*'. Discussions of financial measures surrounded the measurement of feed-in tariffs, utilities and charges. This again had a clear prevention focus, with FC6 stating *'if your electricity bill is rising year on year, you think surely there must be something you can do, or at least you have to try*', and FC16 claiming that their £60million a year energy bill encouraged them to *'make sure that* [they] *don't waste energy'*. Notably, interviewees often linked environmental, operational and financial measures together, with FC1 claiming they '*measure pulses of energy throughout the factory to find ways to cut money*', ultimately preventing waste and pollution.

This corresponds with Shi et al's (2012) conceptual natural-resource-based green supply chain management model, in which environmental, operational and financial measures are prioritised as key components of pollution prevention, based on the argument that markets and companies must be measurable if environmental opportunities are to be identified. Thus, environmental, operational and financial measures are confirmed as a pollution prevention sensing capability, and in order to promote specificity, renamed **'undertaking environmental, operational and financial measures to identify areas for improvement'**.

Cross-functional Integration and Learning towards Environmental Objectives

Whilst learning did not feature in interviews, cross-functional integration was identified in 8 interviews. Demonstrating a cross-functional approach to identifying pollution prevention opportunities, FC16 claimed '*key people from engineering, environment, sustainability, health and safety get together and look at their metrics from the previous month and discuss where the water is, where the waste is and discuss projects they have underway to try and meet new targets'*. Similarly, FC5 argued that the identification of areas where waste and pollution occur is *'the responsibility of everyone in the company'*, whilst FC19 claimed their pollution ideas came *'from a team angle rather than from individuals'*.

Taking into consideration the absence of learning in interviews along with dynamic capabilities sensing underpinnings, the capability 'cross-functional integration and learning towards environmental objectives' is renamed **'cross-functional integration in support of**

the identification of issues and opportunities'. Reinforcing this is links between pollution prevention and cross-functional integration that date back to seminal natural-resource-based view studies, in which Russo & Fouts (1997) argue that all employees have a role to play in pollution prevention, and implications for internal cooperation in pollution prevention and sustainable supply chain management synergies (Ferenhof et al, 2012; Dues et al, 2013).

Continuous Improvement and Optimization of Processes, Machinery & Technologies

Continuous improvement and optimization of processes, systems and technologies featured in 7 interviews, albeit without specific reference to technology. That is implications for continuous improvement were easily identifiable in statements such as *'we are looking to improve on* [waste] *all the time'* (FC19), whilst implications for optimization were identifiable in statements such as *'we are always looking for ways to optimise our operations* [and] *reinventing parts of the business so we can reduce waste further'* (FC18). A focus on processes and machinery was also notable, with FC19 claiming *'we are always looking within the factory for new techniques for washing, cutting and packing that are innovative'*, and FC14 discussing replacing old freezers with new ones, claiming *'we'll gain environmentally from that just because they work better and they are more efficient'*.

Notably, Hart & Dowell (2011) argue that continuous improvement exists as the key strategic resource of pollution prevention, and this is reinforced in theoretical extensions and developments (Aragon-Correa & Sharma, 2003; Menguc & Ozanne, 2005). Shi et al 's (2012) natural-resource-based green supply chain model also prioritises process optimization as a key pollution prevention capability, and optimization features with some prominence in pollution prevention and sustainable supply chain management synergies (Abbasi & Nilsson, 2012; Ashby et al, 2012; Svensson & Wagner, 2012). Taking this into consideration alongside the negligence of technology in phase 2 results and dynamic capabilities sensing underpinnings, the capability 'continuous improvement and optimization of processes, machinery and technology' is renamed **'continuous improvement and optimization of processes and machinery to seek environmental improvements'**. Notably, the need to seek such environmental improvements can perhaps be linked to the sector's high levels of food, packaging and process waste as discussed in the industry review (Mintel, 20121; 2013a; Vision 2020, 2013; DEFRA, 2015) and the incentives for UK agri-food companies to reduce this (Vision 2020, 2013; Visit Scotland, 2014).

8.1.2 Sensing External Capabilities

Analysis of External Markets, Target Markets & Changing Customer Needs

Analysis of external markets, target markets and changing customer needs was the most prominent sensing external capability, featuring in 13 interviews. With regards to the analysis of external markets, an emphasis fell upon NGOs and governing bodies, with specific references made to the Scottish Environmental Protection Agency, the Department of Food and Rural Affairs, the Waste and Resources Action Programme, Linking Environment & Farming and Resource Efficient Scotland. Interviewees claimed that membership of or affiliation with such organisations enhanced understanding and highlighted environmental issues, thus driving pollution prevention. More specifically, both FC4 and FC18 claimed such memberships or affiliations served as an environmental guide, whilst FC8 claimed *'they help us keep our carbon footprint tidy'*. With regards to the analysis of target markets and customer needs, the focus fell upon major supermarkets, who in the most part were considered interviewees' key customers. Supermarket auditing and accreditation schemes were also presented as a means by which to highlight opportunities for pollution prevention and to *'meet certain standards with ethical, sustainable and environmental issues'* (FC19). Reinforcing this, FC9 claimed that such supermarket communications helped them *'to get a good picture of potato waste'*, whilst FC16 claimed to look to the supermarket to identify packaging opportunities and prevent plastic and cardboard waste. Alongside discussions of NGOs, governing bodies and supermarkets, interviewees also appeared to consult external markets via analysis of competitors. That is, FC12, FC13 and FC19 discussed benchmarking of waste and pollution levels, with FC12 stating *'from an external perspective we are actively benchmarking ourselves in terms of water'*.

The need to look out-with the firm for pollution prevention opportunities is picked up on in Aragon-Correa & Sharma's (2003) contingent proactive environmental strategy, in which the identification of environmental issues and their interpretation as opportunities is presented as a key pollution prevention capability. This is reinforced in Menguc & Ozanne's (2005) natural environment orientation, in which the need for firms to be aware of and take into consideration environmental policy and regulations in pollution prevention is stressed. Using interviewee descriptions, the conceptual capability 'analysis of external environments, target markets and changing needs' is modified and divided into three separate capabilities: **'affiliations with external organisations to enhance environmental understanding and guide prevention'**; '**analysis of and striving to meet customer's environmental needs and standards'**; and **'competitor comparison and benchmarking of waste and pollution'**.

Entrepreneurial Insight & Foresight of Environmental Issues

Entrepreneurial insight and foresight of environmental issues featured in 5 interviews, and largely involved the consideration of past issues such as pest or disease out-breaks and environmental forewarnings such as climatic changes. According to both FC3 and FC10, such issues were incorporated into breeding programmes to produce crops resistant to diseases, pests and severe weather, ultimately preventing waste from unviable or damaged crop. Outside of breeding programmes, FC19 claimed to monitor weather predictions to *'adapt and make the best use of the resource'*, making specific reference to incorporating rainwater into internal processes during periods of heavy rain. Atmospheric vulnerabilities also warranted discussion, with FC3, FC4 and FC11 all adapting operations to prevent emissions and pollutants in nitrate vulnerable zones.

The capability 'entrepreneurial insight and foresight' was principally derived from the emergence of entrepreneurial leadership, foresight and insight (Shang et al, 2008) in pollution prevention and innovation synergies. The need to proactively incorporate environmental foresight and insight into planning is also implied in seminal natural-resource-based view studies (Russo & Fouts, 1997) and theoretical extensions and developments (Aragon-Correa & Sharma, 2003; Shi et al, 2012). Thus, whilst it only featured in 5 interviews, the capability 'entrepreneurial insight & foresight of environmental issues' is still confirmed as an external pollution prevention sensing capability.

8.1.3 Seizing Internal Capabilities

Employee Involvement & Skills

Of all pollution prevention capabilities, employee involvement and skills was the most prominent, featuring in 15 interviews and 2 observations. With regards to employee involvement, FC19 stated *'everyone is on board with* [prevention], *that is one of the company objectives, to make sure that all staff are involved'*, whilst FC4 stated *'all staff are expected to be part of our continuous improvement'* and claimed to offer employee reward for successful prevention behaviours. This was commonly linked with employees' understanding that *'waste costs money'* (FC12) and having staff *'trained up*' to ensure they are *'being as sustainable as possible'* (FC16). With regards to employee skills, an emphasis fell upon formal skills and qualifications, with FC9 claiming to promote qualifications to employees and stressing the need to *'nurture experience over time and get the profession right'*. This was linked with recruitment, with FC16 discussing recruiting *'ten university graduates a year who come in*

and look at different projects' and crediting them with directing some of the companies most successful prevention initiatives. Outside of qualifications, interviewees spoke of the recruitment of '*like-minded people'* (FC17) and claimed to *'actively seek people who are passionate and who have ideas that work alongside the business'* and its desire to prevent pollution and waste. Notably, such discursive descriptions were reinforced by observations, in that during tour of FC1's site internal communications surrounding waste and pollution were highlighted and linked with encouraging high involvement in pollution prevention, whilst tour of FC6's site included observation of staff noticeboards in which employee qualifications and achievements were displayed to promote skills and encourage employees to seek out new qualifications.

Interestingly, whilst employee involvement and skills emerge as the most prominent pollution prevention capability in empirical results, it only warranted minor implication in existing literature (Russo & Fouts, 1997; Ferenhof et al, 2012; Walker 2014). Moreover, neither recruitment, environmental reward or training emerged at all as conceptual pollution prevention capabilities. Nonetheless, detailed descriptions and observations in phase 2 encourage the capability 'employee involvement and skills' to be replaced and divided into two more specific capabilities: **'encouraging employee involvement in prevention via training and reward'**; and the **'recruitment and nurturing of employees skilled in environmental practices'**.

The Capacity to Implement & Manage New Environmental Processes

The capacity to implement and manage new environmental processes featured in 11 interviews and 1 observation. Interviewees spoke at length of the need to have '*a system in place to support prevention'* (FC16), or internal systems to '*make sure the resources are here to enable* [prevention] *to maintain itself*' (FC19). This commonly manifested in the discussion of KPIs which interviewees claimed helped to create a *'clear internal procedure'* (FC12) or technology which interviewees suggested allowed pollution prevention to be '*computer controlled*' (FC19). Emerging with significance was lean and six-sigma, with FC8 claiming lean allows you to *'manage your operations efficiently'* and FC9 stating *'we also use things like lean, management information systems and six-sigma'* to manage pollution prevention. Evidencing the value of lean in pollution prevention, FC1 state *'80% of my savings are through lean manufacturing and improvement'*, and during observation of their site made repeated references to the role of lean and six-sigma in supporting pollution prevention systems and technologies. More specifically, during tour of FC1's factory floor, an area described as *'one*

of the areas of greatest environmental impact', it was claimed that both lean and six-sigma were used to prevent and measure *'air leaks and pressure leaks'*.

The capacity to implement and manage new environmental processes in pollution prevention was derived from both seminal natural-resource-based view studies (Russo & Fouts, 1997) and theoretical extensions and developments (Shi et al, 2012). Reliance on KPIs was also implicated in natural-resource-based view extensions and developments (Menguc & Ozanne, 2005; Shi et al, 2012) and reliance on technology throughout pollution prevention and innovation synergies (Utterback & Abernathy, 1975; Smith, 1994; Sharma & Vredenburg, 1998; Jayaram et al, 2014; Walker, 2014). The need for technologies in pollution prevention was further enforced by the earlier industry review, in which technologies that identify problem areas before they develop and manage the application of farming and manufacturing aids only where necessary were discussed (DEFRA, 2010). The focus on lean and six-sigma in empirical results also demonstrates some correspondence with existing literature, in that references to lean are notable in pollution prevention and sustainable supply chain management synergies, based on the argument that lean helps to deliver time, cost and environmental benefits in line with pollution prevention (Galeazzo et al, 2013; Hajmohammad et al, 2013). References to six-sigma perhaps emerge as a modernisation of existing literature's links between pollution prevention and total quality management (Hart, 1995; Shi et al, 2012). Taking all this into consideration, the capability 'the capacity to implement and manage new environmental processes' is divided into two separate capabilities: **'internal systems such as lean and six-sigma to guide and support new prevention processes'**; and **'implementation of prevention technologies and KPIs'**.

Environmental Management Systems

Environmental management systems featured in 8 interviews, most commonly surrounding discussions of ISO systems, with specific references made to ISO 14001, ISO 18001 and ISO 26000. More specifically, ISO 14001 is described as *'an effective management system'* (FC4) and '*a big driver for decision making'* (FC2) in pollution prevention, whilst FC9 claimed ISO 2600 allowed them to '*measure and manage sustainability, giving us a strong grasp on waste in all its various definitions*'.

Links between pollution prevention and environmental management systems go back as far as initial conceptualisation of the resource in which pollution prevention drew inspiration from total quality management (Hart, 1995). Such links are reinforced in theoretical extensions and

developments (Aragon-Correa & Sharma, 2003; Shi et al, 2012) and pollution prevention and sustainable supply chain management synergies (Seuring & Müller, 2008; Hajmohammad et al, 2012). Interestingly, the specific focus on ISO systems in pollution prevention is also identifiable in literature, with Shi et al (2012) making specific reference to ISO 14001, and further enforced by phase 1 interview results. Accordingly, the capability 'environmental management systems' is revised to **'the use of environmental or ISO management systems to measure, manage and guide prevention'**.

Information & Knowledge Management

Information and knowledge management featured in 7 interviews and 4 observations. Mostly this was evidenced via discussion of information and knowledge sharing surrounding pollution prevention targets, behaviours and results. For example, interviewees spoke of training *'sessions from production managers explaining why* [prevention] *needs to be done'* (FC19), *'touring all sites just to confirm the new sustainability model and reiterate it'* (FC12) and '*sustainability conferences within the organisation whereby people present their sustainability stories and achievements and introduce new ways of doing things'* (FC16). Repeated references were made to internal documentation, databases and signage, including *'company-wide newsletters with company-wide sustainability programmes'* (FC16), the creation of an environmental '*database of information so that other people can log on and use it'* (FC16), and having *'documentation all around the place explaining* [prevention] *and why it is important and driving it'* (FC19). Reinforcing this, signage and documentation in support of pollution prevention was observable in 4 of the 6 observations, including signage in staff cafeteria stressing the importance of recycling and stating current recycling levels, details of environmental meetings and documentation of IS0 14001 on staff notice boards and signage to guide staff to prevent waste and pollution by turning off all equipment and lighting when not in use.

Notably, whilst the capability information and knowledge management came from pollution prevention and innovation synergies (Shang et al, 2008), implications for internal communications and information and knowledge sharing are notable in pollution prevention and sustainable supply chain management synergies (e.g. Ferenhof et al, 2012; Hajmohammad et al, 2012; Shi et al, 2012; Galeazzo et al, 2013). This along with phase 2 interview discussions encourage the modification of the capability 'information and knowledge management' to **'information and knowledge sharing of pollution prevention targets, behaviours and results via company-wide communications'**.

Entrepreneurial Leadership

Entrepreneurial leadership featured, to some extent, in 6 interviews. That is, there were elements of entrepreneurial leadership that were somewhat indivisible from employee involvement, but internal leadership in an environmental context is worthy of division. Encouraging an internal leadership approach, FC1 claimed that employees are *'given specific areas that they look after so they almost become the grower for that sector of the crop'*, and stressed the value of having a member of staff in each department to *'focus specifically on the environment'*. Demonstrating this with some strength, FC6's interviewee presented themselves as an entrepreneurial leader, stating '*it is my job personally to look at the bigger picture*' and get pollution prevention strategies '*pushed through'*.

References to entrepreneurial leadership featured in both natural-resource-based view theoretical extensions and developments (Menguc & Ozanne, 2005; Shi et al, 2012) and pollution prevention and innovation synergies (Shang et al, 2008). However, to incorporate phase 2 descriptions and division from employee involvement, the capability 'entrepreneurial leadership' is replaced with **'internal environmental leadership'**.

Advanced Prevention & Safety Measures

Advanced prevention and safety measures featured in just 3 interviews and 1 observation, but was directly linked with pollution prevention. For example, FC2 stressed the need for '*anything with a malfunction being fixed or replaced straight away'* to prevent damaged products and therefore waste, whilst FC1 stressed the need to have *'full maintenance records of every bit of kit'* because *'environmentalism and health and safety are closely linked'* in terms of preventing spillage or damage. This was reinforced during tour of FC1's site, in which faulty machines that leaked oil were pointed out and described as *'a risk to the water treatment system* [that] *took cost and times to deal with as well as heavily contributing to environmental impact'* and the need for *'more efficient* [machinery] *in terms of environmental impact and time'* was stressed.

Advanced prevention and safety measures is presented as a pollution prevention capability in Shi et al's (2012) conceptual natural-resource-based green supply chain model, and perhaps relates back to the initial conceptualisation of the resource (Hart, 1995) in which improved house-keeping is presented as a fundamental pollution prevention activity. The industry review also rendered implications for enhanced maintenance systems to avoid spillages and error

(DEFRA, 2016), whilst phase 1 interviews corroborated prevention and safety measures as a pollution prevention intra-organisational environmental practice. This corresponds with phase 2 interviewees' descriptions of the need to maintain and manage systems and processes to prevent waste associated with damage and spillages. Thus, whilst it only features in 3 interviews and 1 observation, the capability 'advanced prevention and safety measures' is empirically validated as a pollution prevention seizing capability and to maximise clarity, is renamed **'maintenance and safety measures that prevent waste and pollution'**.

8.1.4 Seizing External Capabilities

Evidencing a Reputation of an Environmentally Sound Company

As the only external pollution prevention seizing capability, evidencing a reputation of an environmentally sound company featured in 9 interviews. In large part this manifested in discussion of the external reporting of prevention activities and results, with FC18 claiming to *'constantly communicate* [prevention] *to our customers and to the outside world* [because] '*we want everyone, including our competitors to know that we use 100% renewable energy, that we use a waste disposal company that doesn't send any waste to landfill, that all our packaging is responsible'*. Reinforcing this, FC12 also argued that *'once people know you are determined and passionate and you know what is right* [....] *they start to listen'*, claiming *'our internal sustainability programme is the external tangible evidence of our values'*. Environmental accreditations also emerged with significance, with FC6 claiming to be *'assured by umpteen different bodies'* to externally validate their commitment to the environment and pollution prevention.

This corresponds with Hart's (1995) argument that over time pollution prevention moves from an internally focused resource to an externally focused, legitimacy-based process. Similarities can also be noted with Russo & Fouts (1997) prioritisation of the need to build a good reputation in pollution prevention. Moreover, external reporting of pollution prevention features prominently in theoretical extensions and developments, with Menguc & Ozanne's (2003) natural environment orientation linking pollution prevention and corporate social responsibility, and Shi et al's (2012) natural-resource-based green supply chain model stressing the need to report measurable pollution prevention results. Taking all this into consideration, the capability 'evidencing a reputation of an environmentally sound company' is divided into 2 separate capabilities: **'attaining environmental accreditations to support and demonstrate prevention'**; and **'external reporting of prevention plans and results'**.

8.1.5 Transforming Internal Capabilities

Organisational Capacity to Create New Environmental Processes & Technologies

The creation of new environmental processes and technologies was the most dominant transforming pollution prevention capability, featuring in 13 interviews and 1 observation. Interviewees spoke at length of processes and technologies created to support pollution prevention. This included, purpose built water treatment facilities that prevent excess use or disposal of water (FC2), rain water harvesting systems that '*manage water in a sustainable way* [….] *before it flows off and is lost'* (FC13), and wood chip heating systems that use waste wood to reduce '*dependency on grid supply energy'* and '*improve energy use'* (FC7). This commonly assumed an internal closed-loop approach, with FC18 claiming to have *'low water usage because we're in a closed-loop and we're reusing that water and creating value from it'* and FC16 claiming to install internal technologies and systems because they *'are very interested in reducing waste and the circular economy'*. Similarly, discussions of the use of cow slurry as fertiliser, unviable crop as landspread and food waste as compost for an on-site garden demonstrated internal closed-loop approaches in support of pollution prevention. An internal closed-loop system was also observed during tour of FC1's site, in which a new machine that washed potatoes using waste water from a sprayer that operated only when needed was pointed out. Once the potatoes had been sprayed the water was collected, cleaned and fed through the system again, saving over £100,000 a year in water and effluent charges. According to interviewees, such closed-loop systems are all *'about capturing the damaging effects on the environment* [....] *and making decisions taking that into consideration'* (FC10). Interviewees also suggested that such internal processes and technologies allowed them to cut out waste and pollution altogether, with FC6 stating '*we don't generally use the word waste here because being on a farm nothing is wasted and there is a use for everything'* and FC18 explaining *'in some situations the output of one process might be normally considered waste but if you can use it in another process you stop it from being waste'*.

The need for new environmental processes and technologies in pollution prevention featured in seminal natural-resource-based view studies (Russo & Fouts, 1997) and pollution prevention and innovation synergies (Utterback & Abernathy, 1975; Smith, 1994; Sharma & Vredenburg, 1998; Jayaram et al, 2014; Walker, 2014). However, whilst a closed-loop system is linked with product stewardship in existing literature (Miemczyk et al, 2016) and clean technologies in this study, it has not until this point been linked with pollution prevention. However, as phase 2 results demonstrate, an internal closed-loop approach does correspond with pollution prevention's focus on recyclability and process innovation (Hart, 1995).

Reinforcing this is the earlier industry review, in which the treatment and reuse of waste, particularly water waste (DEFRA, 2010; The Environmental Agency, 2013), was presented an effective and beneficial prevention strategy (DEFRA, 2012a). Based on this, the capability 'organisational capacity to create new environmental processes & technologies' is amended to the **'creation of new internal closed-loop processes and technologies in support of prevention'**.

Organisational Commitment to the Environment

Organisational commitment to the environment featured in 9 interviews, identified in statements such as '*we really, really care about the soil we are working with and the burns and rivers that flow through the land'* (FC2) and '*we are very passionate about coastal ecologies'* (FC5). Interviewees implied that such a commitment must be incorporated into every aspect of the business. For example, FC18 claimed a commitment to the environment is *'at the core of our business values, it has always been something that is really important to us'*, describing it as *'part of the ethos of our business'*. Demonstrating its role as a pollution prevention transforming capability, FC7 claimed organisational commitment to the environment is '*about direction, it's our decision to do these things because we know what direction we want to go* [....] *we have a shared philosophy if you like*', whilst FC12 claimed it helps them to be '*strong and committed in strategy and vision, that drives change'*.

Thus, the capability 'organisational commitment to the environment' is confirmed as a pollution prevention capability. Supporting this is its presence in seminal natural-resource-based view studies (Hart, 1995; Russo & Fouts, 1997; Hart & Dowell, 2011) and reinforcement in theoretical extensions and developments (Aragon-Correa & Sharma, 2003; Shi et al, 2012) which stress the need to assume a proactive approach to the environment. However, phase 2 interviewee discussions of vision and ethos also facilitate the emergence of **'environmentally-driven organisational culture'** as a pollution prevention transforming capability.

Creation of Environmental Policy & Criteria

The creation of environmental policy and criteria featured in 7 interviews, albeit with some discrepancies in that more commonly interviewees referred to the creation of environmental programmes. For example, FC2 referred to a company programme inclusive of goals such as 15% waste reduction and realisation of zero landfill in a five-year period, FC9 claimed their environmental programme drives internal waste prevention, and FC16 discussed an internal

programme called '*doing more for less'* which they claimed acted as a *'roadmap'* for prevention. Purpose built environmental management systems also emerge with significance here, with FC1 discussing a purpose designed *'building management system that monitors half hourly data for the full site*', and FC12 discussing their own greenhouse measurement plan intended to monitor and prevent energy losses. According to FC12, such purpose built environmental management systems *'put in place clear policies in terms of what we do'*, demonstrating their value as a pollution prevention transforming capability.

The need to create organisational policy and criteria in support of pollution prevention is implied in Shi et al's (2012) natural-resource-based green supply chain management model, which stresses the importance of internal environmental policy. In addition, purpose designed environmental management systems can be linked with or presented as an advancement of the prominence of environmental management systems in pollution prevention literature (Hart, 1995; Aragon-Correa & Sharma, 2003; Seuring & Müller, 2008; Hajmohammad et al, 2012). Thus, the 'creation of environmental policy and criteria' is replaced with **'purpose built environmental programmes and management systems'**.

8.1.6 Emergent Capabilities

The industry review and phase 1 of the empirical study resulted in the identification of 6 emergent pollution prevention capabilities. As detailed in table 8.2 below, 5 of those capabilities were validated by phase 2 results and are discussed throughout this section.

Table 8.2 Phase 2 coding results of pollution prevention emergent capabilities

Emergent Capability	Presence in Data	Food Company	Sample Data
Internal Waste Segregation	7 Interviews 1 Observation	1; 4; 8; 12; 13; 16; 20	*'We have systems in place to make sure every member of staff knows how to recycle and segregate waste'* (FC4)
Demand Forecasting	7 Interviews	1; 2; 4; 9; 10; 15; 17	*'We don't order anything in until it is needed, we know it is needed because we are in communication with our customer and work closely with suppliers so that everything can happen really fast'* (FC15)
Zero Waste Philosophy	11 Interviews	1; 2; 4; 8; 11; 12; 13; 16; 17; 18; 20	*We have zero-waste, which for us and for the environment is one of the most important things with keeping waste down and definitely one of the top ten topics in our five-year environmental plan*' (FC4)
Farming & Land Qualifications	0		
Family Management Principles	5 Interviews	6; 7; 12; 13; 15	*'Wanting to make a difference comes party from being a family business'* (FC15)
Financial Capacity to invest in new practices	5 Interviews	2; 3; 4; 6; 16	*'Sustainability in a big way comes down to profitability, if you're not profitable you basically can't be sustainable because you can't carry out all these environmentally sustainable goals* [because] *you need to be able to invest money in them'* (FC6)

A Zero-Waste Philosophy

A zero-waste philosophy was the most prominent emergent capability, featuring in 11 interviews. In the most part, zero-waste acted as a target or driver in pollution prevention, with FC4 stating '*we have zero-waste, which for us and for the environment is one of the most important* [ways of] *keeping waste down and definitely one of the top ten topics in our five-year environmental plan*'. Similarly, FC1 claimed zero-waste *'made us want to recycle more, made us more green and meant we were cutting down on our waste'*, whilst FC8 claimed their being *'the first-zero waste food manufacturer in the world*' encouraged them to continue to reduce waste in innovative ways.

Zero-waste initially emerged as a pollution prevention capability in phase 1 interviews, in which interviewees claimed that zero-waste drove the prevention of waste and delivered cost and efficiency benefits for the firm. However, references to zero-waste can also be identified in the industry review, in which Visit Scotland (2014) suggest that initiatives such as zero-waste supported prevention focused strategies. Notably, despite its prominence, zero-waste does not emerge as its own capability. Rather, as it is considered an official accreditation, such

discussions offer further support for the earlier discussed external seizing capability of 'achieving external environmental accreditations'.

Internal Waste Segregation

Internal waste segregation featured in 7 interviews and 1 observation. For example, FC12 claimed to *'segregate at site level'* and FC16 stated *'when we looked at waste a lot of that was looking at all our processes and identifying waste, segregating the waste, weighing it, looking at contamination classifications, going through all the materials and working out what we could recycle'*. This was reinforced during observation of FC1's site, in which colour-coded bins intended for different types of waste on each production line and storage areas designated to segregated plastics, papers and cardboards were pointed out. Evidencing the value of this in pollution prevention, FC13 claimed segregation allowed waste to be *'bailed on farm and then sent for recycling'* where it makes a profit, whilst FC8 claimed to '*make thousands'* each year from selling on segregated waste.

Internal waste segregation initially emerged as a pollution prevention capability in the industry review, where, in line with phase 2 results, Vision 2020 (2013) suggested it helps companies to avoid landfills and prevent pollution by promoting advanced recyclability. This corresponds with the emphasis on recyclability in Hart's (1995) conceptualisation of pollution prevention. However, despite this, internal waste segregation is not considered a capability. Rather, it emerges as more of an operation, and is therefore merged with the earlier seizing capability 'implementation of prevention technologies, processes and KPIs' to create **'implementation of prevention and recycling technologies, processes and KPIs'**.

Demand Forecasting

Demand forecasting featured in 7 interviews, in which interviewees claimed to place orders on a *'last minute on a day to day basis'* (FC1) and claimed *'we don't order anything in until it is needed, we know it is needed because we are in communication with our customer and work closely with suppliers so that everything can happen really fast'* (FC15). Interviewees argued that such an approach resulted in *'very little unsold'* (FC4) which consequently prevented '*a huge amount of surplus that ends up getting tipped into a hole in the ground* [and] *reduces produce waste massively'* (FC2). Stressing the value of this, FC17 suggested that demand forecasting facilitated a lack of waste and claimed *'that lack of waste means there is very little error so I'm not wasting money'*.

Demand forecasting initially emerged as a pollution prevention capability in the industry review, in which WRAP (2016) presented it as a means by which to prevent the initial occurrence of waste. However, this is somewhat correspondent with earlier discussions of just-in-time (Sarkis et al, 2011; Galeazzo et al, 2013) and lean (Hajmohammad et al, 2012; Galeazzo et al, 2013; Shi et al, 2012) in pollution prevention and sustainable supply chain management synergies. Thus, **'demand forecasting to avoid waste'** emerges as a pollution prevention seizing capability and taking into consideration dependencies placed upon communication with customers and suppliers is categorized as an external capability.

Family Management Principles

Family management principles featured in 5 interviews. For example, FC15 claimed their desire to act environmentally *'comes partly from being a family business'*, whilst FC12 claimed their family ownership *'really influences the processes in terms of how we approach the day to day business'* from an environmental perspective. In the most part, this was linked with a desire to protect the environment for the next generation, with FC13 stating *'why would you not want to sustain your soil if as a farmer, you're probably going to be there for generations and probably you already have been there for generations'*.

Family management principles as a pollution prevention capability was derived from phase 1 interviews, in which in line with phase 2 results, interviewees suggested family ownership instilled a long-term view and greater concern for the environment. Taking phase 2 descriptions into consideration, the **'protection and creation of a sustainable family legacy'** is confirmed as a pollution prevention capability, and references to a long-term perspective encourage its categorization as a transforming internal capability.

Financial Capacity to Invest in New Practices

The financial capacity to invest in new practices also featured in 5 interviews, in which the need for financial investment in pollution prevention was clearly pronounced. That is, FC6 argued *'sustainability in a big way comes down to profitability, if you're not profitable you basically can't be sustainable because you can't carry out all these environmentally sustainable goals* [because] *you need to be able to invest money in them'*. In addition, interviewees spoke at length of the need for government funding and grants that support pollution prevention.

Financial capacity to invest in environmental practices was also derived from phase 1 interviews, where it was argued that pollution prevention required financial investment. Thus, **'sourcing funding for new environmental processes and technologies'** emerges as a pollution prevention capability, whilst references to external sources of funding and sustainable goals encourage its categorization as a transforming external capability.

8.1.7 Newly Emergent Capabilities

As with the results of the industry review and phase 1 of the empirical study, new capabilities emerged from phase 2 interviews. These are detailed in table 8.3 below, and are discussed throughout this section.

Table 8.3 Phase 2 coding results of pollution prevention newly emergent capabilities

Emergent Capability	Presence in Data	Food Company	Sample Data
Personal Motivations	5 Interviews	1; 2; 5; 17; 18	*'In my personal life I am an environmental person* [….] *it would be difficult to separate that from the business'* (FC1)
External Partnerships	10 Interviews	3; 4; 6; 7; 11; 12; 13; 18; 19; 20	*'We partnered with them simply because it is more expensive to get rid of non-recyclable waste which of course acts as a driver to recycle as much as you can'* (FC7)

External Partnerships

External partnerships featured in 10 interviews, with partnerships with recycling partners emerging with particular significance. That is, FC3 claimed their partnership with an external recycler supported their prevention of waste, avoided landfills and created value via the redistribution of waste. Similarly, FC6 praised the use of an '*on-farm recycling facility nearby'* that helped them prevent waste going to landfill, whilst both FC12 and FC20 linked their partnership with an external recycler with zero-waste. FC7 claimed their account with a recycling partner is motivated by the fact that '*it is more expensive to get rid of non-recyclable waste which of course acts as a driver to recycle as much as you can'*. This is again correspondent with Hart's (1995) emphasis on recyclability in initial conceptualisation of pollution prevention. Thus, the capability **'partnerships to support recycling and prevention'** emerges as an external pollution prevention seizing capability.

Personal Motivations

Personal motivations featured in 5 interviews, in that interviewees suggested that they assumed personal interests in preventing waste and pollution. For example, FC1 claimed '*in my*

personal life I am an environmental person' and linked this with the creation of prevention objectives, whilst FC18 stated *'I think in my personal life I try to be quite sustainable'*, adding *'my business partner and I are fairly environmental people in the sense that that was one of the main drivers in setting up the business'*. Similarly. FC6 claimed that their *'passion' and experience in marine ecology encourage* [them] *to want to protect coastal ecologies'*, whilst FC2 discussed a personal desire *'to recycle everything'* that encouraged them to seek out prevention opportunities. Thus, the capability **'personal motivations in seeking out prevention opportunities'** emerges as an internal pollution prevention sensing capability

Table 8.4 Empirical definition of dynamic pollution prevention capabilities

Pollution Prevention Capabilities		
	Internal	**External**
Sensing	➢ **Undertaking environmental, operational & financial measures to highlight identify areas for improvement** ➢ **Cross-functional integration in support of identification of issues & opportunities** ➢ **Continuous improvement & optimization of processes & machinery to seek environmental improvements** ➢ *Personal motivations in seeking out prevention opportunities*	➢ **Affiliations with external organisations to enhance environmental understanding & guide prevention** ➢ **Analysis of and striving to meet customer's environmental needs and standards** ➢ **Competitor comparison & benchmarking of waste & pollution** ➢ Environmental insight and foresight of potential issues
Seizing	➢ **Encouraging employee involvement in prevention via training & reward** ➢ **The recruitment and nurturing of employees skilled in environmental behaviour** ➢ **Internal systems such as lean & six-sigma to guide and support new prevention processes** ➢ **Implementation of prevention & recycling technologies, processes & KPIs** ➢ **The use of environmental or ISO management systems to measure, manage & guide prevention** ➢ **Information and knowledge sharing of pollution prevention targets, behaviours and results via company-wide communications** ➢ **Internal environmental leadership** ➢ **Maintenance & safety measures that prevent waste & pollution**	➢ **Attaining environmental accreditations that support & demonstrate prevention** ➢ **External reporting of prevention plans & results** ➢ *Demand forecasting to avoid waste* ➢ *Partnerships to support recycling & prevention*
Transforming	➢ **The creation of new internal closed-loop prevention processes & technologies** ➢ Organisational commitment to the environment ➢ **Environmentally-driven organisational culture** ➢ **Purpose built environmental programmes & management systems** ➢ *Protection & creation of a sustainable family legacy*	➢ *Sourcing funding for new environmental processes & technologies*

Capabilities shown in bold are renamed; capabilities in italics are emergent capabilities

8.2 Product Stewardship Results

In some contrast to the dominance of pollution prevention demonstrated throughout this thesis, product stewardship emerged as the dominant resource in interviews, having been discussed at length in all 20 interviews. That is, whilst the term 'product stewardship' did not feature, the resource was clearly identifiable in lengthy discussions of the prioritisation of the natural environment throughout the entire product lifecycle. In line with Hart's (1995) conceptualisation of product stewardship, such discussions surrounded conservation, the avoidance of harmful substances and recyclability from a lifecycle perspective. For example, FC16 stressed the need for *'a holistic approach to resource management and the whole issue of water as a resource and its management from cradle-to-grave'*, adding '*if the resource is in short supply in the area you are abstracting you have to have regards for that'*. Again, this placed a reliance on the supply chain, with FC6 claiming product stewardship '*can't be done in isolation on our farm'*, and FC7 arguing that all supply chain members must '*do their best to make sure farms remain sustainable in the long term, economically and from the point of view of conservation'*. With regards to competitive merits, the focus fell upon company benefits such as *'quality, cost and efficiency'* (FC12) and differentiation via the creation of the *'dream product for sustainability'* (FC5) rather than access to scarce resources as Hart intended. Moreover, FC3 argued that their *'whole supply chain'* approach acts both as a stimulant for sustainability and as a core competitive capability, whilst FC10 claimed product stewardship is *'to do with sustainable business as well as being good for the planet'*.

However, again the purpose of phase 2 interviews was to explicate product stewardship capabilities. As demonstrated in table 8.5 below, 17 of the 29 product stewardship conceptual capabilities were verified by phase 2 results, and are discussed throughout this section.

Table 8.5 Phase 2 coding results of product stewardship conceptual capabilities

Product Stewardship Results				
	Conceptual Capability	**Presence in Data**	**Food Company**	**Sample Data**
Sensing Internal	Lifecycle measurements & analysis of products and processes	11 Interviews	1; 2; 4; 5; 7; 8; 9; 10; 12; 16; 17	*'We look at everything from where the seed was produced to being grown and fed and raised'* (FC2)
	Employee awareness of supply chain issues	0		
	Incentive systems for environmental ideas	0		
Sensing External	Supply chain measurements & analysis	0		
	Bringing together suppliers in the same industry to share problems & know-how	11 Interviews	1; 2; 4; 5; 7; 8; 9; 12; 14; 17; 18	*'The whole point of the supplier seminars is to go over different aspects* with *quality, cost and efficiency, sustainability* [….]*'we see companies as well, along with farmers, it's a sort of cooperative'* (FC12)
	Stakeholder integration to select new technologies & direct joint innovation	6 Interviews	1; 7; 10; 12; 19; 20	*'We've come up with new environmental things from sharing ideas, working together'* (FC7)
	Seeking the creation of sustainable products, processes & packaging	0		
	Seeking out professional memberships	11 Interviews	2; 4; 3; 6; 9; 12; 13; 14 ;15; 16; 17	*'The good thing with all those accreditations is they do give you a holistic assessment of what's happening environmentally'* (FC16)
Seizing Internal	Corporate environmental responsibility assessments	0		
	Employee training surrounding environmental behaviours	4 Interviews	1; 5; 6; 9	*'They all need training in full scale traceability [….] scalable production, accreditations, state of the art production'* (FC5)
	Cross-functional integration	0		
	Incentive systems for environmental behaviours	0		
	Choice of suppliers by environmental criteria	13 Interviews	1; 4; 5; 7 ;8 10; 12; 15; 16; 17; 18; 19; 20).	*'We will always take sustainability into consideration, look to understand what the credentials are of a supplier that we're working with and we will always choose the most sustainable option available'* (FC18)
	Management of uncertainty or change	0		
	Top management support	0		
	Risk Taking	0		

Table 8.5 cont.

	Conceptual Capability	Presence in Data	Food Company	Sample Data
Seizing External	Environmental, operational and financial supply chain measures	11 Interviews	1; 2; 6; 7; 8; 10; 11; 12; 16; 17; 18	*'We are actively measuring the footprint of all the farms'* (FC16)
	Building relationships throughout the supply chain	15 Interviews 1 Observation	1; 2; 6; 7; 8; 9; 10; 12; 13; 14; 15; 17; 18; 19; 20	*'Being collaborative or partnership-working is very much about sustainability'* (FC9)
	Cooperation with suppliers for environmental objectives & new, lower impact operations	9 Interviews	2; 4; 8; 9 10; 11; 12; 13; 14	*'Sometimes it's when you get together you're able to actually impact change and develop innovation in a very satisfactory way'* (FC12)
	Assisting suppliers with environmental programmes	11 Interviews	1; 2; 3; 4; 8; 9; 11; 12; 17; 17; 19	*'We encourage our suppliers to get accredited and we help them and talk them through paperwork and all the things that are a part of that process'* (FC9)
	Environmental audits for suppliers' internal management	12 Interviews	1; 2; 4 ;5 ;7; 10; 12; 13; 16; 17; 19; 20	*'Each supplier must do their due diligence with certain paperwork* [….] *there is a lot of auditing going on* [….] *and we need five years of record keeping'* (FC2)
	Capacity for resale, recycling or remanufacturing throughout supply chain	12 Interviews 2 Observations	1; 2; 3; 4; 5; 6; 7; 10; 12; 14; 16; 18	'*Waste is transferred around between all of us to find the best method to use it, whether it is animal feed or putting it to process instead of wasting it or leaving it lying around'* (FC1)
	Investment in cooperative resources and activities	5 Interviews	2; 6; 7; 9; 20	*'Our suppliers often have solar panels, wind turbines and electric vans, and so to some extent that is embedded in the finished product'* (FC20)
	Eo-labelling	8 Interviews 1 Observation	2; 3; 5; 6; 9; 12; 15; 16	*'Your accreditations allow you to say all at once to a customer that you are sustainable'* (FC6)
Transforming Internal	Creation of environmental supply chain policy	8 Interviews	1; 2; 5; 6; 8; 12; 16; 17	*'We are driving recyclability through our KPIs in terms of water, plastics and cardboards. It means we can move our contracts on to a position where zero to landfill is a given'* (FC12)
	Vertical integration	6 Interviews	2; 3; 4; 16; 17; 18	*'We are vertically integrated from a supply chain point of view, we do everything ourselves from production through to distribution so that really makes it easy for us to maintain the entire chain'* (FC18)
	Creation of recyclable or reusable products	7 Interviews	4; 5; 6; 8; 12; 16; 18	*'We've shifted from use-once containers to reusable containers to get that waste down'* (FC6)
	Cradle-to-cradle philosophy	0		

Table 8.5 cont.

	Conceptual Capability	Presence in Data	Food Company	Sample Data
Transforming External	Entrepreneurial leadership in the supply chain	9 Interviews	2; 4; 8; 9; 10; 17; 18; 19; 20	*'We are driving sustainability down through the supply chain* [….] *we kind of push it because sustainability it is at the heart of our business model'* (FC18)
	Informing suppliers about the benefits of cleaner production & encouraging environmental action	10 Interviews	1; 2; 7; 8; 9; 10; 11; 12; 16; 20	*'When you show them the results and its saving them money and helping long term sustainability on their farms by reducing environmental impact you'll find they get on board fairly quickly. As soon as the growers know there is no stopping them'* (FC10)
	The construction of mutual goals throughout the supply chain	0		
	Co-evolution with customers and suppliers	8 Interviews	1; 3; 7; 9; 12; 13; 14; 16	*'We all need to carry on with R&D, that is the most important thing if we are to stand up to the challenges of sustainable supply'* (FC9)

8.2.1 Sensing Internal Capabilities

Lifecycle Measurements & Analysis of Products & Processes

Lifecycle measurements & analysis of products and processes was the only conceptual product stewardship sensing internal capability to be validated by empirical data, featuring in 11 interviews. Interviewee terminologies such as *'farm-to-fork'*, (FC8), *'the-dock-to-the-dish'* (FC17), *'sea-to-shelf'* (FC5), *'de-bone-to-retail'* (FC16) and *'sky-to-scoop'* (FC4) demonstrated a clear lifecycle perspective. Rendering implications for lifecycle analysis and measurement, FC2 claimed to measure environmental impacts *'from where the seed was produced to being grown and fed and raised'*, whilst FC1 claimed to measure *'the effects of the actual processes on the environment'* throughout the lifecycle of their product. According to FC8, such analysis and measures provided them with *'an opportunity to look again and try to improve'*, whilst FC1 and FC10 drew links with the continuous improvement of the lifecycle as a whole.

Notably, lifecycle analysis enjoys some dominance in existing literature, featuring in the initial conceptualisation of product stewardship (Hart, 1995), reinforced in subsequent natural-resource-based view studies (Christmann, 2000; Johnsen et al, 2014) and emerging in product stewardship and sustainable supply chain management synergies (Kurt & Eagan, 2008; Diwekar & Shastri, 2011). In addition, a 'farm-to-fork' philosophy emerged with significance in the earlier industry review of product stewardship, presented as an inclusive supply chain

approach to sustainability (The Department for Business and Innovation, 2012). The phase 2 results add further significance and clarity, and as such 'lifecycle measurements and analysis of products and processes' is confirmed as am internal product stewardship sensing capability.

8.2.2 Sensing External Capabilities

Bringing Together Suppliers in the Same Industry to Share Problems & Know-How

Featuring in 11 interviews, bringing together suppliers in the same industry to share problems and know-how, emerged as a prominent product stewardship capability. Interviewees discussed at length *'regular farmers' meetings where farmers come in and talk to the owners about common issues'* (FC1), meeting suppliers so they can *'share all their difficulties with us'* (FC7), and supplier seminars to discuss *'different aspects* [of] *quality, cost and efficiency* [and] *sustainability'* (FC12). Pertinently, the focus did not just fall upon suppliers but problem and know-how sharing throughout the supply chain, with FC12 stating *'we see companies as well, along with farmers, it's a sort of cooperative'* and FC2 claiming *'we get most of our ideas from the supply chain'*. Going beyond the supply chain, interviewees also discussed sharing problems and know-how with external companies via meet-the-buyer events, industry conferences and trade demonstrations, with FC5 explaining this '*is about knowledge sharing, it is really interesting to see what other companies are doing and how that compares to us'*. The use of online forums also emerged with significance, which FC4 claimed allow '*suppliers to encourage each other and try and find out about LED lights, or solar panels, or wind turbines',* and FC1 claimed were used to *'discuss legislation and things like that'* and *'find ways to improve'*.

Such discussions demonstrate correspondence with Shi et al's (2012) conceptual natural-resource-based green supply chain management model, in which awareness seminars for suppliers and contractors and bringing together suppliers to share know-how and problems are prioritised as product stewardship capabilities. Taking into consideration the descriptions of such activities in phase 2 interviews, the capability 'bringing together suppliers in the same industry to share problems and know-how' is specified as **'problem and know-how sharing with suppliers, customers and competitors via meetings, conferences and online forums'**.

Seeking out Professional Memberships

Seeking out professional memberships also featured in 11 interviews. FC2 suggested they seek out professional memberships to '*keep up to date with legislation',* FC16 suggested professional memberships provide a *'holistic assessment'* of environmental behaviours

throughout the lifecycle, and FC4, FC12 and FC6 claimed they highlight better ways to manage sustainability throughout the food chain. Specific references were made to accreditations or memberships with SEDEX, Agricultural and Horticultural Development Board, Farm Assurance, the Sustainable Road Freight Association, Department of Environmental and Rural Affairs, the Blue Marine Foundation, the Responsible Fishing Scheme and Assure Produce. Supermarket audits also emerged with significance, with FC13 claiming the use of supermarket audits *'enforced a discipline that was genuinely for the good rather than the bad of the business'* and encouraged them *'to invest in environmental things'* throughout the supply chain.

There is some correspondence between such discussions and Menguc & Ozanne's (2005) natural environment orientation, in which the need to look to external bodies for legitimization and opportunities in product stewardship is stressed. In addition, the exploration of product stewardship and sustainable supply chain management synergies stressed the need to consult environmental policy (Carter & Ellram, 1998) and uncovered implications for an environmentally sensitive corporate culture (Min & Galle, 2001). The industry review also suggested that external accreditations and audits support product stewardship (McGill, 2016). This along with phase 2 results encourages the sensing capability 'seeking out professional memberships' to be renamed **'membership and consultation with environmental bodies'**.

Stakeholder Integration to Select New Technologies & Direct Joint Innovation

Stakeholder integration to select new technologies and direct joint innovation featured in 6 interviews. Interviewees implied that integration with supply chain partners resulted in the selection of new technologies and joint innovation. For example, FC10 claimed their environmental innovations and technologies were uncovered through *'working with our farmers in particular',* whilst FC20 stated '*we have some suppliers with great ideas and we benefit from that'*. Reinforcing this, FC7 claimed environmental innovations in their supply chain come from '*sharing ideas* [….] *and working together'*. In the most part, the focus fell upon technologies and processes that could reduce waste from the supply chain as a whole.

Integration with suppliers emerged as a dominant product stewardship capability in literature, tracing back to initial conceptualisation of the resource (Hart, 1995) and later being presented as the key strategic capability of the resource (Hart & Dowell, 2011). More specific references to the role of integration in new technologies and innovation are derived from product stewardship and sustainable supply chain management synergies, in which the need

to cooperate with suppliers for environmental objectives (Carter & Ellram, 1998; Vachon, 2007; Shi et al, 2012), green innovations throughout the supply chain (Jumadi & Zailani, 2010; Garg et al, 2015) and joint sustainable innovation throughout the supply chain (Von Hippel, 1988; Soosay et al, 2008; Ashby et al, 2012, Blome et al, 2012; Ageron et al, 2013; Golicic & Smith, 2013) emerged as conceptual product stewardship capabilities. Taking this into consideration alongside phase 2 results, the capability 'stakeholder integration to select new technologies and direct joint innovation' is slightly modified to **'supply chain integration to select new technologies and direct joint innovation'**.

8.2.3 Seizing Internal Capabilities

Choice of Suppliers by Environmental Criteria

Choice of suppliers by environmental criteria was the dominant product stewardship seizing internal capability, featuring in 13 interviews. In the most part this manifested in the selection of suppliers based on sustainability credentials, with FC18 claiming '*we will always take sustainability into consideration* [and] *look to understand what the credentials are of a supplier that we're working with and we will always choose the most sustainable option available'*. Similarly, FC20 stated *'when we select suppliers to work with sustainability plays a big role in that'*, arguing that their suppliers need '*a responsible attitude towards environmental sustainability'*. Looking for environmental accreditations in suppliers emerged with significance, with FC20 claiming *'we look for accreditations that ensure locality and sustainability'* and FC1 stressing that environmental accreditation acts as a *'good indication'* of high sustainability standards. Interviewees also chose suppliers with *'similar interests'* (FC7) or *'mutual understandings'* (FC20) in sustainability, believing it advanced their own sustainability merits. For the same reason, interviewees also claimed to select suppliers that '*are progressive and eager to go forward with new ideas and concepts'* (FC19) or those that '*are involved in the latest sustainability initiatives*' (FC12).

The need to consider environmental criteria in activities such as supplier selection can be considered supportive of product stewardship's presentation of the natural environment as a key stakeholder and its pursuit of new, lower impact products (Hart, 1995). This was conceptualised in Shi et al's (2012) natural-resource-based green supply chain management model which linked green purchasing with product stewardship and within that, the choice of suppliers by environmental criteria was presented as a core capability. Thus, as well as empirically validating the capability, phase 2 offers greater detail surrounding its role in product stewardship, and as such the capability 'choice of suppliers by environmental criteria'

is renamed **'selecting suppliers based on their environmental beliefs, objectives and accreditations'**.

Employee Training Surrounding Environmental Behaviours

Employee training surrounding environmental behaviours featured in just 4 interviews, in which interviewees stressed the need to have employees trained up to specialise in environmental operations and manage environmental accreditations and paperwork. For example, FC5 stressed the need for employees to be trained in *'full scale traceability* [….] *scalable production, accreditations, state of the art production'* (FC5). Demonstrating the value of this, FC9 credited their successful product stewardship approach with having *'the right people and expertise* [to] *operate a sustainable potato supply chain'*.

Some minor implications for employees in product stewardship featured in the precedence of stakeholder management and integration in product stewardship literature (Hart, 1995; Hart & Dowell, 2011). Employee training specifically emerged as a product stewardship capability in exploration of product stewardship and sustainable supply chain management synergies (Min & Galle, 2001). Adding some specificity, the phase 2 results encourage the capability 'employee training surrounding environmental behaviours' to be renamed **'employee training and specialisation in environmental operations'**.

8.2.4 Seizing External Capabilities

Building Relationships Throughout the Supply Chain

The most prominent of all product stewardship capabilities, building relationships throughout the supply chain featured in 15 interviews and 1 observation. A focus fell upon building long term relationships with both suppliers and customers. Such relationships were credited with offering the most *'collaborative relationships'* (FC1), the greatest sharing of *'knowledge and best practice'* (FC3), and enhanced *'trust to deliver environmentally'* (FC17). Discussion of partnerships were also common, with FC2 claiming sustainability *'is all about partnerships'* and FC10 stating *'partnership is key to delivering sustainability'*. With regards to building relationships, references were made to one-to-one or face-to-face communications, conference calls, online forums, integrative supply chain meetings and parties and social events. The regularity of communications emerged with significance, with FC19 claiming to be *'in regular communication, almost daily communication'* with all suppliers, and FC6 claiming '*we see* [supplier's] *employees every other day'*. Interestingly, a close supplier-customer relationship was observed during FC15's interview, in which a customer of FC15 comfortably entered the

office without knocking. Whilst an order was placed, FC15 and their customer enjoyed a friendly conversation in which they both enquired about each other's family and business and used only first names. According to FC15, they only knew this customer in a business sense and this was a true representation of the type of relationship they aim to conduct throughout the supply chain.

The need for relationships throughout the supply chain in product stewardship emerges with some significance in existing literature, implied in initial conceptualisation of the resource (Hart, 1995) and conceptualised in Shi et al's (2012) natural-resource-based green supply chain model and its prioritisation of awareness seminars for suppliers, bringing together of suppliers and cooperation with suppliers. This was reinforced with strength in product stewardship and sustainable supply chain management synergies in which the argument that the realisation of environmental objectives is dependent on supply chain collaboration (Vachon, 2007; Seuring & Müller, 2008; Abbasi & Nilsson, 2012 Giminez & Tachizawa, 2012; Miemczyk et al, 2012; Jensen et al, 2013) encouraged links between product stewardship and supply chain relationships (Vachon & Klassen, 2008; Johnsen et al, 2014; Miemczyk et al, 2016). Phase 2 results add further significance and encourage the capability 'building relationships throughout the supply chain' to be renamed **'building and nurturing relationships throughout the supply chain to support a stewardship approach to sustainability'.**

Capacity for Resale, Recycling or Remanufacturing Throughout the Supply Chain

The capacity for resale, recycling or remanufacturing throughout the supply chain featured in 12 interviews and 2 observations. This involved the re-distribution of waste for reuse throughout the supply chain, with FC1 claiming '*waste is transferred around'* the supply chain to '*find the best method to use* [waste]*, whether it is animal feed or putting it to process instead of wasting it or leaving it lying around'*. Evidencing the benefits of such an approach, FC6 *'swap straw with local cattle farms and get dung back* [because] '*it balances out and works quite well, giving organic matter for soil'* and reducing cost and waste. This was reinforced by observation results, in which factory workers at FC1 and FC3 were seen grading potatoes according to saleability or reusability, with FC1 claiming to have created supply chain relationships specifically to support reusability and describing this as a '*closed circular economy'*. Further implying a closed-loop approach, FC8 stated '*circularity is also important, particularly in food waste; so this idea that everything can be reused or reincorporated, like anaerobic digestion and feed stock'*.

Recyclability throughout the lifecycle is considered a core activity in product stewardship (Hart, 1995; Christmann, 2000) whilst implications for reusability in the supply chain featured throughout product stewardship and sustainable supply chain management synergies (Min & Galle, 2001; Markley & Davis, 2007; Kurk & Eagan, 2008; Langella & Zanoni, 2011; Jensen et al, 2013; Vazifedoust et al, 2013; Garg et al, 2015; Miemczyk et al, 2016). In line with phase 2 results, implications for the restructuring of production systems (Hart, 1995) and segregation of waste (Min & Galle, 2001) can also be noted in existing literature. Taking all this into consideration, the capability 'capacity for resale, recycling or remanufacturing throughout the supply chain' is renamed **'the reuse or remanufacturing of waste for value throughout the supply chain'**.

Environmental Audits for Suppliers' Internal Management

Environmental audits for suppliers' internal management featured in 12 interviews. That is, FC20 stated *'we do visit our suppliers and we audit them'*, FC1 claimed *'everything you can think of on a farm we look into, even things like soil moisture, biodiversity'*, and FC10 made specific reference to *'water audits'* for suppliers, claiming they allow them to '*get specific information'* and to identify *'the hotspots'* of environmental activity and impact throughout the lifecycle. In addition, FC2 stated *'each supplier must do their due diligence with certain paperwork* [….] *there is a lot of auditing going on* [….] *and we need five years of record keeping'*, whilst FC5 discussed the need for a *'paper trail'* to assess and manage the environmental behaviour of suppliers. Third party auditing also featured here, with FC12 stating *'we also find auditors to audit third party for various schemes'*, and FC7 suggesting third party auditing helps to ensure suppliers *'are meeting standards'*.

The capability 'environmental audits for suppliers' internal management' was derived from Shi et al's (2012) conceptual natural-resource-based green supply chain management model and is empirically validated by phase 2 results, permitting its definition as a product stewardship seizing external capability.

Environmental, Operational & Financial Supply Chain Measures

Environmental, operational and financial supply chain measures featured in 11 interviews. With regards to environmental measures, interviewees spoke of supply chain environmental '*reviews every three months'* (FC6), measuring *'the footprint of all the farms'* (FC16) and undertaking *'impact measurement'* throughout the supply chain (FC12). The measurement of

supply chain emissions was particularly prominent, with FC9 claiming to undertake *'rigorous monthly checks to make sure* [suppliers] *aren't putting out too many dirty emissions'*. With regards to operational measures a focus fell on distribution, with FC8 claiming to measure distribution operations '*to reduce the food miles of products'*, and FC1 stating *'our lorries are all tom-tom monitored and fuel Tran monitored which means I monitor idle times, I monitor everything, miles per gallon, everything you can imagine'* to realise *'environmental improvements'*. Notably, such environmental and operational measures are interrelated and connected with financial measures, with FC17 claiming to measure operational aspects of distribution in order to reduce pollution and fuel and congestion costs, stating *''it is more environmental and it also makes more sense business wise'*. This said, financial measures were not explicitly discussed in relation to product stewardship in any of the 20 interviews.

Notably, there are considerable parallels between 'environmental, operational and financial measures throughout the supply chain' and the earlier discussed capability of 'environmental audits for suppliers' internal management' This encourages the amalgamation of these two capabilities, to create **'environmental and operational supply chain audits and assessments'**. Reinforcing this is implications for audits and measurements throughout existing literature, featuring in natural-resource-based theoretical extensions (Menguc & Ozanne, 2005; Shi et al, 2012), product stewardship and sustainable supply chain management synergies (Min & Galle, 2001; Vachon, 2007) and product stewardship and innovation synergies (Ikasson et al, 2010).

Assisting Suppliers Environmental Programmes

Assisting suppliers' environmental programmes also featured in 11 interviews, in which interviewees claimed they were *'happy to help'* (FC4) and stated '*what is the point in us having this knowledge and experience and not sharing it?'* (FC9). Interviewees claimed to *'provide guidance on how to farm better'* (FC11), to '*spend a lot of time with our farmers working out where their emissions come from'* (FC10) and to give suppliers *'a lot of support, going in and seeing the growers on a weekly basis, helping them with everything from agronomy through to advice on ethical issues, farm assurance issues, sustainability issues, environmental issues'* (FC19). Helping suppliers to attain environmental accreditations featured prominently, with FC9 stating *'we encourage our suppliers to get accredited and we help them and talk them through paperwork and all the things that are a part of that process'*, and FC2 stating *'I show* [suppliers] *the kind of thing involved and the paperwork that is required'*. Moreover, FC2 claimed to have purposefully qualified as a *'field to fork accreditor'* so they can personally

award accreditations throughout the supply chain. Interviewees also discussed helping supply chain partners to find and install new environmental machines

Again, the capability 'assisting suppliers' environmental programmes' was principally derived from Shi et al's (2012) natural-resource-based green supply chain management model, in which guiding suppliers to set up environmental programmes and pressuring supplier to take environmental action were conceptualised as product stewardship capabilities. Adding empiricism and clarity, phase 2 results encourage the replacement of ''assisting suppliers' environmental programmes' with **'offering assistance and guidance of environmental programmes, accreditations and machinery throughout the supply chain'**.

Cooperation with Suppliers for Environmental Objectives & New, Lower Impact Operations

Cooperation with suppliers for environmental objectives and new lower impact operations featured in 9 interviews. Interviewees spoke at length of cooperative projects aimed at maximising sustainability, such as a *'project that is all about energy recovery and heat recovery'* (FC4) or a *'huge project'* aimed at conserving soil and reducing fuel use throughout the supply chain. According to FC12, the creation of sustainable operations *'is a two-way process'*, whilst FC10 claimed cooperation allows companies *'to actually impact change and develop innovation in a very satisfactory way'*.

The creation of new, lower impact operations is a fundamental aim of product stewardship (Hart, 1995), and literature places a reliance on cooperation with suppliers in order to realise this (Hart, 1995; Ikasson et al, 2010; Hart & Dowell, 2011; Ashby et al, 2012; Shi et al, 2012; Jensen et al, 2013; Miemczyk et al, 2016). Phase 2 results empirically validate this, and encourage slight modification of the capability to **'cooperation throughout the supply chain to meet environmental objectives and create lower impact operations'**.

Eco-labelling

Eco-labelling featured in 8 interviews and 1 observation. Interviewees appeared to use eco-labels as a means by which to communicate sustainability and create consistency throughout the lifecycle. In the most part, such eco-labels referred to environmental accreditations, which FC6 claimed *'allow you to say all at once to a customer that you are sustainable'* and keep all supply chain members *'up to standard'*. Again, ISO systems emerged with significance, with FC16 claiming to use ISO 15001 to look at energy use from a lifecycle perspective and crediting ISO 14001 with supporting their *'water stewardship'* programme by providing them

with a *'holistic assessment of our water profile from use, to reuse, to disposal'*. Specific references were also made to BM Trada accreditations, supermarket accreditations and SEDEX accreditations which FC12 claimed guide *'ethics and values from a company perspective and throughout the supply chain'*. Interestingly, accreditations were displayed prominently throughout FC2's facility, with FC2 explaining that this served as a reminder to employees and an advert to visitors that they were a responsible, trustworthy company.

The need for external accreditation is picked up on by Menguc & Ozanne (2005) in their natural environment orientation, in which external reporting and auditing is seen as a process of legitimization for product stewardship. Moreover, Shi et al's (2012) natural-resource-based green supply chain management model conceptualises eco-labelling as a product stewardship capability. Using phase 2 results to expand on this, the capability 'eco-labelling' is replaced with **'environmental accreditations to support sustainable operations'**.

Investment in Cooperative Resources & Activities

Investment in cooperative resources and activities featured in 5 interviews, albeit with some disparities in that cooperative resources appeared more as shared resources. For example, FC7 discussed sharing three electric vehicles throughout their supply chain to reduce environmental impacts and maximise efficiency, whilst FC1 discussed joint investment in solar panels, describing it as a *'win-win situation'* because all supply chain members benefit from energy and cost savings. Going beyond this, FC2 discussed donating machinery to supply chain partners *'because they couldn't afford'* to buy it, and claiming that resulted in *'a growing partnership'*. Even when resources and activities were not physically shared, interviewees implied that associated benefits were, with FC20 claiming that they are '*to some extent embedded in the finished product'*.

Links between product stewardship and investment in cooperative resources and activities emerged from product stewardship and sustainable supply chain management synergies (Vachon & Klassen, 2007), whilst references to shared technologies and machinery can also be identified in existing literature (Jensen et al, 2013; Miemczyk et al, 2016). This along with phase 2 results, encourage the capability 'investment in cooperative resources and activities' to be replaced with **'shared environmental technologies and machinery throughout the supply chain'.**

8.2.5 Transforming Internal Capabilities

Creation of Environmental Supply Chain Policy

The creation of environmental supply chain policy featured in 8 interviews, in which interviewees stressed the importance of creating supply chain *'environmental policy'* (FC6) throughout the supply chain. KPIs featured prominently, with references made to *'landfill KPIs'* rolled out throughout the supply chain (FC2), and *'driving recyclability through our KPIs in terms of water, plastics and cardboards'* (FC12). In addition, FC16 claimed to have created a '*systems based approach to deliver sustainability'* based on '*roadmaps that* [suppliers] *can follow and utilise'*, whilst FC8 discussed their own supply chain *'governance measure for sustainability'*.

The need to create environmental supply chain policy in product stewardship featured in natural-resource-based view theoretical extensions and developments (Menguc & Ozanne, 2005; Shi et al, 2012) and was further reinforced by product stewardship and sustainable supply chain management synergies (Carter & Ellram, 1998; Vachon & Klassen, 2008). Thus, the capability 'creation of environmental supply chain policy' is confirmed as an internal product stewardship seizing capability.

Creation of Recyclable or Reusable Products

Creation of recyclable or reusable products featured in 7 interviews. A focus fell upon the creation of packaging, with FC4 discussing the installation of on-site packaging facilities to create their own fully recyclable packaging, and FC12 investing in '*new technologies in packaging'*. Evidencing a stewardship approach, this placed an emphasis on consumers, with FC5 claiming their creation of recyclable packaging was intended to encourage customers to reuse packaging, whilst FC6 claimed to have made the shift from *'use-once containers to reusable containers'* in an attempt to reduce household waste. As well as preventing consumers from throwing away packaging, FC8 argued that this reduces food waste throughout the lifecycle as a whole.

Again, both recyclability (Hart, 1995; Hart & Dowell, 2011) and reusability (Min & Galle, 2001; Vazifedoust et al, 2013; Garg et al, 2015) feature with prominence throughout existing product stewardship literature. This is reinforced with some strength via links between product stewardship and closed-loop supply chain management (Miemczyk et al, 2013) which permits unsold products and effluents to be reincorporated into the supply chain to be reused in a way which creates added-value (Ashby et al, 2012; Bell et al, 2012; Garg et al, 2015; Govidan et

al, 2015). Interestingly, specific implications for recyclable or reusable packaging can also be identified in product stewardship and sustainable supply chain management synergies (Markley & Davis, 2007; Kurk & Eagan, 2008; Jumadi & Zailani, 2010; Langella & Zanoni, 2011) and are further enforced by the earlier industry review in which efforts to encourage responsible consumption and disposal behaviours (Mintel, 2011; Gould, 2016) via recyclability (Mintel, 2013a) and a circular economy approach was advocated (FHIS, 2013a; Vision 2020, 2013; WRAP, 2015). Based on this, 'creation of recyclable or reusable products' becomes **'creating products and packaging specifically intended for recycling or reuse'.**

Vertical Integration

Vertical integration featured in 6 interviews and was directly linked with product stewardship. For example, FC17 claimed their vertically integrated system is *'genuinely sustainable, not just in an environmental way but ensures sustainable living, a livelihood for our fishermen that is economically and socially sustainable'*, whilst FC2 claimed being *'vertically integrated'* allows them to have a *'system in place where* [they] *can build trust with customers and can invest confidently'* in sustainability. Interviewees implied that such an approach allowed them to control sustainability themselves, with FC18 stating *'we are vertically integrated from a supply chain point of view, we do everything ourselves from production through to distribution so that really makes it easy for us to maintain the entire chain'*.

Links between vertical integration and product stewardship featured with some prominence in exploration of synergies with sustainable supply chain management (Carter & Ellram, 1998) and phase 1 interviews. Phase 2 results add empirical reinforcement to such links and as such the capability 'vertical integration' is confirmed as an internal product stewardship transforming capability.

8.2.6 Transforming External Capabilities

Informing Suppliers about the Benefits of Cleaner Production & Encouraging Environmental Action

As the dominant transforming product stewardship capability, informing suppliers about the benefits of cleaner production and encouraging environmental action featured in 10 interviews. In particular, interviewees claimed to promote the financial and efficiency benefits of cleaner production, with FC1 claiming to highlight that *'the money to be saved there is ridiculous'*, and FC2 claiming that once you inform suppliers that *'you get two more hectares per acre, that you save 20litres per hectare in fuel […] suddenly their ears prick up and its worth*

listening to'. Similarly, FC10 stated *'when you show* [suppliers] *the results and its saving them money and helping long term sustainability on their farms by reducing environmental impact you'll find they get on board fairly quickly'*. With regards to environmental action, FC12 claimed to *'put more pressure on* [suppliers] *to provide us with extras and those extras for me are in the sustainability areas'*, whilst FC16 claimed to *'pay a premium to the farmers'* that measure and try to reduce environmental impacts. According to FC7, promoting cleaner operations and encouraging environmental action throughout the supply chain '*adds a positive light on the end product and what we do as a collective'*.

Informing suppliers about the benefits of cleaner production and pressuring suppliers to take environmental action are presented as a product stewardship capabilities in Shi et al's (2012) conceptual natural-resource-based green supply chain management model. Again, phase 2 results empirically validate such capabilities and accordingly the capability 'informing suppliers about the benefits of cleaner production and encouraging environmental action' is confirmed as an external product stewardship seizing capability.

Entrepreneurial Leadership in the Supply Chain

Entrepreneurial leadership in the supply chain featured in 9 interviews. For example, FC10 stated '*we would describe ourselves as a leader in sustainability and that is engrained in our R&D and everything we do, but it is about working together'*, whilst FC18 claimed they *'are driving sustainability down through the supply chain'*. FC17 claimed they act as leaders of sustainability in the supply chain to *'ensure that the farmers and the producers and the fishermen are doing their jobs in harmony with the marine environment and providing a real quality product'*.

This corresponds with Menguc & Ozanne's (2005) natural environment orientation that prioritizes entrepreneurial capabilities in the realisation of the natural-resource-based view and Miemczyk et al's (2016) earlier study in which leadership throughout the supply chain is linked with product stewardship. Thus, 'entrepreneurial leadership in the supply chain' is also confirmed as a product stewardship transforming external capability.

Co-Evolution with Customers & Suppliers

Co-evolution with customers and suppliers featured in 8 interviews. Interviewees claimed to direct and drive sustainability from a long-term perspective in cooperation with customers and suppliers. For example, FC16 claimed sustainability is important to them '*because we want to*

compliment some of the work the retailers do, so we have a joined-up story for our customers', whilst FC14 claimed supply chain members '*are all reliant on each other and are working together to get the best outcome*' for sustainability. In addition, FC9 stressed the need for the supply chain as a whole to '*carry on with R&D, that is the most important thing if we are to stand up to the challenges of sustainable supply'*.

This again corresponds with Miemczyk et al's (2016) earlier study, in which co-evolution with suppliers and customers is argued to support a product stewardship approach to closed-loop supply chain management. Thus, 'co-evolution with customers and suppliers' is confirmed as a product stewardship transforming external capability.

8.2.7 Emergent Capabilities

The results of the industry review and phase 1 of the empirical study identified three emergent product stewardship capabilities. As demonstrated in table 8.6 below, two of these capabilities were validated by phase 2 interviews, and are discussed in this section.

Table 8.6 Phase 2 coding results of product stewardship emergent capabilities

Emergent Capability	Presence in Data	Food Company	Sample Data
Carbon Measurement & Management	10 Interviews	1; 2; 8; 9; 10; 11; 12; 16; 18	*'We have a carbon footprint navigator tool that we use on all farms to determine the carbon footprint of the farms'* (FC16)
External Collaboration	9 Interviews	2; 4; 5; 7; 9; 10; 11; 12; 16	*'We work with other harvesters around Scotland and Ireland, we do a lot of collaborations'* (FC5)
Geographical Location of Sites	0		

Carbon Measurement & Management

Carbon measurement featured in 10 interviews, with interviewees discussing carbon-in and carbon-out measures, carbon audits, carbon surveys and carbon measurement plans throughout the supply chain. FC11 argue that *'carbon measurement is the latest thing* [in sustainability] *and the focus has to be on the supply chain'*. According to FC8, it is important to '*to take responsibility for the carbon weight of all the food products sent out'* and *'work to minimise'* carbon emissions.

Carbon measurement and management initially emerged as a product stewardship capability in the industry review, in which it was presented as a means by which support the protection of natural resources throughout the supply chain (DEFRA, 2013; The Carbon Trust, 2016). This was reinforced to some extent in phase 1 results, in which interviewees stressed the need to measure environmental outputs such as carbon through each stage of production.

In addition, Eskandarpour et al (2015) identify carbon measurements as the most prominent type of measurement in incorporating environmentalism into supply chain management. However, despite this and its prominence in phase 2 interviews, carbon measurement and management does not warrant its own capability. Rather, it can be considered further support for the existing external product stewardship seizing capability of 'environmental and operational supply chain audits and assessments'.

External Collaboration

External collaboration featured in 9 interviews. Collaborations with academia were particularly prominent, in that interviewees claimed collaborations with universities and knowledge exchange partnerships helped to direct sustainability throughout the supply chain. Interviewees also spoke of collaborations with companies out-with the supply chain to implement new sustainability initiatives and looking to the government support and assistance in sustainability.

External collaboration initially emerged as a product stewardship capability in phase 1, in which interviewees spoke of the value of partnerships with external companies in supporting the creation of sustainable products and the redistribution of waste. References to external collaboration were also notable in industry review discussions of government funded initiatives aimed at encouraging, and in some cases funding, sustainability and stewardship in agriculture (Natural England, 2012). However, whilst it is clear that external collaboration plays a role in product stewardship, it also does not warrant its own capability. Rather, it is amalgamated with the earlier discussed capability of 'cooperation with suppliers and customers to meet environmental objectives and create lower impact operations' to create **'cooperation with supply chain members and externals to meet environmental objectives and create lower impact operations and products'**.

8.2.8 Newly Emergent Capabilities

Again, the analysis of phase 2 interviews resulted in the identification of newly emergent capabilities. These capabilities are depicted in table 8.7 and discussed throughout this section.

Table 8.7 Phase 2 coding results of product stewardship newly emergent capabilities

Emergent Capability	Presence in Data	Food Company	Sample Data
Communicating sustainability out-with the supply chain	7 Interviews	2; 6; 9; 12; 16; 18; 20	*'We need to get people to approach things differently, the whole way we eat and supply food is completely out of whack with how it should be. If we can make small changes here and there and influence the way people buy and consume things we can have a genuine impact'* (FC17)
Supply Chain Technologies	3 Interviews	10; 12; 16	*'Technology, innovation, access to that technology and uptake is so important if you want to get to a good place. As much technology as we can bring together and the more work we can do with everyone the better'* (FC10)

Communicating Sustainability out-with the Supply Chain

Promoting sustainability out-with the supply chain featured in 7 interviews. That is, interviewees claimed to communicate the need for and benefits of sustainability to the public because *'we all need to do what we can to support a sustainable society'* (FC8). This involved educating people about *'conservation and carbon and how to cook food responsibly'* (FC8), encouraging people to '*get on board and consume and dispose of food in a more responsible way'* (FC20) and '*getting people to approach things differently* [and] *make small changes here and there* [to] *have a genuine impact'*. Interviewees claimed to communicate such issues via their website, advertisements and social media. Thus, **'promoting sustainable behaviour via external communications'** emerges as an external transforming capability.

Supply Chain Technologies

Supply chain technologies featured in just three interviews, but was directly linked with product stewardship. That is, FC12 stressed the need for technologies to help measure and reduce emissions throughout the supply chain, claiming '*we have a lot of tech that we look at all the time and see how we can make improvements'*, whilst FC16 discussed the use of measurement technologies in creating a holistic approach to carbon measurement throughout the supply chain. In addition, FC10 discussed technologies that allow supply chain members to record and access each other's environmental information. Reinforcing the value of such technologies, FC10 stated *'technology, innovation, access to that technology and uptake is so important'* with regards to sustainable operations throughout the supply chain, adding '*as much technology as we can bring together and the more work we can do with* [suppliers] *the better'*. Adding some reinforcement to these three interviews are implications for green technologies throughout the logistical process in product stewardship and sustainable supply chain management synergies (Jumadi & Zailani, 2010; Garg et al, 2015) and the prominence of technology in a more general sense in product stewardship and innovation synergies

(Ageron et al, 2013; Boons et al, 2013; Jensen et al, 2013; Szekely & Strebel, 2013). As such, whilst it only features in three interviews, the capability '**implementing technologies to help manage and measure sustainability'** emerges as an internal product stewardship seizing capability.

Table 8.8 Empirical definition of dynamic product stewardship capabilities

Product Stewardship Capabilities		
	Internal	**External**
Sensing	➢ Lifecycle measurements & analysis of products & processes	➢ **Problems & know-how sharing with suppliers, customers & competitors via meetings, conferences & online forums** ➢ **Membership and consultations with relevant bodies** ➢ **Supply chain integration to select new technologies & direct joint innovation**
Seizing	➢ **Selecting suppliers based on their environmental beliefs, objectives & accreditations** ➢ **Employee training and specialisation in environmental operations** ➢ *Implementing technologies to help manage & measure sustainability*	➢ **Building and nurturing trusting relationships throughout the supply chain to support a stewardship approach to sustainability** ➢ **Reuse or remanufacturing of waste for value throughout the supply chain** ➢ **Environmental & operational supply chain audits & assessments** ➢ **Offering assistance & guidance of environmental programmes, accreditations & machinery throughout the supply chain** ➢ **Environmental accreditations to support sustainable operations** ➢ **Cooperation with supply chain members & externals to meet for environmental objectives & create lower impact operations & products** ➢ **Shared environmental technology & machinery throughout the supply chain**
Transforming	➢ Creation of environmental supply chain policy ➢ **Creating products & packaging specifically intended for recycling & reuse** ➢ Vertical integration	➢ Informing suppliers about the benefits of cleaner production & encouraging environmental action & certification ➢ Entrepreneurial leadership in the supply chain ➢ Co-evolution with customers and suppliers ➢ *Promoting sustainable behaviour via external communications*

*Capabilities shown in bold are renamed; capabilities in italics are emergent capabilities

8.3 Clean Technologies Results

Clean technologies was identified in all 20 interviews, and benefited from detailed discussion in 15 of those 20 interviews. As with the industry review and phase 1 of the empirical study, all four of Pagel & Shevchenko's (2007) categories of clean technologies featured. Energy technologies assumed some dominance, with repeated discussion of solar panels, wind turbines, anaerobic digesters, bio-nuclear technologies, hydrogen fuel cells, biogas and

biomass technologies, hydro power and combined heat and power technologies. Discussion of transport technologies included tom-tom monitored vehicles, gas powered tractors and bio-diesel technologies, whilst water technologies included water treatment and reuse facilities, water storage and rain catchers. References to building technologies included cold storage technologies, free cooling, electric tippers, drones, vertical farming, robotics, 3D imaging, aquaponics and micropropagation. The competitive benefits of such technologies were also easily identifiable and again focused on cost and efficiency. That is, FC1 claimed to make money from selling on energy produced from energy technologies, FC4 claimed clean technologies are *'energy efficient which of course reduces cost'* and FC10 claimed their clean technologies *'allow us to be more efficient and have more efficient use of resources'*. Referencing competitive benefits surrounding differentiation, FC16 claimed clean technologies *'gives us more advantage in the market place because our competitors can't get into it'*.

Again, the purpose of phase 2 was not to assess the existence of clean technologies, but rather to explicate capabilities. As demonstrated in table 8.9 below, 17 out of 25 conceptual clean technologies capabilities were empirically validated by phase 2 interviews. These capabilities are discussed here, and along with validated emergent capabilities and newly emergent capabilities, are presented in the final definition of clean technologies in table 8.12.

Table 8.9 Phase 2 coding results of clean technologies conceptual capabilities

Clean Technologies Results				
	Conceptual Capability	**Presence in Data**	**Food Company**	**Sample Data**
Sensing Internal	Continuous assessment & improvement of environmental impact	9 Interviews 2 Observations	1; 2; 3; 4; 5; 6; 8; 13; 19	*'Continuous improvement is integrated in the way we work with our yearly reviews and things* [….] *we have a commitment that we want to find new things'* (FC4)
	Resource impact assessment	7 Interviews	2; 3; 4; 5; 8; 16; 20	*'our driver getting that I suppose was resource utilisation in terms of the resources that we were consuming* [….] *we needed to control these resources in a more effective manner'* (FC8)
	Environmental, financial and non-financial measures	9 Interviews	1; 2; 4; 6; 8; 9; 10; 12; 16	*'Its when things like your energy prices, water and other consumables were increasing in price* [….] *so you have to think there are economic incentives to produce your own electricity* [….] *it all needs to make sense for both the sustainable route and the financial route of the company'* (FC4)
	Green research and development	0		
	Employee awareness of clean technologies	9 Interviews	1; 2; 4; 9; 12; 13; 14; 19; 20	*'We might go out to the factory floor and ask people for ideas, often it is someone in the factory who has a great idea'* (FC2)
Sensing External	Consumer & environmental consultation of new technologies & innovations	14 Interviews	3; 4; 5; 6; 7; 8; 9; 10; 12; 13; 14; 18; 19; 20	*'Knowledge comes from the desire to find out things, so because we have a desire to find out things that makes us want to go out and investigate things and speak to people and learn'* (FC8)
	Seeking the advanced reduction of energy & material consumption	0		
	Supplier environmental impact audits	0		
Seizing Internal	Organisational capacity to implement, manage & create clean technologies	8 Interviews	1; 3; 6; 8; 12; 13; 14 ;16	*'We've got a small management team so we are able to take on ideas and implement them quite quickly'* (FC14)
	Technological & quality management systems	0		
	Environmental, & financial and measures	0		
	Employee technological know-how & skills	12 Interviews	1; 2; 3; 4; 6; 10; 12; 13; 14; 16; 19; 20	*'The boy that runs the design room is one of these magicians, he thinks outside the box and he is unbelievable, he's thought of a few things over the years* [….] *he won't put anything in that he doesn't think is at the forefront of technology'* (FC2)
	Continuous assessment & improvement of environmental impact	9 Interviews 2 Observations	1; 2; 3; 4; 5; 6; 8; 13; 19	*'Continuous improvement is integrated in the way we work with our yearly reviews and things* [….] *we have a commitment that we want to find new things'* (FC4)

Table 8.9 cont.

	Conceptual Capability	Presence in Data	Food Company	Sample Data
Seizing External	Supplier guidance surrounding clean technologies and positive impact operations	0		
	Sharing & creating new technologies throughout the supply chain	8 Interviews	2; 4; 5; 6; 9; 10; 12; 13	*You might have an idea, but you only have 20% of that idea, so you bounce it off other companies and somebody else has another 20% of that idea, or someone comes in with a totally different way of looking things and that gets us 60% of the way there'* (FC6)
Transforming Internal	Aptitude for disruptive change	6 Interviews	2; 4; 12; 13; 14; 16	*'Conventional thinking will not be good enough to get us to where I think we want to be* [….] *it's healthy to have a disruptive attitude towards day-to-day activities* [….] *people understand and they know you can't stand still so they know I'm not being disruptive for the sake of being disruptive'* (FC12)
	Strategic planning for the future	6 Interviews	4; 6; 7; 10; 12; 13	*'It all depends on having a long term perspective* [….] *we talk about the future* [….] *we take a 25-year view'* (FC12)
	A global, lifecycle perspective of operations	5 Interviews	3; 4; 8; 13; 17	*'It is about leaving the world in a state for our children that isn't completely impossible for them to manage. Its something that our species as a whole needs to start thinking about, and thinking about the way we interact with this planet in an entirely different way'* (FC17)
	Creating closed-loop systems	7 Interviews 1 Observation	1; 02; 4; 8; 11; 12; 14; 18	'*We use hydroponics and aquaculture to farm fish in water without soil* [….] *it's the fish poo that creates nutrient rich water which we then pump to the roots of the plant to support their growth, the plants in turn then purify the water which is sent back to the fish* [….] *its essentially a closed-loop system'* (FC18)
	Ecological leapfrogging	8 Interviews 1 Observation	2; 4; 7; 8; 12; 13; 14; 16	*'We adopt tech quickly ahead of the curve because it gives us an advantage'* (FC13)
	Creating environmental & political regulations	0		
	Eco-design	8 Interviews 1 Observation	1; 2; 3; 12; 14; 16; 18; 19	'*We completed our £26m facility last year, that has 40% recycling rate, 100% carbon neutral and a load of innovation and technology* [….] *it's the most sustainable beef abattoir ever built because it was built from a sustainability point of view'* (FC16)

Table 8.9 cont.

	Conceptual Capability	Presence in Data	Food Company	Sample Data
Transforming External	Commercialization of clean technologies	6 Interviews	1; 2; 4; 12; 16; 18	*I was drawn to aquaponics because no one had really commercialised it yet'* (FC18)
	Political acumen surrounding clean technologies	0		
	Knowledge transfer and capacity building throughout industry	10 Interviews	3; 4; 5; 6; 8; 10; 13; 14; 18; 20	*'We are keen to promote what we've learnt and I think that is really valuable* [….] *on the wider scale as an industry and as society'* (FC8)

8.3.1 Sensing Internal Capabilities

Continuous Improvement & Assessment of Environmental Impact

Continuous improvement and assessment of environmental impact featured in 9 interviews and 2 observations. Continuous improvement featured prominently and explicitly, with FC4 stating *'continuous improvement is integrated in the way we work'* and linking it with '*a commitment that we want to find new things'*. Similarly, FC3 claimed '*we are all the time looking for something new'*, whilst FC6 stressed the need to have an *'enthusiasm to improve and keep making strides forward'*. Evidencing an environmental focus, FC19 claimed to continuously improve because *'we can't just carry on the way we are going if we want to become more efficient and sustainable'*. Implications for assessment were less obvious, but nonetheless identifiable in discussions of the need to continuously assess *'issues you have on the farm'* (FC6) and *'constantly scan'* for threats and opportunities. Environmental impact assessments featured in observations, in that FC1 pointed out a trial testing the environmental impact and benefits of air drying versus water spraying and FC2 pointed out a mast that was assessing the potential of implementing a wind turbine and the benefits of doing so. According to FC1, *'at any one time there will be three of four projects being ran'*, the results of which, if successful, *'typically render savings of over £1million'*.

Notably, the need for continuous improvement is arguably a product of clean technologies pursuit of the advanced development of new, clean processes and products (Hart, 1997; Hart & Dowell, 2011). This is reinforced by Matapolous et al (2014) who explicitly link continuous improvement with clean technologies. In addition, implications for environmental assessments featured in clean technologies and sustainable supply chain management synergies (Weinberger et al, 2012; Schrettle et al, 2014). As such, the capability 'continuous improvement and assessment of environmental impact' is confirmed as a clean technologies sensing internal capability.

Environmental, Financial & Non-Financial Measures

Environmental, financial & non-financial measures featured in 9 interviews. Environmental measures included measuring energy use, carbon emissions and eco-efficiency. Financial measures were more prominent, with FC12 discussing a *'financial mechanism'* to identify opportunities for new technologies, and FC6 stating '*we would have all the figures out on the table and see if* [a new clean technology] *would be worth it'*. Interviewees implied that financial measures encouraged them to seek out clean technologies because '*energy prices, water and other consumables were increasing in price'* (FC16) and *'there are economic incentives to produce your own electricity'* (FC4). Environmental and financial measures were interrelated, with FC4 stressing the need for measures that '*make sense for both the sustainable route and the financial route of the company'*. Other than environmental measures, no non-financial measures featured in discussions of clean technologies.

Environmental, financial and non-financial measures emerged as a conceptual clean technologies capability in clean technologies and sustainable supply chain management synergies (Holtbrügge & Dögl, 2012; Montinel & Delgado-Caballos, 2014). However, as the phase 2 results did not empirically validate specific non-financial measures, this capability is replaced with **'environmental and financial measures to identify clean technologies opportunities'**.

Employee Awareness of Clean Technologies

Employee awareness of clean technologies also featured in 9 interviews. Interviewees claimed employees were *'well aware'* of the need to find clean technologies (FC20) and that *'often it is someone in the factory who has a great idea'* (FC2), as a result of their *'experience of the past plus the technology of the future'* (FC13). In support of this, FC19 stated *'our staff spend a lot of time going to meetings with various advisory bodies and committees'* to discover new technologies, whilst FC14 claimed *'we've sort of given* [employees] *the opportunity to go off and do things, trial things and see how they work and they've spent a huge amount of time recording those results and the improvements we have seen is quite incredible'*, adding '*we're quite fortunate that they are all interested in that type of thing'*. Communication and knowledge sharing emerged with significance here, with FC14 claiming ideas for clean technologies often '*comes down to the different ways we share information throughout the company'* and FC1 suggesting their ideas come from *'a combination of employee thought processes, what we can do and the experience of the company'*.

This corresponds with Andersson & Bateman's (2000) claim that it is often one 'champion' who interprets and exploits opportunities for sustainable innovation. Thus, 'employee awareness of clean technologies' is also confirmed as an internal clean technologies sensing capability.

Resource Impact Assessment

Resource impact assessment featured in 7 interviews. Interviewees implied that measuring their *'water footprint'* (FC2) encouraged them to seek out water technologies, or that a *'vested interest'* in resource impacts encouraged them to seek out technologies and processes that *'reduce impact on the land'* (FC3). FC4 claimed that resource impact assessments are vital to find new ways *'to reduce climate change'* given that the world *'uses three times the resources available'*. Reinforcing this, FC8 claimed such assessments provide an understanding of *'of what natural resources are available'* allowing you to '*control these resources in a more effective manner'*.

The need for resource impact assessment can be linked back to initial conceptualisation of clean technologies (Hart, 1997), which seeks the advanced reduction of energy and material consumption. More specific links between resource impact and clean technologies came from clean technologies and sustainable supply chain management synergies (Bell et al, 2012; Matapolous et al, 2014), whilst clean technologies and innovation synergies rendered implications for resource allocation (Yam et al, 2010). Thus, 'resource impact assessments' are also confirmed as a clean technologies sensing internal capability.

8.3.2 Sensing External Capabilities

Consumer & Environmental Consultation of New Technologies & Innovations

Consumer and environmental consultation of new technologies and innovations was the most dominant clean technologies capability, featuring in 14 interviews. Interviewees implied that clean technologies were often uncovered through customer consultation, with interviewees stressing the *'need to keep moving and react to the end customer'* (FC6). According to FC4, consumers *'like to see* [clean technologies] *and that circles back to us, making us want to do more'*. With regards to environmental consultation, an emphasis again fell upon NGOs and advisory boards, which were described as *'really valuable'* (FC8) in terms of uncovering clean technologies. Specific references were made to the Department of Environmental, Farming and Rural Affairs, The Rowett Institute, The Food and Drink Federation, The Waste and Resource Action Plan, Green Peace and Innovate UK. Outside of NGOs and advisory boards,

interviewees claimed to get clean technologies ideas from '*the farming press, normal press and just issues in farming'* (FC6), *'the aspirations of the Scottish Government'* (FC19), '*benchmarking of our competitive set'* (FC12) and *'from going abroad where we see new ideas and can pick up new ways of doing things'* (FC19). Reinforcing the value of external consultations in sensing clean technologies, FC8 claimed that clean technologies came from knowledge and *'knowledge comes from the desire to find out things, so because we have a desire to find out things that makes us want to go out and investigate things and speak to people and learn'*.

Consumer and environmental consultation emerged as a conceptual clean technologies capability in clean technologies and sustainable supply chain management synergies (Weinberger et al, 2012), whilst implications for innovation and technologies were consistent throughout existing clean technologies literature (Hart, 1997; Bell et al, 2012; Jensen et al, 2013; Hart & Dowell, 2011; Cuerva et al, 2011). However, based on the detailed descriptions in phase 2 interviews, the capability 'consumer and environmental consultation of new technologies and innovations' is specified and divided into: **'clean technologies aimed at customer needs and expectations'**; and **'consultation of relevant bodies and sources to uncover clean technologies'**.

8.3.3 Seizing Internal Capabilities

Employee Technological Know-How & Skills

Employee technological know-how and skills featured in 12 interviews. Interviewees claimed that employee technological know-how '*really delivered some fantastic results'* (FC14) with regards to clean technologies. Managers and specific employees were often appointed to manage clean technologies, which FC1 claimed was instrumental in *'driving environmental improvements'*. Bringing in links with employee skills, FC2 described such an employee as '*one of these magicians, he thinks outside the box and he is unbelievable, he's thought of a few things over the years'*, claiming *'he won't put anything in that he doesn't think is at the forefront of technology'*. An integrative approach emerged with significance here, with FC2 stating *'I am a firm believer that when you are bringing in something new you have to consult the people of the floor, they can give you the problems that need to be tackled'*. References to the recruitment of graduates also featured in discussion of employee skills, with FC19 claiming graduates '*come in with fantastic ideas and new technologies we can use in the fields'*, and FC16 claiming graduates '*bring in expertise to show us new ways to be innovative and drive the business forward, they are our future and they will manage us in the long term'*.

Implications for employee technological know-how and skills featured in clean technologies and sustainable supply chain management synergies (Weinberger et al, 2012) and clean technologies and innovation synergies (Andesson & Bateman, 2000; Cuerva et al, 2014). Adding some specificity, phase 2 results encourage the capability 'employee technological know-how and skills' to be replaced with **'recruitment and training of employees specialised in clean technologies'**.

Investment in Innovations for the Future

Investment in innovations for the future featured in 11 interviews and 2 observations. That is, FC1 claimed they want to invest in *'anything that is at the forefront of technology'*, FC16 claimed investment in '*innovation is key to sustainability'* and FC16 stated '*we invested £20m* [in clean technologies] *in the last two years and as a result we reduced our water footprint by about 50%'*. Discussion of investment commonly came back to financial return, with FC2 claiming '*when it comes to these technologies, it's a no-brainer when its £15,000 but with a two-year payback'* and FC13 describing clean technologies as '*a long-term investment, although it does stack up commercially, you could think of it as another income stream'*. Evidencing a focus on both financial return and positive environmental impacts, FC18 stated *'it kind of has to be a bit of both because when we need to finance the business investors want to see financial returns within a few years, but we do see the business as something that is intended to have an impact far beyond finances and far into the future'*. Discussions of investments in innovation also featured in observations, with FC1 pointing out a newly installed free cooling system in the factory intended to improve environmental impact and crediting it to company and government funding, and FC2 pointing out new tractors that they claim to have invested £5million in to maximise positive environmental impacts and efficiency and incorporate the latest technology.

Investment in innovation featured in initial conceptualisation of clean technologies with Hart (1997, p73) arguing that companies '*must begin to plan for and invest in tomorrow's technologies'*. Interestingly, in correspondence with phase 2 results, Lee & Min (2015) suggest a long-term perspective on the financial payback of sustainable investments supports adoption of such innovations. Taking all this into consideration, the capability 'investment in innovations of the future' is replaced with **'financial capacity to invest in clean technologies'** and **'assessment of long term financial and environmental returns'**

Organisational Capacity to Implement, Manage & Create Clean Technologies

Organisational capacity to implement, manage and create clean technologies featured in 8 interviews, albeit without creation of clean technologies. Management structures emerged with significance, with FC3 claiming *'short management chains'* support the implementation of clean technologies, and FC14 explaining *we've got a small management team so we are able to take on ideas and implement them quite quickly'*. Measurement and management systems also emerged with significance, with FC12 stressing the need to *'develop a clear energy strategy so that we can really focus on our operational efficiencies'* and for management systems that *'take into account sustainability'*.

There are some correspondences between such discussions and the earlier literature review. For example, exploration of clean technologies and innovation synergies revealed implications for an organizing capability in which intra-firm departments work together (Yam et al, 2010) and flexibility towards the adoption and implementation of new sustainable innovations (de Medeiros et al, 2014). Implications for management systems also featured in literature (Vachon, 2007; Cuerva et al, 2014). This along with the phase 2 results encourages the capability 'organisational capacity to implement, manage and create clean technologies' to be specified and divided into: **'integrated or short management structure in support of the fast implementation of new technologies'**; and '**management systems capable of running or measuring clean technologies'.**

8.3.4 Seizing External Capabilities

Sharing & Creating New Technologies Throughout the Supply Chain

Sharing and creating new technologies throughout the supply chain featured in 8 interviews. The focus fell on creating new technologies, with FC9 describing their suppliers as *'joint collaborators'* and FC5 claiming *'a lot of technologies come from working with the farmers'*. According to FC6, creating new technologies throughout the supply chain is effective because *'you might have an idea, but you only have 20% of that idea, so you bounce it off other* [supply chain members] *and somebody else has another 20% of that idea, or someone comes in with a totally different way of looking things and that gets us 60% of the way there'*. Reinforcing this, FC10 claimed creating clean technologies *'is not about working in isolation but about working together'*, whilst FC4 claimed *'sometimes having a partner helps'* with regards to the implementation of clean technologies.

Again, this can be considered a product of clean technologies founding need for new, clean processes and technologies (Hart, 1997). Clean technologies and sustainable supply chain management synergies also renders implications for supply chain aptitude for new technologies (Bell et al, 2012; Schrettle et al, 2014). Using descriptions of this in phase 2 results, the capability 'sharing and creating new technologies throughout the supply chain' is replaced with **'working with supply chain members to create and implement clean technologies'**.

8.3.5 Transforming Internal Capabilities

Ecological Leapfrogging

Eco-logical leapfrogging featured in 8 interviews and 1 observation. Interviewees spoke of their desire to *'buck the trend'* (FC2) and described themselves as *'quite pioneering and early adopters'* of clean technologies (FC4). A focus fell on the need to beat competitors, with FC13 claiming they *'adopt* [technology] *quickly ahead of the curve because it gives them an advantage'*, and FC14 rendering implications for differentiation stating *'we were one of the first* [to create clean technologies], *we managed to do something quite different'*. To some extent, ecological leapfrogging was observed during tour of FC4's site, in that when pointing out innovation awards, FC4 referred back to the roots of the company which they claimed encouraged the desire to experiment with and create new things. Moreover, during tour of the onsite wind and solar farms, FC4 made repeated reference to them being the largest and the first of their kind, suggesting this had resulted in considerable positive media attention.

Eco-logical leapfrogging as a clean technology capability was derived from exploration of clean technologies and sustainable supply chain management synergies, in which Weinberger et al (2012) call for the quick and innovative sustainable replacement of unsustainable processes or products. Phase 2 results reinforce this and as such the capability 'ecological leapfrogging' is confirmed as an internal clean technologies transforming capability.

Eco-design

Eco-design featured in 8 interviews and 1 observation. In the most part, this referred to designing and building sites specifically to support the implementation and operation of clean technologies and support positive impact operations. For example, FC12 claimed their new sites are purposely designed to facilitate *'investing in the renewable side'*, and claimed *'when and if we do look at new sites* [….] *we should be making those sites sustainability sites so that is where we will end up in the future'*. FC16 discussed designing their own *'£26m facility last*

year, that has 40% recycling rate, 100% carbon neutral and a load of innovation and technology', describing it as *'the most sustainable beef abattoir ever built because it was built from a sustainability point of view'*. Such an 'eco-designed' site was observed during tour of FC1's facility, which was designed so that produce could flow through in a linear fashion, maximising efficiency and preserving and supporting the distribution of energy and water. In order to evidence this, the tour began at the beginning of the internal process and finished at the end of the process, in which a logical approach and a reliance on technology was forcefully demonstrated.

Again, parallels can be noted with Hart's (1997) initial conceptualisation of clean technologies and its calls for the advanced development of new, clean processes and products and advanced reduction of energy and material consumption. Environmentally sustainable production systems (Matapolous et al, 2014; Garg et al, 2015) and process modification (Matapolous et al, 2014) also emerged with significance in clean technologies and sustainable supply chain management synergies, whilst eco-design itself featured in clean technologies and innovation synergies (Quist & Tukker, 2010; Boons & Lüdeke-Freund, 2013). It is descriptions derived from phase 2 results that encourage the capability 'eco-design' to be replaced with **'purpose built sites to maximise environmentalism and support clean technologies'**.

Creating Closed-Loop Systems

Creating closed-loop systems featured in 7 interviews and 1 observation, in which interviewees spoke at length of creating clean technologies that assumed a closed-loop philosophy. This included water technologies that not only permit reuse but create sand *'that is sterilised and full of nutrients'* to be used as top soil (FC2) and energy technologies that turn slurry into hydrogen power and straw into bioethanol to create *'better ways of generating energy'* (FC11). In addition, FC18 discussed using *'hydroponics and aquaculture to farm fish in water without soil'*, explaining *'it's the fish poo that creates nutrient rich water which we then pump to the roots of the plant to support their growth, the plants in turn then purify the water which is sent back to the fish'*, and describing it as *'essentially a closed-loop system'*. FC11 claimed that such closed-loop clean technologies offer *'both environmental benefits and waste management elements'*, whilst FC8 suggested they have allowed them to create their *'dream farm'* that is completely *'self-financing and self-sufficient'*. An example of a purposefully designed closed-loop system was observed at FC1, via tour of a water facility which collected rainwater from the factory floor, pushed it through the system using lasers

which operated only when needed, added in a natural element to separate water from mud but preserve high nutrient quality and then distributed both the water and the mud for reuse. Excess water from the system was also filtered through to a man-made pond intended to promote biodiversity, with FC1 claiming the system *'saved more water than could possibly be used'*.

As discussed, existing literature draws links between a closed-loop approach and product stewardship (Miemczyk et al, 2016), but not with clean technologies. However, as argued in the earlier literature review and demonstrated in phase 2 results, a closed-loop approach emerges with significance in clean technologies. That is, the presentation of a closed-loop as a system that derives value from by-products and effluents (Ashby et al, 2012; Bell et al, 2012; Garg et al, 2015; Govidan et al, 2015) resonates with clean technologies desire to derive value via the preservation and reuse of resources and waste (Pernick & Wilder, 2007). To some extent this is reinforced in the emphasis placed on a cradle-to-cradle approach (Bell et al, 2012; Jensen et al, 2013) and remanufacturing (Matapolous et al, 2014) in clean technologies and sustainable supply chain management synergies. Thus, using phase 2 results for empirical validation and clarity, the capability '**creating closed-loop systems'** is renamed **'the creation of closed-loop clean technologies'**.

Aptitude for Disruptive Change

Aptitude for disruptive change featured in 6 interviews. FC12 claimed *'conventional thinking will not be good enough to get us to where I think we want to be* [….] *it's healthy to have a disruptive attitude towards day-to-day activities'*, and added *'people understand and they know you can't stand still so they know I'm not being disruptive for the sake of being disruptive'*. Implications for disruptive change also featured in FC4's claim that *'the thing we've never been frightened of is taking a risk with something'* and FC16's claim that *'we are that type of innovative company'* that loves to take on new challenges.

The need for disruptive change in clean technologies featured prominently in seminal natural-resource based clean technologies, in which it is argued that companies must accept disruptive change (Hart & Milstein, 1999) and cannibalising technologies (Hart & Dowell, 2011). Phase 2 discussions imply that interviewees are accepting of such disruption and technologies, and as such the capability 'aptitude for disruptive change' is confirmed as a clean technologies transforming internal capability.

Strategic Planning for the Future

Strategic planning for the future also featured in 6 interviews. For example, FC6 stated '*part of decision making is guessing what the future will hold'*, whilst FC10 stated *'you have to look at doing things differently for the future'.* In large part, interviewees claimed to assume a long-term perspective, which FC13 claimed is common in agri-food because farmers *'aren't there to make a fast buck on the latest trend'*, whilst FC7 claimed farmers '*have more of a long-standing commitment to do as much as we possibly can at this time for the environment'*. Mission and vision statements emerged with significance here, with FC6 stating '*ours is to maintain or improve the land for the next generation'* and FC4 stating *'our vision for the future is to be a Scottish global brand from the greenest company in Britain'*, adding '*we want to be 100% self-sufficient in renewable energy'*.

Again, strategic planning featured prominently in seminal natural-resource-based view studies, in that it is argued that clean technologies required future planning and vision (Hart & Milstein, 1999; Hart & Dowell, 2011). In addition, strategic planning emerged as a capability in exploration of clean technologies and innovation synergies (Yam et al, 2010). Thus, the capability 'strategic planning for future' is also confirmed as a clean technologies transforming internal capability.

A Global Lifecycle Perspective of Operations

A global lifecycle perspective of operations featured in 5 interviews, albeit without discussion of lifecycles. That is, interviewees commonly implied clean technologies were intended to protect and support the planet via positive impact operations. For example, FC4 claimed '*we feel we're doing our own little bit for the world or the climate'* via their clean technologies, whilst FC17 claimed clean technologies are '*something that our species as a whole needs to start thinking about, and thinking about the way we interact with this planet in an entirely different way'*.

Implications for a global lifecycle perspective were derived from clean technologies and sustainable supply chain management synergies, in which parallels were drawn between clean technologies and corporate environmental responsibility. More specifically, Kovác (2008) stresses the need to consider the impact of operations on the global environment, whilst Kogg & Mont (2011) discuss the need to consider operations from a global perspective. Phase 2 results encourage the capability 'a global lifecycle perspective of operations' to be replaced

with **'organisational responsibility to render positive environmental impacts on a global scale'**.

8.3.6 Transforming External Capabilities

Knowledge Transfer & Capacity Building throughout Industry

Knowledge transfer and capacity building throughout the industry featured in 10 interviews. In the most part this involved the promotion of clean technologies and research throughout industry to *'ensure the overall industry environmental impact is reduced as well'* (FC3). For example, FC8 claim *'we are keen to promote what we've learnt and I think that is really valuable* [….] *on the wider scale as an industry and as society'*, whilst FC4 claimed *'though we want to be the greenest company we don't want that to be at the expense of everyone else, the more you share the greener the country will be'*. Interviewees spoke of delivering talks, giving press interviews, providing tours of or access to sites and sharing information with marketing groups to promote clean technologies throughout industry. References were also made to working with legislation and policy, with FC20 stating '*we all need to work together to stop the mentality we've got into, we need new laws about what we can do with food waste and new technologies to support that'*.

It was through exploration of clean technologies and sustainable supply chain management synergies in which knowledge transfer and capacity building emerged as a clean technology capability. More specifically, Weinberger et al's (2012) paper on environmental technologies stresses the need for knowledge transfer and capacity building. Using phase 2 results as empirical validation, the capability 'knowledge transfer and capacity building throughout the industry' is confirmed as a clean technologies transforming external capability.

Commercialization of Clean Technologies

Commercialization of clean technologies featured in 6 interviews, with interviewees claiming their patented technologies are *'selling all over the world'* (FC2). In addition FC18 claimed to be attracted to aquaponics solely because *'no one had really commercialised it yet'*. Interviewees also spoke of selling energy generated from energy technologies, with FC4 claiming their commercialization of energy technologies has allowed them to become *'an energy producer'*.

In Hart & Dowell's (2011) fifteen-year review of the natural-resource-based view it is argued that companies require commercialization capabilities in clean technologies. Again,

phase 2 results empirically validate this and as such the capability 'commercialization of clean technologies' is confirmed as a clean technologies transforming external capability.

8.3.7 Emergent Capabilities

The industry review and phase 1 of the empirical study identified 5 emergent clean technologies capabilities. As demonstrated in table 8.10 below, 3 of those 5 capabilities were validated by phase 2 interviews. These are discussed here, and incorporated into the final definition of clean technologies capabilities (*table 8.12*).

Table 8.10 Phase 2 coding results of clean technologies emergent capabilities

Emergent Capability	Presence in Data	Food Company	Sample Data
External Partnerships	12 Interviews	2; 3; 4; 8; 9; 10; 11; 12; 13; 15; 16; 20	*'We have all sorts of people working with us on tech, the scientific community, the civil society, the government, NGOs'* (FC10)
Environmental Off-setting	4 Interviews	4; 8; 16; 18	'*We are offsetting for every for every kilowatt of electricity'* (FC4)
Use of Online Forums	0		
Industry Conferences	0		
Family Management Principles	8 Interviews	3; 4; 6; 7; 9; 12; 13; 14	*'My children are going to benefit from what we do now* [….] *you have to leave it as you found it, if not better'* (FC7)

External Partnerships

External partnerships featured in 12 interviews. Interviewees spoke of partnerships with academics, universities, research institutes and innovation advisory boards to work on specific clean technologies projects such as '*creating fuel cells and prototypes which can potentially be used to convert slurry into hydrogen as a source of power'* (FC11). References were also made to collaborating with external food companies, with FC20 claiming *'the owner does a lot of collaborations, he gets really excited about what new companies are doing and how people are creating better, more sustainable food'*. Partnerships with energy companies emerged with significance, with FC13 claiming you can '*partner up with an energy company'* to invest in and implement clean technologies. According to FC12 *'your partners help you decide on a commitment and that drives the strategy of the business'*.

External collaborations emerged as a clean technologies capability in the industry review, in which it is argued that collaboration with external companies supports the identification and creation of new clean technologies (Visser, 2014). This corresponds with clean technologies pursuit of new, clean technologies and processes (Hart, 1997) and is considered further support

for the earlier discussed external seizing capability 'working with supply chain members to discover and implement clean technologies'. In addition, phase 2 results facilitate the emergence of an additional clean technologies seizing external capability: **'partnerships with energy companies to support energy technologies'**.

Family Management Principles

Family management principles featured in 8 interviews in that interviewees implied that family ownership or management meant they were more likely to invest in clean technologies. This was commonly linked with a long-term view of environmental impact and sustainability, with FC14 claiming their family ownership means *'we may take a slightly different view to other companies, I think we may take perhaps a longer-term view'*. Similarly, FC4 claimed their family ownership gave them a *'long-term view that you are looking after the land'*, whilst FC7 claimed '*my children are going to benefit from what we do now'*, adding *'you have to leave it as you found it, if not better'*. Reinforcing this, FC6 stated *'we have three kids, so we do expect to make long-term investments* [….] *we've had four generations here already and there is no reason we can't keep in shape for another four generations, it's all about that, all about building for the next generation'*, claiming *'the family thing is definitely the driver, you make some seriously different decisions'*.

This corresponds with phase 1 results, in which it was claimed that family management principles encourage a *'genuine desire to achieve sustainability in the long term'* (Interviewee 7), which in turn drives interest in clean technologies. Thus, using phase 2 descriptions, the capability **'desire to provide for future generations'** emerges a clean technologies transforming internal capability.

Environmental Off-Setting

Environmental off-setting featured in just 4 interviews, but assumed clear links with clean technologies. That is, FC8 claimed to offset the environmental impact of their products by introducing positive impact initiatives, making specific reference to a '*compost hub that we have at the factory which about 150 tonnes of compost goes through every year'* which is then shared with local and global environmental organisations. References were also made to '*offsetting for every for every kilowatt of electricity*' (FC4) and '*offsetting travel emissions*' (FC16).

Environmental offsetting initially emerged as a clean technologies capability in phase 1 interviews, in which interviewees spoke of offsetting carbon emissions. However, neither

phase 1 or phase 2 results are enough to present environmental off-setting as a clean technologies capability. Rather, implications for positive impacts and a global reach render consideration of, and thus reinforce, the earlier discussed internal clean technologies transforming capability of 'organisational responsibility for positive environmental impacts on a global scale'.

8.3.8 Newly Emergent Capabilities

Again, interviewee discussions of clean technologies facilitated the identification of newly emergent capabilities. These are detailed in table 8.11 below, and are discussed throughout this section.

Table 8.11 Phase 2 coding results of clean technologies newly emergent capabilities

Emergent Capability	Presence in Data	Food Company	Sample Data
Personal Interests in Clean Technologies	6 Interviews	2; 4; 6; 8; 9; 14	*'We do have some excitement about trying new things, when something becomes available we want to try it'* (FC4)
Evidencing expertise in clean technologies & positive impact operations	4 Interviews	2; 3; 4; 14	*'That's why we have turbines and cows and stuff on our packaging. It sends that message out'* (FC4)

Personal Interests in Clean Technologies

Personal interests in clean technologies featured in 6 interviews. That is, interviewees implied that a personal passion for technology drove identification and implementation of clean technologies. For example, FC8 stated *'I started this business* [….] *and I would still want to operate as sustainability as I could'*, adding *'I do have strong personal beliefs when it comes to sustainability'* and the need for technology. According to FC4, such personal interests became company-wide to create *'an attitude'* throughout the company of finding new things, whilst FC6 claimed they encouraged an organisational wide desire *'to keep making strides, making it sustainable in the longer term'*.

However, whilst it is clear that personal interests do play a role in clean technologies, they again do not emerge as their own capability. Rather personal interests in clean technologies offers further support for the earlier discussed sensing capability of 'employee awareness of clean technologies', encouraging its slight modification to **'employee awareness of and interest in clean technologies'**. Similarly, discussions of a company-wide ethos for trying out something new supports the earlier discussed capability of 'aptitude for disruptive change', encouraging its slight modification to **'company-wide ethos of disruptive change'.**

Evidencing Expertise in Clean Technologies & Positive Impact Operations

Evidencing expertise in clean technologies and positive impact operations featured in 4 interviews. An emphasis fell upon customers, with FC2 claiming that clean technologies are *'a big appeal'* to customers, because *'you've got to be seen to be ticking the right boxes'*. FC4 stated '*consumers like to see us doing our bit for the planet'*, and claimed to use social media, newsletters and packaging to demonstrate their expertise in clean technologies and a positive impact approach to customer. Going beyond customers, FC3 claimed to advertise their clean technologies in response to '*global aspirations about being nice to the planet'*, whilst FC14 stated '*we produce a quarterly wildlife report that goes on our website'*, adding '*we find it delivers some real positives within our business and actually the conversations we are able to have with people'*. Interestingly, FC3 implied that failing to evidence responsibility or expertise in clean technologies may impact detrimentally on the business, stating '*people will look up* [at the farm] *and think it's a horrible set-up'*. Based on such discussions, the capability **'evidencing expertise in clean technologies and positive impact operations'** emerges as a clean technologies seizing external capability.

Table 8.12 Empirical definition of dynamic clean technologies capabilities

Clean Technologies Capabilities		
	Internal	**External**
Sensing	➢ Continuous improvement & assessment of environmental impact ➢ **Environmental & financial measures to identify clean technologies opportunities** ➢ Employee awareness of and interests in clean technologies ➢ Resource impact assessment ➢ Seeking out clean technologies to satisfy personal technological interests	➢ **Clean technologies aimed at customer needs & expectations** ➢ **Consultation of relevant bodies and sources to uncover clean technologies**
Seizing	➢ **Recruitment & training of employees specialised in clean technologies** ➢ **Financial capacity to invest in clean technologies** ➢ **Assessment of long-term financial & environmental return expectations** ➢ **Integrated or short management structure in support of the fast implementation of new technologies** ➢ **Management systems capable of running or measuring clean technologies** ➢	➢ **Working with supply chain members and externals to create & implement clean technologies** ➢ *Partnerships with energy companies to support energy technologies* ➢ **Evidencing expertise in clean technologies & positive impact operations**
Transforming	➢ Ecological leapfrogging ➢ **Purpose built sites to maximise environmentalism & support clean technologies** ➢ **Creation of closed-loop clean technologies** ➢ **Company-wide ethos for disruptive change** ➢ Strategic planning for the future ➢ **Organisational responsibility to positive environmental impacts on a global scale** ➢ *Desire to provide for future generations*	➢ Knowledge transfer and capacity building throughout industry ➢ Commercialization of clean technologies

*Capabilities shown in bold are renamed; capabilities in italics are emergent capabilities

8.4 Base of the Pyramid Results

Base of the pyramid featured, albeit obscurely, in just 2 interviews. FC3 expressed interest in emerging markets such as Russia, India, China, Saudi Arabia, Cuba, Morocco and Thailand, demonstrating concern for both social and ecological degradation in such markets. More specifically, FC3 claimed *'emerging markets are a long way off making a commitment to moral decisions'*, and added *'water use* [and] *soil is a big issue for some of the emerging markets'*. Similarly, FC10 discussed working in Russia, the Middle East, and references to *'climate change and severe weather conditions'* and the *'changing economic outlook and the volatile commodity prices* [that]*impact on the farmer'* in such markers demonstrated some correspondence with base of the pyramid. Reinforcing this, and bringing in links with clean technologies, FC10 stated *'as a global company we have a responsibility to develop best practices and find the best solutions and put that into training all over the world, like we did with drip irrigation'*. Outside of FC3 and FC10's discussions of base of the pyramid, interviewees did express some interest in emerging markets, claiming that *'the world is becoming a smaller place'* (FC4) and stressing *'demand for* [British] *products all around the world'* (FC15). This did involve some minor implications for ecological degradation, with references to sustainable global sourcing, destruction of rainforests and global water scarcity. To a lesser extent, references to social degradation also featured, primarily focused on world hunger and malnutrition.

However, whilst this does demonstrate some correspondence with Prahalad & Hart's (2002) base of the pyramid, missing from such discussions were links with competitiveness or enhanced innovativeness. Rather, emerging markets featured as opportunities to expand sales, and were rarely distinguished from established markets. Thus, it is again difficult to confirm the existence of base of the pyramid and consequently empirically validate base of the pyramid conceptual capabilities.

8.5 Common Capabilities

As detailed throughout this chapter, phase 2 interviews resulted in empirical explication of 72 dynamic natural-resource-based view capabilities: 26 for pollution prevention; 21 for product stewardship; and 25 for clean technologies. Not only is this the first empirical definition of such capabilities, but the detailed descriptions of each capability in supporting its

corresponding resource responds to calls for the explanation of the complex relationship between capabilities and resources and competitiveness over time (Grant, 1991; Rashidirad et al, 2015). This said, to some extent this falls short of overcoming natural-resource-based view issues of practical inapplicability, in that 72 capabilities offers a somewhat convoluted depiction of the operationalisation of the natural-resource-based view. As such, it may be of value to identify common capabilities between the empirical findings for pollution prevention, product stewardship and clean technologies. Reinforcing this approach is Nath et al (2010), who in acknowledgement of the complexities of defining specific resource-based capabilities, stresses the value of common capabilities in competitive resources.

This said, definition of common capabilities should not detract from the definition of specific pollution prevention, product stewardship and clean technologies capabilities, nor the value of each resource in its own right. It is the explication of specific capabilities in each resource that remains the core objective of this study, and in which the complex relationship between a capability and its corresponding resource is elucidated. Whilst some common capabilities do exist, arguably on account of the interrelated nature of natural-resource-based view resources (Hart, 1997), they are subject to variance according to their corresponding resource. For example, measurement emerged as a prominent sensing capability in pollution prevention, product stewardship and clean technologies, but the types of measurements and the 'sensed' opportunities differed. The internal measurement of carbon, effluents, utilities and recycling levels identified areas of built up waste in pollution prevention, lifecycle measurements were used to identify opportunities for environmental improvement throughout the supply chain in product stewardship, and financial measures were used in clean technologies to assess the scope for investment and potential return of new technologies. Thus, whilst common capabilities may offer a more approachable, albeit simplified, depiction of natural-resource-based view capabilities, exclusivity and classification of capabilities according to their own resource remains important.

This section builds upon commonalities between the 72 empirical pollution prevention, product stewardship and clean technologies capabilities, to produce 17 common capabilities *(table 8.13)*. As with conceptual definition of capabilities this was achieved via extensive discussion between three independent researchers. Taking into consideration the resource-based theory, natural-resource-based view and dynamic capabilities roots, such common capabilities can be considered to guide the continuous identification and exploitation of sustainability opportunities for competitiveness over time. Notably, the absence of base of the

pyramid in the empirical results prevents its inclusion, as and such common capabilities only represent pollution prevention, product stewardship and clean technologies.

8.5.1 Natural-Resource-Based View Sensing Capabilities

Performance Measurements

'Environmental, operational and financial measures to identify areas for improvement' emerged as a pollution prevention capability, 'lifecycle measurements and analysis of products and processes' emerged as a product stewardship capability, and 'environmental and financial measures to identify clean technologies' emerged as a clean technologies capability. Given that all three of these capabilities were categorized as sensing internal capabilities, it becomes clear that internal measurements assume a prominent role in seeking out natural-resource-based view opportunities. Thus, taking an inclusive title, '**performance measurements'** can be considered a common capability.

Employees

'Cross-functional integration in support of the identification of issues and opportunities' emerged as a sensing internal pollution prevention capability, whilst 'employee awareness of and interest in clean technologies' emerged as a seizing internal clean technologies capability. As such, it appears that employees also play a prominent role in seeking out natural-resource-based view opportunities. Reinforcing this is product stewardship's sensing external capability of 'problem and know-how sharing with suppliers, customers and competitors via meetings, conferences and online forums' which also places a reliance on employees. As such, '**employee aptitude to seek out new opportunities'** emerges as a common capability.

Continuous Improvement

'Continuous improvement and optimization of machinery and processes to seek environmental improvements' emerged as a pollution prevention sensing internal capability, whilst 'continuous improvement and assessment of environmental impact' emerged as a clean technologies sensing internal capability. Whilst continuous improvement did not emerge explicitly as a product stewardship capability, prominent discussions of lifecycle analysis demonstrate some correspondence with a continuous improvement approach. As such, '**continuous improvement of internal processes to maximise environmentalism'** can be considered a common sensing capability.

Personal Sustainability Interests

'Personal motivations in seeking out prevention opportunities' emerged as a new pollution prevention sensing internal capability, whilst 'seeking out clean technologies to satisfy personal technological interests' emerged a new clean technologies sensing internal capability. Whilst again personal preferences did not feature in any of product stewardship's sensing internal capabilities, this remains an interesting finding. Thus, whilst it can't be considered a common natural-resource-based view capability, it does perhaps add some reinforcement to the aforementioned common capability of 'employee aptitude to seek out new opportunities'.

External Memberships, Consultations & Affiliations

'Affiliations with external organisations to enhance environmental understanding and guide prevention' emerged a pollution prevention sensing external capability, 'memberships and consultations with relevant bodies' emerged a product stewardship sensing external capability, and 'consultation of relevant bodies and sources to uncover clean technologies' emerged as a clean technologies sensing external capability. Thus, it becomes clear that such external connections can help to seek out new natural-resource-based view opportunities, presenting **'external memberships, consultations and affiliations'** as a common capability.

Customers

'Analysis of and striving to meet customers' environmental needs and standards' emerged as a pollution prevention external sensing capability, 'problems and know-how sharing with suppliers, customers and competitors via meetings, conferences and online forums' emerged as a product stewardship external sensing capability, and 'clean technologies aimed at customer needs and expectations' emerged as a clean technologies sensing external capability. From this, commonalities emerge surrounding the need to understand customer expectations of sustainability and striving to meet them. As such, **'analysis and prioritisation of customers' sustainability expectations'** emerges as a common capability.

Competitors

'Competitor comparison and benchmarking of waste and pollution' emerged as a pollution prevention sensing external capability, whilst references to competitors can also be noted in the product stewardship sensing external capability of 'problems and know-how sharing with suppliers, customers and competitors via meetings, conferences and online forums'. Moreover, some discussion of competitors featured in reference to the clean technologies sensing external capability of 'consultation of relevant bodies and sources to uncover clean

technologies'. Thus, awareness of and comparison to competitors' sustainability also appears to help seek out natural-resource-based view opportunities, presenting **'analysis of competitors' sustainability behaviours'** as a common capability.

8.5.2 Natural-Resource-Based View Seizing Capabilities

Employees

Employees again emerge as a commonality with regards to seizing internal capabilities. That is, both 'encouraging employee involvement in prevention via training and reward' and 'the recruitment and nurturing of employees skilled in environmental behaviour' emerged as pollution prevention capabilities, 'employee training and specialisation in environmental operations' emerged as a product stewardship capability and 'recruitment and training of employees specialised in clean technologies' emerged as a clean technologies capability. The amalgamation of these capabilities presents **'maximisation of sustainability skills and knowledge in employee training and recruitment'** as a common capability.

Measurement

Measurement also re-emerges as a common natural-resource-based view capability in seizing as it did sensing. That is 'the use of environmental or ISO management systems to measure, manage and guide prevention' featured as a pollution prevention seizing internal capability, whilst 'assessment of long-term financial and environmental return expectations' featured as a clean technologies capability. However, rather than being about identifying new natural-resource-based view opportunities, measurement here is about helping to implement and manage such opportunities once they have been 'seized'. Internal systems and technologies emerge with particular significance here, with 'internal systems such as lean and six-sigma to guide and support new prevention processes' featuring as a pollution prevention seizing internal capability', 'implementing technologies to help management and measure sustainability' featuring as a product stewardship capability and 'management systems capable of running or measuring clean technologies' featuring as a clean technologies seizing internal capability. Taking all of this into consideration, **'management systems in support of the implementation and measurement of internal sustainability processes and technologies'** emerges a common capability.

Accreditations

'Attaining environmental accreditations that support and demonstrate prevention' emerged as a pollution prevention seizing external capability, whilst 'environmental accreditations to

support sustainable operations' emerged as a product stewardship seizing external capability. As such it appears that external accreditations support the realisation of the natural-resource-based view. Reinforcing this, albeit without explicit reference to accreditations, is the pollution prevention seizing external capability of 'external reporting of prevention plans and results' and clean technologies seizing external capability of 'evidencing expertise in clean technologies and positive impact operations', both of which rendered implications for reporting in line with environmental accreditations. As such, **'environmental accreditations'** can be considered a common seizing capability.

Collaborations

Collaborations emerge as the most dominant common natural-resource-based view capability. That is collaborations feature in one pollution prevention capability, three product stewardship capabilities and two clean technologies capabilities. More specifically, 'partnerships to support recycling and prevention' for pollution prevention, 'building and nurturing trusted relationships throughout the supply chain to support a stewardship approach to sustainability', 'cooperation with supply chain members and externals to meet for environmental objectives and create lower impact operations and products' and 'shared environmental technology and machinery throughout the supply chain' for product stewardship, and 'working with supply chain members and externals to create and implement clean technologies' and 'partnerships with energy companies to support energy technologies' for clean technologies. The amalgamation of these 6 capabilities presents **'supply chain collaborations to create and invest in sustainable processes and technologies'** as a common seizing capability.

Reuse and Recycling

'Implementation of prevention and recycling technologies, processes and KPIs' emerged as a pollution prevention seizing capability, whilst 'reuse or manufacturing of waste for value throughout the supply chain' emerged as a product stewardship seizing capability. In addition, the pollution prevention seizing capability of 'partnerships to support recycling and prevention' and the clean technologies seizing capability of 'partnerships with energy companies to support energy technologies' involved some discussion reuse of waste products. Thus, reuse and recycling also emerges as a commonality in pollution prevention, product stewardship and clean technologies capabilities. However, some complexity arises in the categorization of pollution prevention's 'implementation of prevention and recycling technologies, processes and KPIs', as an internal capability, whilst the other capabilities are categorized as external. Thus, it would appear that reuse and recycling assumes both and

internal and external focus, encouraging the emergence of two common capabilities: **'reuse and recycling of internal wastes'** and **'reuse and recycling of waste throughout the supply chain'**.

8.5.3 Natural-Resource-Based View Transforming Capabilities

Circularity

'The creation of new internal closed-loop prevention processes and technologies' emerged as a pollution prevention transforming internal capability, 'creating products and packaging specifically intended for recycling and reuse' emerged as a product stewardship transforming internal capability, and 'the creation of closed-loop technologies' emerged as a clean technologies transforming internal capability. From this clear commonalities emerge surrounding the '**creation of circular processes, products and technologies'**, permitting its presentation as a common transforming capability.

Organisational Commitment to Environmentalism

'Organisational commitment to the environment' emerged as a pollution prevention transforming internal capability, whilst 'organisational responsibility to positive environmental impacts on a global scale' emerged as a clean technologies transforming internal capability. As such, it appears that the organisations' own commitment to environmental issues plays a prominent role in the natural-resource-based view. Reinforcing this is the pollution prevention transforming internal capability of 'environmentally driven organisational culture', whilst product stewardship's transforming internal capability 'creation of supply chain environmental policy' also involved discussions of internal environmental culture. As such, the capability **'organisational commitment to the environment'** can be considered a common capability. 2

Future Generations

'Protection and creation of a sustainable family legacy' emerged as a new pollution prevention transforming internal capability, whilst 'desire to provide for future generations' emerged as a new clean technologies transforming internal capability. From this it can be argued that concern for future generations, both from a firm perspective and a sustainability perspective, plays a role in the natural-resource-based view. Reinforcing this is clean technologies' transforming internal capability of 'strategic planning for the future'. As such **'prioritisation of future generations'** emerges as a common capability.

Externally Promoting Sustainability

The product stewardship transforming external capabilities of 'informing suppliers about the benefits of cleaner production and encouraging environmental action and certification' and 'promoting sustainable behaviour via external communications', along with the clean technologies transforming external capability of 'knowledge transfer and capacity building throughout industry' identify commonalities surrounding the external communication of sustainability. As such, **'externally promoting sustainability'** emerges as a common capability.

Collaborations

As with seizing, collaborations also emerge with significance in transforming capabilities. That is, pollution prevention's 'sourcing funding for new environmental processes and technologies' made reference to external collaborations with other firms, governments and NGOs, whilst product stewardship's 'co-evolution with customers and suppliers' also renders clean implications for collaboration. Moreover, clean technologies 'knowledge transfer and capacity building throughout industry' makes reference to collaborations throughout both the supply chain and industry as a whole. With this in mind, **'external collaborations to drive sustainability'** also emerges as a common transforming capability.

Table 8.13 Common pollution prevention, product stewardship & clean technologies capabilities

Common Capabilities		
	Internal	**External**
Sensing	➢ Performance measurements ➢ Employee aptitude to seek out new opportunities ➢ Continuous improvement of internal processes to maximise environmentalism	➢ External memberships, consultations & affiliations ➢ Analysis & prioritisation of customers' sustainability expectations ➢ Analysis of competitors' sustainability behaviours
Seizing	➢ Maximisation of sustainability skills & knowledge in employee training & recruitment ➢ Systems in support of the implementation & management of internal sustainability processes & technologies ➢ Reuse and recycling of internal waste	➢ Environmental accreditations ➢ Supply chain collaborations to create & invest in sustainable processes & technologies ➢ Reuse and recycling of waste throughout the supply chain
Transfor	➢ Creation of circular processes, products & technologies ➢ Organisational commitment to the environment ➢ Prioritisation of future generations	➢ Externally promoting sustainability ➢ External collaborations to drive sustainability

8.6 Summary of Findings

The completion of phase 2 of the empirical study resolved the final research objective of this study, and in doing so successfully answers the research question guiding this study: *what are the organisational capabilities that support the four natural-resource-based view resources in practice?* Again, disparities exist surrounding the existence of base of the pyramid, but nonetheless phase 2 results, in line with the results of the industry review and phase 1 of the empirical study, reinforce the existence of pollution prevention, product stewardship and clean technologies. Phase 2 interview's detailed descriptions of these resources provide value insight into their operationalisation, explicating and elucidating dynamic natural-resource-based view capabilities.

Pollution prevention, in line with the earlier literature and industry reviews and phase 1 of the empirical study, enjoys a prominent and positive representation in phase 2 results. A high level of correspondence exists between conceptual pollution prevention capabilities and those explicated from empirical investigation, whilst emergent capabilities from the industry review and phase 1 and newly emergent capabilities from phase 2 are also included in the final empirical definition of pollution prevention capabilities. Interestingly, in some divergence from dominance of pollution prevention throughout preceding stages of this study, product stewardship emerges as the dominant resource in phase 2. That is, of all resources, product

stewardship warranted the greatest discussion in interviews, and pertinently featured in all 20 interviews. Again, capabilities explicated from such discussions demonstrated correspondence with conceptual capabilities and emergent capabilities, and facilitated the emergence of some new capabilities. Clean technologies also warranted detailed discussion in interviews, resulting in successful explication of capabilities that again correspond with conceptual capabilities and emergent capabilities whilst identifying new capabilities. Review of all pollution prevention, product stewardship and clean technologies capabilities identified a number of commonalities, permitting the identification of 17 common capabilities in support of competitive sustainability in UK agri-food.

The absence of base of the pyramid in phase 2 results corresponds with phase 1 results and follows on from its negligence in literature and its inconsistent presence in the industry review. Nonetheless, the resource is still not falsified as a result of this study's non-contradictory synthesis, consideration of contextualities and appreciation of the intended scarcity of natural-resource-based view resources (Hart, 1995).

Table 8.14 Phase 2 Findings

Phase 2 Findings	
Pollution Prevention	➢ Existence in industry empirically evidenced ➢ 26 capabilities empirically defined
Product Stewardship	➢ Existence in industry empirically evidenced ➢ Emerges as dominant resource ➢ 23 capabilities empirically defined
Clean Technologies	➢ Existence in industry empirically evidenced ➢ 24 capabilities empirically defined
Base of the Pyramid	➢ Existence in industry unconfirmed ➢ Empirical definition of capabilities impossible

9.0 Emergent Findings

The purpose of this study was to explicate the capabilities of pollution prevention, product stewardship, clean technologies and base of the pyramid. With the exception of base of the pyramid, this has been achieved. However, two additional findings of interest emerge from this study. More specifically, prominent discussions of social sustainability out with a base of the pyramid context warrant the proposal of a fifth natural-resource-based view resource, whilst phase 2 findings contradict the traditional linear presentation of the natural-resource-based view. Accordingly, this chapter proposes 'local philanthropy' as the fifth resource, and a shift from the natural-resource-based view hierarchy to a natural-resource-based view cycle.

9.1 Local Philanthropy as a Fifth Resource

Whilst the industry review and empirical study did not confirm the existence of base of the pyramid, a social sustainability resource did emerge with significance. That is, the results of the industry review and both phase 1 and phase 2 of the empirical study revealed detailed discussions of social sustainability in a competitive context. Such discussions do not correspond with Prahalad & Hart's (2002) base of the pyramid, in that the emphasis did not fall upon emerging markets or opportunities for innovation. Instead, social sustainability applied to local contexts, and focused on the alleviation of social ills via philanthropic initiatives and investments. Despite philanthropic foundations, competitive benefits surrounding commercial opportunities and differentiation were notable and correspond with the competitive underpinnings upon which resource-based theories are founded (Wernerfeldt, 1984; Hart, 1995; Russo & Fouts, 1997). Moreover, arguments that social sustainability is increasingly difficult to realise in modern business (The Guardian, 2016; Gould, 2016) correspond with resource-based theories' presentation of competitive resources as those that are '*presently scarce, difficult to imitate'* (Powell, 1992, p552). Taking this into consideration, a fifth natural-resource-based view resource in which social philanthropy in local markets permits competitive differentiation is proposed. This resource is named local philanthropy.

Notably, such discussions demonstrate some correspondence with Kolk et al's (2014) argument that base of the pyramid over time has diverged from its global focus and profit intentions to become a locally-focused strategy. However, as detailed in the literature review, such an argument somewhat undermines the rarity and inimitability of competitive resources

(Barney, 2001) and the global intentions of sustainable development from with which it was derived (WCED, 1987). Moreover, Hart et al (2016) forcefully contend that base of the pyramid as it was initially conceived remains a feasible, albeit complex, resource in modern business. Reinforcing this is the growth of social sustainability efforts focused upon the development of emerging markets (Berger-Walliser & Shrivasta, 2015) as discussed in the literature review and demonstrated to some extent in the industry review (DEFRA, 2012b; NFU, 2014; UK Trade and Investment, 2016). It is for such reasons that base of the pyramid is not falsified in this study, and local philanthropy is not proposed as its alternative. Rather, local philanthropy represents social sustainability as it appears most prominently in the UK agri-food sector, and conceptualises it as a competitive resource alongside the four other natural-resource-based view resources *(table 10.1)*. Whilst comparison can be made to corporate social responsibility and the triple-bottom line, which also share philanthropic intentions and links with competitiveness (Maloni & Brown, 2006; Hutchins & Sutherland, 2008; Matapolous et al, 2014; Berger-Walliser & Shrivasta, 2015), its presentation as a competitive resource goes beyond this to encourage the exploitation of locally-focused social sustainability for firm gain. This also addresses the natural-resource-based view's negligence of such social sustainability and responds to calls for greater conceptualisation of social sustainability in the domestic market (Hutchins & Sutheland, 2008).

Table 9.1 A five-resource perspective of the natural-resource-based view

Pollution Prevention
➢ The minimisation of waste & emissions via prevention rather than disposal ➢ Reduced emissions & capital expenditure ➢ Financial, efficiency and quality competitive benefits
Product Stewardship
➢ Prioritisation of natural environment throughout entire lifecycle ➢ Creation of wholly sustainable products ➢ Financial, efficiency and quality competitive benefits throughout supply chain
Clean Technologies
➢ Positive impact operations, process focused ➢ Move away from traditional routines to support positive impact operations ➢ Financial, efficiency and quality benefits and creation of value and differentiation
Local Philanthropy
➢ Philanthropic activities in local markets ➢ Stimulation of economic and social development via community embeddedness and investment ➢ Competitive differentiation
Base of the Pyramid
➢ Alleviation of social ills on a global scale ➢ Stimulation of economic growth/ support of emerging markets at the base of the pyramid ➢ Access to scarce/ unsaturated markets and enhanced innovativeness

Pertinently, whilst local philanthropy does emerge as its own resource, interrelations with the other resources do exist. For example, similarities can be noted with pollution prevention,

via local philanthropy's prioritisation of food poverty which places a reliance on preventing food waste. Local philanthropy's desire to support local farmers renders connotations of a lifecycle approach in line with product stewardship, whilst concerns for health, well-being and the promotion of sustainable lifestyles imply a positive impact approach that resembles clean technologies. As discussed, links can be made with base of the pyramid on account of the alleviation of social ills, but distinctions arise from the local versus global perspective, and philanthropic versus innovative profit driven motivations. Hart et al (2016) reinforce such distinction suggesting that base of the pyramid strategies commonly fail on account of philanthropic intentions, whilst Echebarria et al (2017) imply interconnectedness arguing that the alleviation of social ills in the domestic market may support the realisation of globally focused social sustainability. This is typical of resource based theory which places dependencies on combinative resource bundles (Rubin, 1973; Teece et al, 1997; Lockett et al, 2009) and corresponds with the intended interrelated nature of the natural-resource-based view (Hart, 1997).

9.1.1 Local Philanthropy in Industry

Local philanthropy initially emerged in the industry review, where a heavy focus on social sustainability, out-with the scope of base of the pyramid, was demonstrated. That is, there appeared a drive for food companies to attempt to alleviate social ills on a national or local scale via philanthropic activities. In particular, a focus fell upon the support of local farmers, animal welfare, the alleviation of food poverty and the promotion of healthy and active lifestyles. This corresponds discussions of local sustainability in the literature review, in which employment, healthcare and charitable donations emerged with significance (Hutchins & Sutherland, 2008). However, stressing the competitive value of such pursuits, industry sources render clear links with competitive differentiation (Davis, 2015; Roberts, 2016; Wood, 2016a; 2016b) as detailed throughout this section.

Support for Farmers & Animal Welfare

The results of the industry review indicated strong support for farmers in UK agri-food. It is argued that farmers are treated unfairly and under increasing pressure from major retailers (Harvey, 2016; Roberts, 2016), and this along with turbulent weather conditions and increased threat of disease has put *'Britain in the midst of a farming crisis'* (Rayner, 2016). As a result, buying directly from farmers, farm shops or farmers' markets is presented both as a means to support farmers and to support the local community and local business (Gregory-Kumar, 2015; NFU, 2016). Thus, placing a reliance on the supply chain (Roberts, 2016), retailers are

encouraged to promote locality and traceability to consumers (NFU, 2016; Roberts, 2016), and demonstrate commitment to the fair payment and treatment of all suppliers (Gregory-Kumar, 2015), which in turn offers opportunities for competitive differentiation (Roberts, 2016). Similarly, promotion of a high regard for animal welfare is presented as an opportunity for competitive differentiation (Davis, 2015), and in particular consumers are drawn to products where animals have been grass-fed and naturally-bred by local farmers (Roberts, 2016).

Food Poverty

The industry review also placed a heavy focus on 'the foodbank crisis'. That is, depleting socio economic conditions across the UK (Moreton, 2015) have resulted in growing numbers of people forced to turn to food banks for help feeding themselves and their families (Vision 2020, 2013). As a result, food banks and charities are placing increasing pressure on food companies to donate unsold food (Wood, 2016a). Again, within this there exists opportunities for competitive gain, in that after the prevention of waste altogether, the donation of food waste to charities and food banks is seen as the best way to create value from waste (Vision 2020, 2013). Evidencing this is Tesco, who having become the first major retailer to donate all unsold food, resulting in the provision of over 22,000 tonnes of food within 6 months (Mortimer, 2016), benefited from positive media attention and customer response (Wood, 2016a).

Health & Well-Being

The industry review also presented health as a national crisis (BBC, 2013) that food companies are under increasing pressure to address (The Green Party, 2016). Concerns surrounding overconsumption or consumption of junk foods are linked with growing levels of disease and ill-health (The Green Party, 2016). As such food companies are expected to play a role in enhancing accessibility and understanding of healthy and nutritious food (Roberts, 2016; Triggle, 2016). In response, health, nutrition and information surrounding responsible and healthy cooking are playing an increasingly prominent role in advertising, customer communications and packaging (BBC, 2013). In particular, a focus falls on children's health and diets (The Green Party, 2016; Triggle, 2016), encouraging initiatives such as free fruit for children (Wood, 2016b) and bans on targeting unhealthy products at children (BBC, 2013). As well as dietary concerns, food companies are also expected to promote healthy lifestyles and encourage exercise (BBC, 2013). There exist calls for the donation of land to be used as public gardens, parks, allotments and community orchards to facilitate the growth of sustainable lifestyles and promote exercise in local communities (The Green Party, 2016).

Again, competitive benefits are identifiable in suggestions that companies that demonstrate commitment to and concern for health and wellbeing benefit from positive customer response and differentiation (Wood, 2016b).

9.1.2 Local Philanthropy in Phase 1

The fifth resource also warranted minor discussion in phase 1 of the empirical study, featuring in 4 of the 7 interviews. In correspondence with the industry review results, interviewees discussed philanthropic activities intended to support the fair treatment of farmers, animal welfare, food poverty and health within a competitive context. For example, Interviewee 1 stated '*we treat our farmers fairly, we actually give them a price ahead of harvesting and that way if something goes wrong with that crop they still get paid that price and we just have to manage with what they give us',* claiming *'this is something we advertise'* to demonstrate support of local suppliers and communities and appeal to consumers. Interviewee 6 stated *'animal welfare is a big concern for us',* claiming it is something that their customers are looking for. Interviewee 7 claimed 'a *'focus should fall on human consumption* [....] *and we try to redistribute products that we realise we can't sell for community donations',* and claim to have incorporated health, wellbeing and family issues into decision making and marketing in order to be seen as *'a trusted brand'*. Thus, phase 1 results reinforce the feasibility and existence of local philanthropy as the fifth natural-resource-based view resource.

9.1.3 Local Philanthropy in Phase 2

Local philanthropy enjoyed a more prominent presence in phase 2 of the empirical study, where it featured in 17 of the 20 interviews. As discussed throughout this section, phase 2 interviewees demonstrated a strong desire to support local causes in line with those identified in the industry review and phase 1, and implied associated competitive benefits. As well as discussing support for farmers, animal welfare, food poverty and health and wellbeing, phase 2 results revealed additional activities of local philanthropy: sponsorship of local causes and charities and commitment to employees. Again this corresponds with discussions of locally-focused social sustainability in the literature review, in which charitable donations and employment issues emerged with significance (Hutchins & Sutherland, 2008).

Moreover, phase 2 discussions of local philanthropy facilitated the explication of local philanthropy capabilities, which are depicted and categorized in table 9.2. Pertinently, this assumed an inductive approach given that unlike the other natural-resource-based view resources, local philanthropy capabilities cannot be compared to existing literature or a

conceptual framework of capabilities. As such, further investigation of local philanthropy capabilities is recommended. However, it is notable that such capabilities demonstrate some correspondence with the common natural-resource-based view capabilities defined in the previous chapter *(table 8.13).* For example, measurement again emerges as a sensing internal capability, whilst 'awareness of issues in local community' corresponds with the common sensing external capability of 'external memberships, consultations and affiliations'. The prominence of employees in local philanthropy seizing internal capabilities corresponds with the common sensing internal capability of 'maximisation of sustainability, skills and knowledge in employee training and recruitment', whilst seizing external commonalities surround collaboration and eco-labelling. Similarly, local philanthropy transforming capabilities surrounding the promotion of healthy lifestyles and lobbying for social sustainability and legislation agree with the common transforming capability of 'externally promoting sustainability'. Again, such commonalities are perhaps a product of the interrelated nature of natural-resource-based view resources (Hart, 1997).

Support for Farmers

Support farmers emerged as a consistent theme in phase 2 interviews, largely surrounding discussion of the fair treatment of small suppliers and growers, with FC15 describing their treatment by large companies as a *'big problem'*. More specifically, FC2 claimed small farmers *'are losing money hand over fist'* at the hands of larger companies, and added *'there is no question the screw is getting tightened to the point there is no money in* [farming] *and when there's no money there is no enthusiasm, no drive* [….] *we need to look after our farmers'*. As such, FC17 call for '*small-scale, cool, artisanal ways of life that actually support the local community'* and are *'sustainable for our nation'*, linking failure to do so up to this point with *'benefits and levels of unemployment'*. Demonstrating competitive benefits, FC6 claimed to promote that their products are 100% Scottish because *'from a sustainability point of view that sends a bit of a message, people like the local aspect'*, whilst FC4 claimed using local produce provides them with a *'provenance'* that sets them apart from their competitors.

With regards to capabilities, the focus fell upon fair payment and treatment throughout the supply chain. That is, FC16 claimed their *'pay on the day'* approach to suppliers supports the farmer and *'puts a lot of money back into the community again'*, whilst FC9 stated *'we find that growers feel they are fairly treated by us, they get a fair price'*. An emphasis also fell upon local sourcing, with FC5 stating *'we harvest locally, from local coastal communities'*, and FC8 claiming *'local sourcing is something that we prioritise'*. Looking towards the other

end of the chain, FC17 claimed to choose customers to stock their product based on locality, claiming *'it is more that kind of 'buy local, support small businesses', which you know is a big part of sustainability, we're all for helping out the little guy'*. The creation of long-term committed relationships also emerged with significance, with FC2 suggesting that growers should seek *'a long-term, guaranteed margin with a main multiple'*, and FC10 stressing the need to *'develop fairness and trust'*. Eco-labelling also emerged as a capability, with particular reference to fair-trade which FC7 claimed *'supports farms by adding value and paying a good price'* and demonstrates commitment to farmers to consumers. Some references were also made to structure, with FC2 suggesting *'there needs to be more vertical integration between the main multiples and the growers'* in order to ensure the fairness, and FC17 claiming to have designed a new approach to the food chain that is *'essentially a new way of supplying seafood, ensuring fair prices for fishermen that fish responsibly'*.

Animal Welfare

Animal welfare was also discussed in phase 2 interviewees, with FC2 stating *'99% of farmers really care about the animals they are rearing'*, and FC16 claiming *'we look at animal welfare and the way we deal with our animals and respect them whilst they are living with us'*. FC7 claimed that to be focused on *'grassland farming'*, and boasted about becoming the first certified provider of free-range milk. Interestingly, discussions of animal welfare didn't just apply to animals involved directly in production or the supply chain, but rather references were made to supporting local wildlife on a more general scale. For example, FC6 claimed to *'have participated in conservation and wildlife studies'* and work with the *'honey producer next door'* to support bees.

With regards to capabilities, certifications emerged with significance, with FC7 claiming that despite being a difficult process, certifications supports their realisation of social sustainability goals and respond to consumer needs. Discussions of supporting local wildlife also rendered some discussion of external collaborations, with FC6 making specific reference to the Royal Society for the Protection of Birds, Operation Bumble Bee and external food companies.

Food Poverty

Discussions of food poverty in phase 2 results surround the donation of unsold food to food banks and charities in local communities. FC8 claimed *'we give food to Harry Chrisnas and a local charity every week which in turn is donated to feed the homeless in and around*

Camden' and FC20 stating *'if we have usable food we donate it, normally to local causes and food banks'*. Demonstrating a philanthropic approach, FC12 claimed to prioritise *'human consumption'* of food waste over the creation of animal feed despite incurring a loss of profits from the sale of food waste as animal feed. Interestingly, discussions of affordability also emerged with significance, with FC20 claiming '*the company is basically about one man's passion for food and brining good, fresh food to people whether they are rich or poor',* adding '*no matter what your budget is you can eat healthy'*.

Taking such discussions into consideration, the 'redistribution of unsold food for human consumption' and 'seeking the provision of responsible, affordable food' emerge as local philanthropy capabilities. Employee involvement also emerged with significance, in that FC12 claimed their ability to redistribute food for human consumption is the result of *'quite a lot of internal discussion'*.

Health & Well-Being

Support for health and well-being emerged as a dominant theme in phase 2 interviews, with FC8 stating *'food companies have a big responsibility when it comes to making a positive change'* with regards to healthy eating and lifestyles. More specifically, FC13 discussed a *'move towards healthier diets and tackling the obesity crisis and reducing junk food'* and claimed '*we have a wonderful set of products that we know can help the country become more healthy'*. A focus on children's health was reinforced, with FC20 stating '*we particularly focus on children and families, we have a motto that kids are king, and that's about teaching the next generation to eat healthy'*. Evidencing competitive benefits, FC6 claimed their *'school talks'* resulted in increased attention on their social media sites and sales to local parents, whilst FC18 suggested such talks are a good opportunity given that school children '*are the consumers of the future'*. With regards to healthy lifestyles, FC12 stressed the need to *'get families out running with their children',* whilst FC11 claimed to promote that *'being outside in the countryside is good for your health, mentally as well as physically'*.

Taking such discussions into consideration, the promotion of healthy eating and lifestyles emerged as a local philanthropy capability. Working with schools was dominant, with FC12 discussing going *'around schools to teach about health and nutrition',* FC9 discussing *'an ongoing project with local primary schools* [where] *we introduce them to agriculture',* and FC16 discussing '*a programme called 'calves in the classroom' where we donate ten claves to schools and it is the responsibility of the class to rear that animal to beef and see it*

slaughtered to encourage people to see where their food comes from and to engender agriculture in the community'. Outside of school talks, the promotion of healthy eating and lifestyles took place via recipes, company websites, social media, workshops and newsletters. The donation of resources to promote healthy eating and lifestyles also emerged as a local philanthropy capability, with FC11 creating a public footpath through their site, FC8 creating a permaculture forest that they donated to the local community for use as a park, and FC12 donating park benches. In addition, a company ethos for health emerged with significance, with FC20 claiming *'the owner is renowned for trying to make people eat healthy and communicating that* [….] *that side of things came really easily because it was built into the company ethos and is a big part of our passion'*.

Sponsorship of Local Causes and Charities

Whilst it did not emerge in the industry review or phase 1 of the empirical study, the sponsorship of local causes and charities emerged as a local philanthropy activity in phase 2 results. For example, FC7 stated *'sustainability comes from the community* [….] *we are involved in our community and we support community events as much as possible through charities and donations'*. Similarly, FC6 claimed to sponsor activities such as the local firework display, refurbishment of the new village hall and victims of local flooding, stating *'we've certainly got an active role in our local communities'*. In many cases, interviewees spoke of sponsoring official charities, with FC12 claiming *'we see them as partners that we work with in order to help with health issues and awareness',* or creating their own charities. According to FC15, the sponsorship of local causes and charities has meant *'we have established a reputation for being a good supplier, we are known in the farming community',* again stressing the benefit of a local philanthropy approach.

Taking such discussions into consideration, 'the sponsorship of local causes and partnership with charities' and 'the creation of charities and community investment programmes' emerge as local philanthropy capabilities. FC2 also stressed the need to be aware of issues in local communities, suggesting *'you've got to be able to adapt'*. Employee involvement and internal management structures again emerged with significance, with FC12 stating *'we have a very clear structure in place'* allowing them to *'set the strategic objectives of what they should invest in and where they should invest it'*.

Commitment to Employees

Commitment to employees also emerged as a local philanthropy activity in phase 2 results, with FC12 claiming to be *'concerned about how we work with people'*, and FC14 stating *'we are very concerned about our staff*'. In the most part this manifested in the maximisation of employee welfare, with discussions of *'a fair wage, fairness to the employee, looking after them from a health and safety point of view, looking after them in terms of health, looking after wellbeing across the sites, making sure they aren't overworked or involved in slavery'* (FC16). However, going beyond this, FC4 stated *'we want people to enjoy their work here'*, whilst FC14 claimed *'as soon as* [employees] *have completed a year of employment with us they all become eligible for profit share'*. Discussions of the employment of local people also emerged with significance, with FC14 claiming it *'provides a lot of stability in the local area'*, and FC16 stating it '*puts a lot of money into the local community'*. More specifically, FC18 stated *'for us social sustainability is all about job creation, anywhere we build a farm we are eager to create jobs'*. An emphasis fell upon the recruitment of disadvantaged people, with FC12 claiming to be *'creating opportunities to progress in life and break the cycle of social progression'*, adding *'we focus on the disadvantaged side'*, and FC20 stating *'we're also very interested in societal rehabilitation* [….] *we hire unemployed young people, or people with convictions and we train them and give them opportunities to work* [….] *and a chance for a better future'*.

With this in mind, 'prioritisation of employee welfare' and 'creating employment opportunities for local or disadvantaged people' emerge as local philanthropy capabilities. Social auditing also emerged as a capability, with FC19 claiming '*we do a lot of social auditing, both of the companies that supply staff to us and our growers staff*', making specific reference to employee welfare. Accreditations also featured here, with FC4 referring to Invested in People and FC9 bringing in some discussion of management system IS0 2600 in reference to their treatment of employees.

Additional Capabilities

Out-with discussions of dominant local philanthropy activities, additional implications for capabilities were identifiable. For example, FC8 discussed *'a social measure for sustainability'* aimed at *'creating a better standard of living for everyone'*. FC9 stressed the need to *'engage with young people'* and made reference to working with graduates on social sustainability projects. FC12 claimed that their desire to alleviate social ills in the local community came from being a family business, whilst FC14 claimed their social sustainability

is driven by *'a family ethos'*. FC20 stated '*we also do a lot of lobbying, getting behind social and environmental issues and pushing legislation and we have quite a lot of power with things like that because of our status and our owner'*. These capabilities, along with those explicated from dominant local philanthropy activities, and depicted in table 10.2, below.

Table 9.2 Local Philanthropy capabilities

Local Philanthropy Capabilities		
	Internal	**External**
Sensing	➢ Seeking the provision of responsible, affordable food ➢ A social measure for sustainability	➢ Awareness of issues in local communities
Seizing	➢ Employee involvement in social sustainability ➢ Selecting suppliers & customers based on locality & commitment to social sustainability ➢ Attaining socially sustainable certifications ➢ Redistribution of unsold food for human consumption ➢ Prioritisation of employee welfare ➢ Creating employment opportunities for local or disadvantaged people ➢ Socially motivated internal management systems	➢ Fair payment & treatment of suppliers ➢ Building trusting relationships throughout the supply chain ➢ Communicating commitment to local communities via eco-labelling ➢ External collaborations with socially sustainable companies ➢ Sponsorship of local causes and partnership with charities ➢ Social auditing of suppliers
Transforming	➢ Donation of company resources for community use ➢ Company ethos for health ➢ A family ethos with interests in social sustainability ➢ Creation of charities & community investment programmes	➢ Creation of socially sustainable supply chain structures ➢ Promotion of healthy eating lifestyle via company website & documentation ➢ Working with local schools to encourage a more sustainable & healthier future ➢ Lobbying for social causes and legislation

9.2 From a Hierarchy to a Cycle

It is commonly implied in literature that the natural-resource-based view is a hierarchal structure in which each resource is dependent on its forerunner (e.g. Menguc & Ozanne, 2005; Shi et al, 2012). Interestingly, whilst this is somewhat conflictive of Hart's (1995) initial conceptualisation of the theory, it can be linked to Hart's (1997) later presentation of pollution prevention as stage 1, product stewardship as stage 2 and clean technologies as stage 3. Adding to this are inferences of base of the pyramid's dependencies on clean technologies (Prahalad & Hart, 2002; Hart, 2007; Hart & Dowell, 2011), whilst the suggestion that the alleviation of social ills in the domestic market may support the realisation of globally focused social sustainability (Echebarria et al, 2017) also implies some reliance on local philanthropy. To some extent, such interdependencies emerge with logic in that pollution prevention's advanced minimisation of waste and pollutants in the firm may inspire product stewardship's desire to do so throughout the lifecycle. Product stewardship's creation of wholly sustainable products and processes may lead to positive impact operations in line with clean technologies. Accreditations achieved in pollution prevention or product stewardship, such as ISO systems, may advance approaches to clean technologies.

However, to return to underpinning resource-based theory, this can perhaps be linked to the combinative nature of competitive resources (Rubin, 1973; Teece et al, 1997; Lockett et al, 2009), and Hart's (1995) founding argument that natural-resource-based view resources are 'interconnected'. A distinction should be made between interconnected and interdependent, inviting query to the literature's misinterpretation of the natural-resource-based view as a hierarchal structure. That is, linear evolution of resources is not only conflictive of seminal resource-based theory literature and natural-resource-based view conceptualisation, but, as evidenced in this study, offers a naïve construal of competitive sustainability in industry.

More specifically, the results of phase 2 imply that natural-resource-based view resources do not always evolve from pollution prevention to product stewardship to clean technologies and then to local philanthropy or base of the pyramid. The fact that product stewardship emerged as the dominant resource in phase 2 conflicts dependencies on pollution prevention, whilst some companies demonstrated greater experience of clean technologies or local philanthropy than they did pollution prevention. Of particular interest was the realisation and prioritisation of social sustainability ahead of environmental sustainability, and claims that the former may lead to the latter which reverses the traditional hierarchal flow of the natural-

resource-based view. For example, FC12 claimed that once their social sustainability was *'quite mature'* they moved towards *'a wider sustainability role'* in which environmental initiatives were prioritised. FC8 described themselves as a *'social enterprise focused on food sustainability'*, whilst FC18 stated *'being a social enterprise is really important because it is one of the main reasons we set the business up'*. Such companies implied that social sustainability was of greater value than environmental sustainability, with FC7 stating '*if I was trying to get a contract with Sainsbury's, I would certainly be promoting our free-range milk over our recycling policies, I think we are just more interested in social sustainability than environmental responsibility, which is maybe wrong but it is our belief and it really is what our business has become about'*.

Thus, a shift from a natural-resource-based view hierarchy to a natural-resource-based view cycle is proposed, offering more accurate depiction of competitive resources and competitive sustainability as it exists in UK agri-food. In correspondence with the intended combinative nature of resources (Penrose, 1959; Rubin, 1973; Teece et al, 1997; Lockett et al, 2009) and Hart's (1995) initial conceptualisation, interrelations between the resources remain. This is demonstrated via the fact that phase 2 companies tended to possess more than one natural-resource-based view resource, and correspondences between each resource which feature throughout this study. Thus, the argument that one resource's assets may support another (Teece et al, 1997; Lockett et al, 2009) and that competitiveness is rarely derived from a resource in isolation (Rubin, 1973) is not contested, and Hart's (1995) 'interconnected' resources of greater value when implemented conjunctively supported. Moreover, the traditional evolution of resource is not falsified (Hart, 1997), acknowledging both its logic and emergence in phase 2 results. Rather, this study argues that such evolution is not a perquisite to the realisation of competitive sustainability or the natural-resource-based view, but that evolution may differ from firm to firm. Notably, it is arguable that heterogenous evolution perhaps adds strength to the resource-based theory founding argument that bundles of resources should be unique (Lockett et al, 2009) or difficult to replicate (Wernerfeldt, 1984).

Pertinently, given that this is based on the 20 interviews undertaken in phase 2 which were intended solely to explicate dynamic natural-resource-based view capabilities, such a proposal requires further, more specific research of the evolution and interdependencies of resources. Nonetheless, the emergence of the natural-resource-based view cycle in this study offers an interesting development and challenges existing perceptions of the natural-resource-based view, returning attention to underpinning theory. Moreover, it is further demonstrative of the

value of the undertaken qualitative abductive approach, which permits the researcher to deviate from core topics of study to explore and explicate unexpected avenues of interest.

Figure 9.1 A natural-resource-based view cycle

9.3 Summary of Findings

This chapter has introduced two emergent findings which both offer developments to theory based on empirical observations: local philanthropy as the fifth resource and the shift from a natural-resource-based view hierarchy to a natural-resource-based view cycle. However, given that neither of these serve as the object of study, this study alone is not enough to argue with great force either the existence of a fifth resource nor the nature in which the natural-resource-based view evolves. As such, local philanthropy and its capabilities require greater investigation, whilst the natural-resource-based view cycle also requires greater research in order to test its feasibility and offer greater clarification of the relationship between each resource.

10.0 Conclusions

As has been evidenced throughout this thesis, the natural-resource-based view assumes great significance in modern business. As demonstrated in the literature review, the theory still benefits from considerable academic attention and appears to play an influential role in the development of modern theory, with particular regards to sustainable supply chain management (Shi et al, 2012; Johnson et al, 2014; Miemczyk et al, 2016). This said, the breadth of literature argues that the natural-resource-based view does not exist outside of theory (Hart & Dowell, 2011; Ashby et al, 2012), in the most part on account of a lack of practical applicability and ill-defined capabilities (Menguc & Ozanne, 2005; Hart & Dowell, 2011), which is to some extent inherited from its resource-based theory roots (Grant, 1991; Lockett et al, 2009; Rashidirad et al, 2015). This study challenges claims that the natural-resource-based view does not exist, linking them to the positivistic dominance of resource-based theory research (Acedo et al, 2006) which prevents observation of the tacit and complex nature of competitive resources (Butler & Priem, 2001; Lockett et al, 2009). In response this study assumes a qualitative approach with which to explore the tacit existence of natural-resource-based view's resources, and explicate its capabilities. This facilitates empirical definition and elucidation of dynamic natural-resource-based view capabilities, addressing a research gap and supporting operationalisation in UK agri-food.

10.1 Answering the Research Question

The purpose of this study was to answer the research question: *what are the organisational capabilities that support the four natural-resource-based view resources in practice?* The following research objectives were set and resolved:

- Identify natural-resource-based view capabilities from review of seminal studies and exploration of sustainable supply chain management and innovation synergies;
- Categorize and refine capabilities into a dynamic capability framework;
- Investigate the existence of the natural-resource-based view in UK agri-food;
- Explore links between each resource and sustainable supply chain management and innovation in UK agri-food;
- Empirically define dynamic natural-resource-based view capabilities

10.1.1 Identify Natural-Resource-Based View Capabilities from Review of Seminal Studies & Exploration of Links with Sustainable Supply Chain Management and Innovation

A comprehensive literature review (chapter 2) resolved the first research objective: identify natural-resource-based view capabilities from review of seminal studies and exploration of sustainable supply chain management and innovation synergies. This involved the collection and analysis of literature from seminal natural-resource-based view studies and natural-resource-based view theoretical extensions and from this extraction of implications for capabilities. In addition, synergies between each natural-resource-based view resource and corresponding topics of sustainable supply chain management and sub-types of innovation were reviewed, resulting in extraction of further implications for capabilities.

10.1.2 Categorize and Refine Capabilities into a Dynamic Capability Framework

The resolution of the second research objective of categorizing capabilities into a dynamic framework involved the reduction and refinement of the capabilities derived from literature. As discussed, this was a lengthy and complex process, involving intercoder reliability and extensive discussion by three independent researchers. Application of Teece's (2007) dynamic capabilities concept permitted the categorization of capabilities according to sensing, seizing and transforming activities, whilst sub-categorization according to an internal versus external focus adds distinction to the endogenous or exogenous nature of resources (Barney, 2001; Lockett et al, 2009; Rashidirad et al, 2015). The successful completion of this resulted in the definition of conceptual dynamic capabilities for pollution prevention *(table 3.2),* product stewardship *(table 3.3),* clean technologies *(table 3.4)* and base of the pyramid *(table 3.5).* As well as supporting the design, undertaking and analysis of the empirical study, this conceptually links such capabilities with competitive sustainability.

10.1.3 Investigate the Existence of the Natural-Resource-Based View in UK Agri-Food

An in-depth industry review (chapter 5) was conducted to resolve the third research objective: investigate the existence of the natural-resource-based view in UK agri-food. This involved collection and analysis of secondary data from UK agri-food media articles, government publications and policy, NGO publications and food company websites. Within such data, detailed descriptions of pollution prevention, product stewardship and clean technologies were identifiable. Descriptions of base of the pyramid were also identifiable, but featured to a lesser extent and exposed conflict surrounding demand for and realisation of the resource, thus preventing confirmation of its existence. Nonetheless, the industry review evidenced the

existence of the natural-resource-based view in UK agri-food, thus supporting the feasibility of the empirical investigation of its capabilities.

In addition, links between the natural-resource-based view and sustainable supply chain management and innovation were also identifiable, whilst implications for emergent capabilities were extracted from UK agri-food data. Moreover, the proposed fifth resource of local philanthropy emerged from industry review results, based upon the dominance of competitive social sustainability out-with a base of the pyramid concept.

10.1.4 Explore links between each resource and sustainable supply chain management and innovation in UK agri-food'

Seven in-depth interviews with UK agri-food experts (chapter 8) were undertaken to resolve the fourth objective: explore links between each resource and sustainable supply chain management and innovation in UK agri-food. Discursive data derived from these interviews again entailed detailed descriptions of pollution prevention, product stewardship and clean technologies. Such discussions revealed commonalities surrounding sustainable supply chain management and innovation in line with the synergies discussed in the literature review. As well as offering some empirical support for links between the natural-resource-based view resources and sustainable supply chain management and innovation, this adds strength to the derivation of conceptual capabilities, and identified further capabilities of interest. This was considered 'phase 1' of the empirical study, and served as a necessary predecessor for phase 2 of the empirical study.

Notably, whilst base of the pyramid did not feature in any of the 7 interviews, preventing empirical exploration of its links with sustainable supply chain management and innovation, discussions of social sustainability did feature in phase 1 interviews. As detailed in chapter 9, such discussions supported the emergence of local philanthropy as the fifth resource, addressing the natural-resource-based view's inattention of the value of locally-based, philanthropic sustainability as a competitive resource.

10.1.5 Empirically Define Dynamic Natural-Resource-Based View Capabilities

Having identified and categorized conceptual dynamic natural-resource-based view capabilities, evidenced the existence of the natural-resource-based view in UK agri-food and empirically reinforced links with sustainable supply chain management and innovation, this study resolved the fifth and final research objective: empirically define dynamic natural-resource-based view capabilities. This involved interviews and observations with 20

purposefully selected UK agri-food companies (chapter 8). Again, data derived from this provided detailed descriptions of pollution prevention, product stewardship and clean technologies. The coding of this data according to corresponding conceptual capabilities and emergent capabilities from the industry review and phase 1 of the empirical study, along with the identification of newly emergent capabilities resulted in a final, empirical definition of dynamic natural-resource-based view capabilities. In line with the abductive nature of this study, such capabilities were compared with existing literature and the earlier industry review and phase 1 results, and where appropriate were re-worded to incorporate both theoretical influences and empirical descriptions. This was considered 'phase 2' of the empirical study, and it is here that the research question '*what are the organisational capabilities that support the four natural-resource-based view resources in practice?'* was answered, thus completing this study. In addition, reflection of the pollution prevention, product stewardship and clean technologies capabilities explicated in phase 2 facilitated the definition of common natural-resource-based view capabilities, which can be considered to support the realisation of competitive sustainability over time in a broader sense.

Again, base of the pyramid did not feature to a satisfactory extent in phase 2 interviews to empirically confirm its existence, nor empirically validate its capabilities. As such, this study's base of the pyramid contributions do not extend past definition of conceptual dynamic base of the pyramid capabilities *(table 3.5)* and discussions of the value of resource in both the literature review and industry review that deter its falsification. However, this study does offer some insights into the operationalisation of social sustainability as a competitive resource in UK agri-food via the conceptualisation of local philanthropy. It is within phase 2 that detailed descriptions of the value of such locally-focused, philanthropic sustainability in UK agri-food emerge. Within such discussions clear links to competitiveness were identified, as were implications surrounding the capabilities required to support operationalisation of local philanthropy as a competitive resource in UK agri-food.

The results of phase 2 also challenge existing presentations of the natural-resource-based view as a hierarchal construct in literature (e.g. Hart, 1997; Menguc & Ozanne, 2005; Shi et al, 2012). That is, claims that social sustainability may lead to environmental sustainability or the dominance of product stewardship in interviewee discussions conflict the argument that the natural-resource-based view evolves in a linear fashion in which each resource is dependent on its forerunner. Rather it appears that resources, albeit commonly interrelated, may be realised in any order or exclusively. Whilst phase 2 results alone are not enough to

empirically validate such an argument, they do invite further research of the fruition of resources and their interrelations.

10.2 Contributions

In resolving the research objectives and answering the research question, this thesis makes considerable contributions to both theory and practice. Such contributions, as discussed throughout this section, demonstrate originality and advance and challenge existing understandings of the natural-resource-based view and its operationalisation, and more broadly resource-based theory, dynamic capabilities and sustainability. Consequently, this study renders a number of theoretical and practical implications, as summarized in table 10.1 at the end of this section.

10.2.1 Empirical Definition of Natural-Resource-Based View Capabilities

The empirical definition of natural-resource-based view capabilities exists as this study's leading contribution. Theoretical contributions are three-fold: offering significant elaboration of natural-resource-based view theory; resolving inconsistencies in resource-based theory and research; and refined and empirical definition of the operationalisation of sustainability. Practical contributions emerge in the creation of capability tool-kits for managers in pursuit of competitive sustainable operations.

Theoretical Implications

Several theoretical implications can be identified, in that empirical definition of natural-resource-based view capabilities renders contributions to natural-resource-based view theory, preceding resource-based theory and sustainable operations theory. Most prominently are contributions to natural-resource-based view theory, in that definition of capabilities responds to calls for enhanced managerial guidance (Menguc & Ozanne, 2005; Ashby et al, 2012). More specifically, this study provides the first and only empirical definition and explanation of pollution prevention, product stewardship and clean technologies capabilities, offering valuable elaboration of natural-resource-based view theory. In overcoming issues of practical inapplicability this addresses what Hart & Dowell (2011) claim is natural-resource-based view's major theoretical flaw, Moreover, it resolves insufficiencies in existing literature that offer only vague and unempirical discussion of capabilities. It is this which emerges as the leading contribution of this thesis, and which has guided this study. Adding further strength is

the definition of common capabilities, which in offering a more inclusive depiction of dynamic natural-resource-based view capabilities lends itself well to subsequent study of the theory.

The empirical definition of dynamic natural-resource-based view capabilities also contributes to resource-based theory. It goes beyond the argument that capabilities and resources are intrinsically linked (Barney, 2001) to explicitly link specific capabilities with a corresponding resource. This is supported by the qualitative nature of this study, which in moving away from the positivistic dominance of resource-based theory research (Acedo et al, 2006) and its quantification of capabilities (Newbert, 2007; Nath et al, 2010), permits elucidation of the complexities between capabilities and resources. In particular, the presentation of capabilities as internal or external dynamic capabilities offers valuable insight to the management of competitive resources which was previously misunderstood (Teece et al, 2007; Rashidirad et al, 2015). Moreover, the explication of capabilities from empirical observation of the natural-resource-based view itself contests claims that competitive resources and capabilities cannot be empirically studied or defined (Christmann, 2000; Barney, 2001; Priem & Butler, 2001; Lockett et al, 2009). In fact, this study offers a methodological framework to guide researchers in the study of capabilities in competitive resources out-with the natural-resource-based view.

Finally, the empirical definition of dynamic natural-resource-based view capabilities also contributes to more broadly to sustainability theory. That is, the capabilities in this study, particularly common capabilities, can be considered supportive of competitive sustainability beyond the context of the natural-resource-based view. Supporting this is their derivation from natural-resource-based view, sustainable supply chain management and innovation literature and the discursive accounts of sustainability experts with no knowledge of the natural-resource-based view. In particular, such refined and empirical definition of sustainability capabilities responds to calls for enhanced guidance of the management of sustainable operations in modern business (Berger-Walliser & Shrivasta, 2015) which has become oversaturated due to an array of recommendations (Pagell & Shevhchenko, 2014).

Practical Implications

The empirical definition and elucidation of dynamic natural-resource-based view capabilities also contributes to practice. This was pertinent if the natural-resource-based view theory-practice gap was to be addressed and practical applicability maximised. Specifically, the frameworks of dynamic pollution prevention, product stewardship and clean technologies

capabilities serve as tool-kits for managers in pursuit of competitive sustainable operations. As discussed throughout this section, their segregation according to each resource allows managers to target a specific area of sustainability, whilst the dynamic nature of the defined capabilities guides adaptability. The distinction of capabilities to internal or external offers further clarity, whilst their renaming to accurately reflect their application in UK agri-food adds practicality. Given the growing demand for competitive sustainability as demonstrated in the industry review (Foresight, 2011; DEFRA; 2013; WRAP, 2015; McGill, 2016), such tool-kits assume timeliness and relevance in UK agri-food. Again, the common capabilities expand on this. That is, in there more comprehensive definition they address competitive sustainability on a broader scale, and in doing so emerge with significance in the creation of sustainability policy & strategy.

10.2.2 Dynamic Capability & Internal-External Categorization

Whilst the empirical definition of dynamic natural-resource-based view capabilities emerges as the leading contribution of the thesis, additional theoretical and practical contributions arise from their categorization according to dynamic capabilities and an internal-external focus. More specifically, whilst such categorization played a fundamental role in explication and definition, contributions expand beyond the scope of the natural-resource-based view and thus warrant discussion.

Theoretical Implications

This study offers the long overdue realisation of dynamic capabilities as Teece (2007) intended. In particular, categorization according to sensing, seizing and transforming activities maximises the value of dynamic capabilities, and contests existing criticisms of tautology, obscurity and inapplicability (Fiol, 2001). More specifically, the misinterpretation of dynamic capabilities as a specific set of capabilities to be added on to resources is dismissed. Rather, this study offers, for the first time, explicit application of dynamic capabilities as a tool with. which to explain capabilities and guide competitiveness in resources. From a resource-based theory perspective, this addresses insufficiencies in literature surrounding competitive invalidity and impermanency, which are well noted (Barney, 1991; Grant, 1991; Black & Boal, 1994; Hart, 1995; Fiol, 2001; Aragon-Correa & Sharma, 2003; Hitt et al, 2015). That is, whilst dynamic capabilities is acknowledged an important theoretical development (Hart & Dowell, 2011), its misinterpretation undermined its propensity to overcome research gaps surrounding competitiveness over time (Rashidirad et al, 2015). Pertinently, such gaps are of particular significance in the natural-resource-based view, where the unpredictability of the

natural-environment exacerbates the need for adaptability (Chakrabarty & Wang, 2012; Li & Liu, 2014). Thus, the realisation of dynamic capability activities of sensing, seizing and transforming in this study contributes to theory in three ways: first its advances understandings of dynamic capabilities by overcoming its misinterpretation and challenging criticisms; second its resolves gaps surrounding the complexities of resources and competitiveness over time; and third it responds to calls for the maximisation of adaptability in natural-resource-based view resources.

Categorization according to an internal or external focus also renders theoretical contributions to both resource-based theory and the natural-resource-based view. With regards to resource-based theory, such categorization responds to claims that distinctions between internal and external capabilities is lacking (Rashidirad et al, 2015) and the tendency to overlook externally focused capabilities (Lockett et al, 2009) in resource-based theory. With regards to the natural-resource-based view, this challenges the misperception of its resources as internal-external counterparts (Menguc & Ozanne, 2005). More specifically, the presentation of pollution prevention as an internal resource dependent upon intra-organisational practices and product stewardship as its external counterpart dependent upon inter-organisational capabilities (Shi et al, 2012) offers a naïve construal of the natural-resource-based view that overlooks the internal and external nature of resources (Barney, 2001; Lockett et al, 2009). Moreover, building on dynamic capabilities need to *'build and reconfigure internal and external competencies'* (Teece et al, 1997, p516), it undermines the need to sense, seek and transform both internally and externally. Notably, this also corresponds with the pertinence of inbound and outbound activities in modern sustainable supply chain management (Malhotra & Mackelprang, 2012) in promoting supply chain flexibility (Defee & Fugate, 2010; Beske et al, 2014), and the reliance on both internal competencies and external opportunities in innovation (Tidd & Bessant, 2009; Crossan & Apaydin, 2010; Walker, 2014). Thus, the need for internal-external distinction emerges with logic and is realised in this study.

Practical Implications

As discussed, this study's dynamic capability and internal versus external categorization of capabilities maximised the intelligibility of the conceptual definition of capabilities in support of the effective design and analysis of the empirical study. It is within this that practical implications can be recognised. That is, such categorization allows capabilities to be presented in an approachable framework as opposed to an undefined list. However, practical implications extend beyond this. The presentation of capabilities as dynamic capabilities encourages

managers to continuously *sense* and *seize* opportunities and *transform*. This promotes adaptability which Miemczyk et al (2012) argues is a key challenge in modern sustainable supply chain management, and Teece & Leih (2016) directly link with innovation. Reinforcing this is Teece (2007) who argues that dynamic capabilities should be used to provide managerial guidance to sustaining competitiveness. The internal and external categorization also makes contributions beyond the lucidity of capabilities. It encourages managers to look both inside and outside the firm to support the realisation of competitive resources. According to Malhotra & Mackelprang (2012) this enhances performance and further supports adaptability. Thus, without dynamic capability or internal-external categorization, the value of the capability tool-kits in industry would be restricted.

10.2.3 The Four-Resource Perspective of the Natural-Resource-Based View

The four-resource perspective of the natural-resource-based view adopted throughout this study can also be considered a contribution. This study is the first of its kind to tackle all four natural-resource-based view resources: pollution prevention, product stewardship, clean technologies and base of the pyramid. This expands understandings of each resource by defining their purpose and differences, and adds clarity and classification to the natural-resource-based view framework. Of particular importance is the realisation of sustainable development's division into clean technologies and base of the pyramid, which is scarcely acknowledged in literature.

Theoretical Implications

With specific regards to the natural-resource-based view, several theoretical implications can be noted. First, this study deviates away from existing literature's dominant focus on pollution prevention, which Hart & Dowell (2011) claim has detracted attention from the other resources. Second, in adding definition to each resource assumptions that pollution prevention and product stewardship exist as internal-external counterparts are challenged. And third, it acknowledges the commonly disregarded (e.g. Menguc & Ozanne 2005; Markley & Davis, 2007; Shi et al, 2012; Matapolous et al, 2014) division of Hart's (1995) original sustainable development to promote clean technologies and base of the pyramid. This also encourages a shift away from the presentation of the natural-resource-based view as an environmental strategy to incorporate its social sustainability merits.

Out-with the natural-resource-based view, theoretical implications also emerge with regards to sustainability. For example, the competitive value of sustainability is maximised, going beyond corporate social responsibility and the triple-bottom-line's links with

competitiveness to present sustainability as an opportunity to be exploited for firm gain. In particular, the acknowledgement of clean technologies and base of the pyramid adds clarity to the oversaturated topic of sustainable development (Pagell & Shevchenko, 2014) in literature, clearly distinguishing between its environmental and social aspects and stressing their independent intents and competitive benefits. This study's empirical exploration of clean technologies heightens the value of its new products and processes in support of advanced environmental sustainability. Moreover, via discussion of successful UK agri-food clean technologies and capabilities this study provides insight as to how businesses might address growing issues of global environmental degradation, which in spite of the prominence of corporate social responsibility and the triple-bottom-line in sustainable development, remains an under-researched area in literature (Boken et al, 2013; Pagell & Shevcheno, 2014; Song et al, 2015; Echebarria et al, 2017).

Whilst the same cannot be said for base of the pyramid due to its absence in the empirical study, the four-resource perspective still brings attention to the topic of social sustainability in emerging markets. Reinforcing the value of this is the growth of social sustainability efforts focused upon the development of such markets (Berger-Walliser & Shrivasta, 2015) and calls for greater understanding and conceptualisation of the social aspects of sustainable development (Eskandarpour et al, 2015). Notably, this is not to argue that base of the pyramid offers a wholly effective conceptualisation of competitive social sustainability, as this study's local philanthropy contests, but rather to support its continued investigation and challenge calls for its realignment or falsification (Kolk et al, 2014).

Practical Implications

Practical implications can also be identified. The deviation away from the existing focus on pollution prevention corresponds with the real-life existence of the natural-resource-based view, which as demonstrated in phase 2 of the empirical study, presents product stewardship rather than pollution prevention as the dominant resource. The maximisation of the natural-resource-based view's social sustainability merits supports the growing importance of social sustainability as a source of competitiveness in UK agri-food (DEFRA, 2012b; NFU, 2014; UK Trade and Investment, 2016). Perhaps more explicitly, the explanation and classification of each resource allows managers to focus on specific areas of sustainability and to better identify strengths and weaknesses in their own approach to sustainability. For example, a company with strong pollution prevention or clean technologies within the firm may choose to target product stewardship in order to extend sustainability throughout the supply chain, and

therefore employ the product stewardship capability framework as a guide. This perhaps offers a more appealing alternative to the implementation of corporate social responsibility, which strays from competitive exploitation. Adding to this is the presentation of corporate social responsibility as a necessity in modern business (McWilliams & Siegel, 2001), detracting from its value and rendering criticisms of greenwashing and scepticism (Illia et al, 2013).

10.2.4 Linking the Natural-Resource-Based View, Sustainable Supply Chain Management & Innovation

This study's identification and verification of links between the natural-resource-based view, sustainable supply chain management and innovation also emerges as a contribution. This results in, for the first time, definitive conceptualisation of synergies between each natural-resource-based view resource and specific sustainable supply chain strategies and innovation typologies. Empirical investigation of such synergies results in their validation and greater explanation of their relationship.

Theoretical Implications

This refines over twenty years' worth of literature and as such renders theoretical implications. That is, this study highlights and expands upon existing inferences for the role of the supply chain and innovation in seminal natural-resource-based view literature. In particular, it goes beyond such inferences to identify and verify specific synergies between specific resources and corresponding supply chain strategies and innovation sub-types. This also answers calls for enhanced understanding of the management of sustainable supply chains (Miemczyk, 2012). Importantly, linking the natural-resource-based view with sustainable supply chain management as opposed to green supply chain management further maximises the significance of social sustainability.

Practical Implications

With regards to practical implications, the sustainable supply chain management and innovation underpinnings of the capability frameworks add practical approachability and appeal. Approachability is derived from sustainable supply chain management's widespread practical appeal and acceptance (Johnsen et al, 2014). Adding strength to this is that many sustainable supply chain strategies, including those amalgamated with natural-resource-based view resources, are conceived of in industry (Pagel & Shevchenko, 2014). In addition, the incorporation of innovation appeals to the growing interest and demand for innovation in industry (Cuerva et al, 2014). Moreover, both sustainable supply chain management and

innovation, along with the natural-resource-based view, assume strong links with competitiveness that add further appeal.

10.2.5 Conceptualisation of Local Philanthropy & Proposal of the Natural-Resource-Based View Cycle

This study's emergent findings serve as the final contribution. That is, local philanthropy, whilst not intended to replace base of the pyramid, offers a more approachable and modern perspective of social sustainability based upon empirical observations and descriptions of competitive social sustainability in UK agri-food. Similarly, the natural-resource-based view cycle challenges existing misunderstandings surrounding the fruition of resources, using empirical results to propose that resources may evolve exclusively or in any order and return attention to theoretical underpinnings. Such emergent findings depict the natural-resource-based view as it exists in UK agri-food, and enhance and challenge existing understandings of the theory. This said, both local philanthropy and the natural-resource-based cycle warrant further investigation, given that neither served as the intentions of this study.

Theoretical Implications

The emergence of local philanthropy as a fifth resource addresses the natural-resource-based view's negligence of the competitive value of locally-focused, philanthropic social sustainability. That is, there appears a gap between the environmental intents of pollution prevention, product stewardship and clean technologies and base of the pyramid which focuses on the development of emerging markets for firm gain. Reinforcing this are links between such locally-focused, philanthropic social sustainability and competitiveness, out-with a natural-resource-based view context. For example, corporate social responsibility places a focus on social sustainability with philanthropic intentions in both domestic and global markets (Carroll, 1979). Whilst it differs from the natural-resource-based view on account of its emergence as a moral principle of business (Davis, 1960), links between its social sustainability efforts and competitiveness do feature prominently (Drucker, 1984; Galbreath, 2009; Green & Peloza, 2011; Matapolous et al, 2014). As such, the natural-resource-based view's disregard of locally-focused, philanthropic social sustainability as a competitive resource emerges as theoretical flaw which this study addresses via the conceptualisation of local philanthropy. Local philanthropy goes beyond corporate social responsibility's obligatory handling of social issues to present them as opportunities for firm gain. Supporting this are the detailed discussions of such issues in a competitive context throughout the industry review and empirical study.

The introduction of a natural-resource-based view cycle also renders theoretical implications. In suggesting that resources may evolve exclusively or in any order the misinterpretations of the natural-resource-based view as a hierarchal structure (e.g. Hart, 1997; Menguc & Ozanne, 2005; Shi et al, 2012) is challenged and attention retuned to resource-based theory's combinative resources bundles (Rubin, 1973; Teece et al, 1997) and Hart's (1995) initial proposition of interconnected resources. The argument that social sustainability may precede and influence environmental sustainability is of particular importance, reversing the traditional fruition of resources and further diverging from the environmental dominance of the natural-resource-based view. Notably, this does not contend the value of combinative resources that feature prominently in resource-based theory (Rubin, 1973; Teece et al, 1997; Lockett et al, 2009), nor the claim that resources are of greater value when implemented conjunctively (Hart, 1997). Rather, this argues that the linear evolution of resources offers a naïve construal of competitive sustainability in UK agri-food, and invites investigation to the evolution of and interrelations between natural-resource-based view resources.

Practical Implications

Whilst in need of further investigation, the conceptualisation of local philanthropy and the natural-resource-based view cycle does render some practical implications. The definition of local philanthropy and its capabilities from expert firms offers a proven and approachable framework for competitive social sustainability in UK agri-food. Given claims that it is the social aspects of sustainability that managers struggle with (Hall & Vrendenberg, 2004) and the growing demand for social sustainability in the sector (Foresight, 2011), this emerges with significance. The proposition of the natural-resource-based view cycle adds further support to the targeting of specific areas of sustainability to suit the needs of the firm, as opposed to following a hierarchy.

Table 10.1 Thesis contributions

Contribution	Theoretical Implications	Practical Implications
Empirical definition of NRBV capabilities	- In offering the first empirical definition & elucidation of NRBV capabilities, gaps surrounding practical applicability are addressed. - Answers calls for the explanation of the complex relationship between competitive resources & capabilities in resource-based theory. - Adds empirical definition to the management of sustainability.	- Offers capability tool-kits for managers in pursuit of competitive sustainable operations.
Dynamic capability & internal-external categorization	- Explicit application of dynamic capabilities activities overcomes misinterpretations and criticisms of the theory in existing literature, addresses research gaps surrounding competitiveness over time in resource-based theory & maximises adaptability of the NRBV. - Internal-external categorization maximises the exogenous and indigenous nature of resources, contesting their naïve construal as internal-external counterparts of one another in NRBV literature.	- Dynamic capabilities in tool-kits encourages managers to continuously sense, seek & transform, thus promoting adaptability. - Internal-external categorization supports the identification and exploitation of resources from inside and outside the firm.
The four-resource perspective of the NRBV	- Resolves environmental dominance of NRBV literature & adds distinction to each resource. - Adds definition to sustainability, particularly in terms of competitiveness & sustainable development, thus expanding on existing sustainability frameworks.	- Supports a shift from environmental to social sustainability - Segregation of tool-kits to each resource allows managers to target specific areas of sustainability to suit the needs of the firm.
Linking the NRBV, SSCM & Innovation	- Refines & expands on existing literature to identify & empirically verify links between specific NRBV resources and SSCM strategies and innovation sub-types.	- Derivation of capabilities from SSCM maximises applicability, whilst capabilities from innovation maximises appeal in tool-kits.
Conceptualisation of local philanthropy & the NRBV cycle	- Offers a more approachable depiction of the NRBV based on empirical observation & theoretical underpinnings. - Addresses social sustainability gaps in the NRBV.	- Adds an additional, more approachable, dimension of social sustainability. - Supports realisation of sustainability in any order, further deviating from environmental dominance.

10.3 Limitations

This study was subject to a number of limitations, which although largely unavoidable, have undoubtedly impacted upon its undertaking and completion, and as such warrant discussion. Such limitations relate to this study's philosophical influences, contextual setting, Representivity, categorization of data and the absence of base of the pyramid in the empirical study. Pertinently, it is notable that no study is without limitation (Bryman & Bell, 2011), and as such the limitations discussed below should not detract from the results or value of this study.

10.3.1 Philosophical Limitations

With regards to philosophical limitations, this study's critical realist ontological and epistemological assumptions may be criticized in comparison to alternative philosophical stances. For example, the presentation of the natural-resource-based view as its own entity is conflictive of the positivist's need for tangibility (Bryman & Bell, 2011), whilst the explication of capabilities from discursive data and tacit knowledge conflicts the positivistic need for physically measurable and quantifiable data (Saunders et al, 2012). However, it is notable that to date resource-based theory research, including that of the natural-resource-based view, is dominated by positivism (Acedo et al, 2006), which in some part may account for the lack of research explaining the complex relationship between capabilities and resources. Critical realism, as discussed in detail in chapter 5, is well equipped to explore the tacit existence of complex capabilities, and to elucidate phenomena, in this case capabilities, within that. As such, this study's philosophical stance is considered to be of great value, certainly with regards to answering the research question. Moreover, as Edwards et al (2012) contend, the philosophical assumptions underpinning a study are unintentional and cannot be separated from the research at hand, rendering any limitations wholly unavoidable.

10.3.2 Contextual Limitations

Contextual limitations may also be argued on account of the decision to investigate the natural-resource-based view solely within the context of the UK agri-food sector only. More specifically, the results are limited to the UK agri-food context given the logical assumption that the natural-resource-based view may exist differently or not at all in other sectors. Again, such limitations are largely unavoidable due to the time, location and access restraints imposed on this study. However, it is notable that Rashidirad et al (2015) suggest that the study of resource-based capabilities should acknowledge contextualities, arguing that managers should

be focused on the specific resources and capabilities within the sectors that they operation. Reinforcing this, Barney (1991) argues that competitive resources cannot be separated from their own context, which according to Lockett et al (2009) has served as a deterrent to their empirical study. Thus, whilst transferability of results is typically desirable in business studies (Saunders et al, 2012), the need to understand contextualities in resource-based theory research is important. Moreover, the empirical results perhaps borrow some generalisability from the non-context-specific conceptual definition of capabilities upon which empirical investigation was guided.

10.3.3 Representativeness

The use of just 7 companies in phase 1 and 20 in phase 2 of the empirical study may also warrant criticism surrounding representivity. To some extent this can again be attributed to time, location and access restraints, but again the critical realist stance must be considered. That is, as discussed in chapter 6, the purpose of this study was not to seek generalised rules about resource-based capabilities, but to explicate specific natural-resource-based view capabilities in UK agri-food and elucidate their role in supporting their corresponding resource. As such, the need for statistically relevant samples is diminished, and the need for discursive, detailed data maximised. The interviews undertaken in this study, as demonstrated throughout the results, were sufficient to answer the research question. This said, some efforts were made to maximise representivity, with regards to employment of the most effective sampling method and the collection of data from all UK agri-food sub-sectors and stages of the food chain.

Social desirability bias must also be considered with regards to representivity. That is, the extent to which interviewees wished to appear 'sustainable' to the interviewers may have altered the data collected, thus preventing an accurate representation of natural-resource-based view resources. Roxas & Lindsay (2011, p224) claim that studies investigating the management of sustainability practices are likely to *'strike a wide range of moral, ethical and legal sensitivities'* which may lead to '*systematic bias'* in the results. Most commonly this results in interviewees exaggerating their sustainable behaviours or minimizing unsustainable behaviours. Chung & Monroe (2003) argue that this is a common and largely unavoidable issue in research. However, whilst it may be unavoidable, there are measures that may reduce such bias (Roxas & Lindsay, 2011), some of which were employed in this study. For example, information provided about the study to all respondents was restricted. That is, whilst respondents were aware sustainability was the core topic of discussion, specific areas in

relation to the natural-resource-based view resources were withheld, so that any implications emerge without bias. Similarly, specific natural-resource-based view or capability terminologies in interviews were avoided. Social desirability bias was also minimised in participant observations in that those observed were not aware of the intents of the study and as such are less likely to moderate behaviours. Moreover, the observation of on-site processes, systems and activities itself helped to minimise social desirability bias by adding tangibility and verification to discursive data. It is also notable, that consultation of secondary company data in sampling and recruitment, and in some cases during interviews, also supported substantiation of any discussed sustainability merits. According to Saunders et al (2012) such measures are effective in mitigating social desirability bias and maximising robustness of data, and thus were of significance in this study.

10.3.4 Categorization of Data

As discussed, the categorization of capabilities according to both dynamic capability activities and an internal versus external focus was an important part of this study. However, whilst the need for categorization has been evidenced, it is still subject to limitation. For example, the amalgamation of synonymous capabilities extracted from literature may reduce their accuracy, whilst the reduction of capabilities also risks pertinent capabilities being overlooked. It is for such reasons that the literature review was consistently referred to throughout each stage of this study, and the initial set of capabilities extracted from literature was not discarded *(appendix 1),* as supported by the abductive nature of this study. However, more importantly, the categorization of capabilities was dependent upon researchers' interpretations, perhaps further reducing their accuracy and rendering concerns of researcher bias, particularly given that categorization involved several lengthy and complex stages. It is for such reasons that intercoder reliability was used, involving three researchers. The researchers' independent coding of data in the first stage of categorization relied on percentage agreement, which according to Lombard (2002) promotes reliability. Subsequent stages of categorization involved lengthy and detailed discussion of the capabilities and their corresponding categories, which the critical realist believes enhances comprehension of the topics under study (Edwards et al, 2012). Such precautions were undertaken in order to maximise the effectiveness and reliability of categorization. This said, it is notable that as the conceptual capability frameworks *(table 3.2, 3.3, 3.4, 3.5)* were intended solely to guide the empirical study, the pertinence of accurate categorization is somewhat lessened by the final definition of dynamic natural-resource-based view capabilities that reflect their existence in UK agri-food.

10.3.5 Absence of Base of the Pyramid

The absence of base of the pyramid may be seen as the main limitation of this study, given that it prevents confirmation of its existence or empirical definition of its capabilities. In addition, the decision not to falsify the resource may also be seen as a weakness. However, the absence of base of the pyramid truly reflects the UK agri-food sample, and corresponds with industry review findings that UK agri-food companies are not yet targeting emerging markets (DEFRA, 2012b). The decision not to falsify to some extent can be attributed to the critical realist's non-contradictory synthesis (Sayer, 1992), but also emerges with logic. That is, to falsify base of the pyramid would discard its significance to growing interest in social sustainability in emerging markets discusses in literate (Berger-Walliser & Shrivasta, 2014) and implied in the industry review (GFS; 2010; 2012; Vison 2020, 2013). In addition, the intended scarcity and complexity of resources (Wernerfeldt, 1984; Barney, 2001; Locektt et al, 2009) must be taken into consideration, as must the contextual limitations of this study. It is further notable that, base of the pyramid does benefit from some theoretical extension in this study via conceptualised links with sustainable supply chain management and innovation and conceptual definition of its capabilities.

10.4 Future Research

Along with its contributions to theory and practice, and in some cases in response to its limitations, this study identifies areas for and facilitates future research. These are discussed throughout this section. This said, the presentation of this study as a basis for future research should not diminish its strength.

10.4.1 Empirical Study of Competitive Resources and their Capabilities

As discussed in the literature review, the empirical study of competitive resources has to date proved troublesome. It is argued that the complex and tacit nature of resources (Butler & Priem, 2001) has acted as a deterrent to empirical investigation (Lockett et al, 2009). This in turn prevents access to resource-based capabilities, which are themselves believes to be difficult to assess (Amit & Schoemakr, 1993) on account of their implicit and inherent existence (Lockett et al, 2009). This study, in contrast to the positivistic dominance of resource-based theory research (Acedo et al, 2006), evidences that it is possible to empirically study competitive resources and define capabilities. More specifically, the critical realist approach and its qualitative methods may serve as a guide for researchers in pursuit of the definition of resource-based capabilities out-with the context of the natural-resource-based

view. Further supporting this is this study's application of dynamic capabilities and the internal-external focus, which may serve as an effective template for such definition.

10.4.2 Definition of Routines

The purpose of this study was to answer the research question: *what are the organisational capabilities that support the four natural-resource-based view resources in practice?* In answering this via the definition of pollution prevention, product stewardship, clean technologies and common capabilities this study, as discussed, makes several important contributions. However, resource-based theory contends that capabilities over time form routines (Lockett et al, 2009) that can be considered 'organisational skills' (Grant, 1991). Hart (1995) acknowledges this, placing dependencies on both capabilities and routines in the natural-resource-based view. Moreover, dynamic capabilities are also believed to form routines (Teece, 2007), whilst Beske (2012) argues that recurring sustainable supply chain management practices form routines from which dynamic capabilities are derived. As such, the definition of natural-resource-based view routines emerges as interesting topic for future research. Given that such routines are derived from capabilities, this study's definition of capabilities offers a basis for such research.

10.4.3 Assessing the Natural-Resource-Based View Capabilities out-with UK Agri-Food

This study explores and represents the natural-resource-based view as it exists in the UK agri-food sector, restricting the results to that context. In response, the natural-resource-based view should be explored out-with the UK agri-food sector, allowing for further assessment of the dynamic natural-resource-based view capabilities. As well as testing the results of this study, this may invite further discussion of contextual variance, which Rashidirad et al (2015) claim is an interesting topic in resource-based theory research. In addition, whilst base of the pyramid did not feature in UK agri-food data, it may well feature in another context, reinforcing the need for further research. In particular, a sector with a strong presence in emerging markets and a high aptitude for innovation may be of interest.

10.4.4 Empirical Investigation of the Socially Sustainable Resources of the Natural-Resource-Based View

Whilst this study's four-resource perspective and conceptualisation of local philanthropy does detract from the environmental dominance of the natural-resource-based view, empirical investigation of the socially sustainable resources of the natural-resource-based view is called for. This is both in response to the growing significance of social sustainability in academia

and industry (Hall & Vrendenberg, 2012; Berger-Walliser & Shrivasta, 2015), and the limitations of this study. That is, it may address the absence of base of the pyramid in the empirical study, and using the conceptual definition of dynamic base of the pyramid capabilities *(table 3.5)* as a guide, permit empirical definition of its capabilities. In addition, it would expand on this study's conceptualisation of local philanthropy, offering further insight and empirical validation to locally-focused philanthropic social sustainability as a competitive resource.

10.4.5 Exploring the Fruition of Natural-Resource-Based View Resources and their Interrelations

As detailed in chapter 10, this study opens up discussion of the fruition of natural-resource-based view resources. More specifically, based on the finding of phase 2 of the empirical study, it challenges the typical presentation of the natural-resource-based view as a hierarchal structure in which each resource is dependent on its forerunner to propose that resources may evolve exclusively or in any order. However, given that this was not the object of study further study is called for. In consideration of the value of combinative resources (Rubin, 1973; Teece et al, 1997; Lockett et al, 2009) and Hart's claim that natural-resource-based view resources are of greater value when implemented conjunctively, such study should include resource interrelations.

10.4.6 Investigating Additional Theoretical Influences

As discussed, this study focuses on Hart's (1995) natural-resource-based view and also renders contributions more broadly for resource-based theory and dynamic capabilities. However, there are additional theoretical influences that warrant investigation, which according to Kauppi et al (2013) often enhances understandings of a topic. In some consequence, investigation of stakeholder theory and institutional theory within the context of the natural-resource-based view and with regards to this study's findings emerges as an opportunity for further research.

Stakeholder theory featured prominently throughout the literature reviewed in this study (e.g. Hart, 1995; Aragon-Correa & Sharma, 2003; Kovacs, 2008; Faisal, 2010; Erghott et al, 2011; Hart & Dowell, 2011; Kogg & Mont, 2011; Klassen & Vereeke, 2012; Hoejemose et al, 2013; Jensen et al, 2013; Matapolous et al, 2014; Montinel & Delgado-Caballos, 2014; Darkow et al, 2015; Wang et al, 2015). Interestingly, Sarkis et al (2010) have already drawn links between stakeholder theory and resource-based theories, but explicit links with the natural-resource-based view are yet to be explored. Stakeholder theory prioritises wide ranging

groups and society in business (Polonsky, 1995; Lee, 2011), arguably corresponding with the natural-resource-based view's presentation of the natural environment as a key stakeholder (Hart, 1995) and responsiveness to societal demand for less damaging operations (Russo & Fouts, 1997). Stakeholder theory also supports managerial practices (Clement, 2005; Co & Barro, 2008) intended to help firms meet end objectives (Polonsky et al, 1995), and thus may further advance understandings of the realisation of natural-resource-based view resources. In particular, implications for various stakeholders in this study's definition of dynamic natural-resource-based view capabilities may benefit from application of stakeholder theory. For example, it may further legitimize and explain the role of employees, supply chain partners, NGOs or accreditors, all of which feature prominently throughout this study, in the natural-resource-based view. This may also render some consideration of the extended resource-based view. Reinforcing the value of such future research is the growing prominence of stakeholder theory in supply chain (Co & Barro, 2008) and sustainability research (Clement, 2005; Hahn & Kühnen, 2013).

Also emerging with significance is institutional theory, having been linked with both resource-based theory (Yang & Su, 2014) and stakeholder theory (Lee, 2011; Hahn & Kühnen, 2013). However, again, institutional theory is yet to be investigated with specific regards to the natural-resource-based view. Given that institutional theory focuses upon '*social, economic and political resources in order to adapt to specific institutional environments in view of enhancing firm performance'* (Yang & Su, 2014, p721), its relevance in this study becomes clear. In particular, institutional theory's argument that business activities are not necessarily rational in a business sense but may instead be driven by the wider external environment (Hahn & Kühnen, 2013) may strengthen the prioritisation of sustainability within each resource. This is arguably particularly significant in local philanthropy, where local or national communities exist as an institutional environment and business decisions may be less rational and more emotive. Moreover, the role of institutional mechanisms such as regulations, certifications, affiliations and memberships and organisational culture and shared beliefs that featured prominently in all resources may again be further legitimized and explained via application of institutional theory. Adding further strength is the dominance of institutional theory in marketing research (Yang & Su, 2014), and its increasing precedence in supply chain (Miemczyk, 2008; Kauppi, 2013) and sustainability literature (Lee, 2011; Hahn & Kühnen, 2013).

10.5 Concluding Remarks

This chapter offers a summary of this thesis, acknowledging its limitations and proposing opportunities for future research. It concludes with emphasis of its contributions:

- Empirical definition of natural-resource-based view capabilities;
- Dynamic Capability & Internal-External Categorization
- The Four-Resource Perspective of the Natural-Resource-Based View
- Linking the Natural-Resource-Based View, Sustainable Supply Chain Management & Innovation
- Conceptualisation of Local Philanthropy & Proposal of the Natural-Resource-Based View Cycle

Such contributions, as discussed, render theoretical and practical implications and therefore fulfil the basic requirements of business research (Saunders et al, 2012). Moreover, they demonstrate originality, advancing and challenging existing understandings of the natural-resource-based view and supporting its value as both an academic theory and a valuable practical tool over twenty years after its initial conceptualisation. Additional implications for preceding resource-based theory and the broader school of sustainable operations add further value.

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APPENDIX 1: Conceptual Natural-Resource-Based View Capabilities

Conceptual Pollution Prevention Capabilities	
1. Continuous innovation	18. Environmental measurement
2. Process innovation	19. Operational measurement (ISO 14001, eco-efficiency, lean, just-in-time) Financial measures
3. Employee involvement & skills/ Internal knowledge & expertise	20. Transforming environmental changes into action
4. Cross functional integration	21. Internal environmental policy/ management procedures
5. Organisational commitment & learning	
6. Technological know-how	22. Use of environmentally friendly materials
7. Human resource management/ personnel management	23. Substitution of questionable materials
	24. Consideration of environmental criteria
8. Reputation	25. Process optimisation to reduce solid waste
9. Political acumen	26. Internal recycling
10. Continuous improvement	27. Environmental total quality management
11. Proactive approach to the environment	28. Advanced prevention and safety methods
12. Managerial competence	29. Internal & external cooperation
13. Stakeholder integration	30. Identification & implementation of new processes
14. Higher order shared learning/ organisational learning	31. Organisational capacity
	32. Consideration of externalities
15. Interpretation of environmental issues as opportunities	33. Entrepreneurial leadership, foresight & insight
16. Resource reconfiguration/ management	34. Information/ knowledge management
17. Financial measures	35. Reconfiguration of processes & technologies

Conceptual Product Stewardship Capabilities	
1. Stakeholder management/ integration	23. Suppliers ISO 14001 certification
2. Cross-functional management	24. Second tier supplier environmentally friendly practice evaluation
3. Lifecycle analysis	
4. Development of new, lower impact products	25. Use of recycled or reused material in production
5. Restructuring of production systems	26. Use of renewable energies
6. Entrepreneurship	27. Environmentally friendly transportation
7. Innovativeness	28. Avoidance of hazardous materials
8. Proactiveness	29. Environmentally sensitive corporate culture
9. Risk Taking	30. Employee training
10. Environmental measurement throughout supply chain	31. Environmental auditing
	32. Waste segregation at source
11. Operational measurement throughout supply chain	33. Environmental improvement of packaging
	34. Green innovations/ technologies throughout logistical process
12. Financial measures throughout supply chain	
13. Transforming environmental changes into action throughout supply chain	35. Recovery of end of life product/ packaging
	36. Resale, remanufacture or recycling unwanted goods
14. Holding awareness seminars for suppliers and contractors	37. Management of uncertainty/ change
	38. Vertical coordination
15. Guiding suppliers to set up environmental programmes	39. Policy entrepreneurs
	40. Incentive systems
16. Bringing together suppliers in the same industry to share know-how and problems	41. Top management support
	42. Accident prevention
17. Informing suppliers about the benefits of cleaner production and technologies	43. Investment in cooperative resources & activities
	44. The construction of mutual goals
18. Pressuring suppliers to take environmental action	45. Joint sustainable innovation throughout the supply chain
19. Choice of suppliers by environmental criteria	
20. Eco-labelling of products	46. Technology
21. Cooperation with suppliers for environmental objectives	47. R&D
	48. Corporate social responsibility
22. Environmental audits for suppliers' internal management	

Conceptual Clean Technologies Capabilities	
1. Advanced development of new, clean processes and products	26. Cradle-to-cradle lifecycle/ closed-loop approach
2. Advanced reduction of energy & material consumption	27. Technological & managerial innovativeness
3. Investment in innovation	28. Product acquisition
4. Disruptive change	29. Reverse logistics
5. Future positioning & Vision	30. Inspection and disposition
6. Commercialization of clean technologies	31. Remanufacturing, refurbishment and repair
7. Entrepreneurial activities	32. Remarketing
8. Political acumen	33. Transport optimization
9. Technological management systems	34. Environmentally sustainable production & distribution systems
10. Organisational know-how	35. Network design
11. Consumer and environmental consultation	36. Strategic decision making
12. Knowledge transfer and capacity building	37. Resource impact assessment
13. Environmental assessments and auditing	38. Scarce resource avoidance
14. Environmental lifecycle analysis	39. Continuous improvement
15. Ecological leapfrogging	40. Environmental & political regulations
16. Supply chain aptitude for new technologies	41. Process & product modification
17. Stakeholder integration	42. Green R&D
18. Extensive recycling throughout the supply chain	43. Resource Allocation
19. Supplier audits & guidance	44. Strategic planning
20. ISO 14001	45. Organisational capacity
21. Global lifecycle perspective	46. Employee skills
22. Governance	47. Proactivity
23. Compliance	48. Flexibility
24. Environmental, financial & non-financial performance measurement	49. Eco-design
	50. Optimization
	51. Quality management systems
25. Long term perspective	52. Product differentiation strategy
Conceptual Base of the Pyramid Capabilities	
1. Entrepreneurial activities (redesign of business models & products)	27. Exploitation of external opportunities
2. Technological innovation	28. Use of advanced technologies
3. Strategic market entry	29. Governance
4. External collaboration	30. Monitoring of external environment
5. Social embeddedness (non-traditional collaboration, co-invention, spread of resources)	31. Social media communications
	32. Strategic planning of sustainable practices
	33. Employee awareness/ commitment/ training/
6. Embedded innovation	34. Resource reconfiguration/ adaptation
7. Fair Trade	35. Consumer concern
8. Maximisation of human & working rights	36. Measurement of sustainability benefits
9. Firm & supplier self assessment/ auditing	37. Awareness of sustainable supply chain practices
10. Supplier certification	38. Knowledge management
11. Supplier training & capacity building	39. Network structure
12. Supplier selection	40. Discovery of radical innovation opportunities
13. Support of supply chain partners	41. Transforming innovation into business proposal
14. Rewards & penalties	42. Marketing & commercialisation
15. Information management/ transparency	43. Entrepreneurial power/ creativity of individuals
16. Stakeholder integration	44. Flexible approach to innovation
17. Joint planning for social objectives	45. Management of technological change
18. Architectural & radical innovation of new markets, management systems & performance outcomes	46. Scaling & replication to create systematic social change
	47. Meeting new or overserved market needs
19. Risk management & mitigation	48. Creating less costly and simpler products that are of value to specific consumers
20. Vertical integration	
21. Third-party auditing	49. Generating resources from donations, grants, volunteers, or intellectual property/ availability of funds
22. Organisational culture , beliefs & shared value	
23. Top management support	
24. Regulatory framework	50. Product or process customization
25. Global perspective	51. Inter -Organisational learning
26. Integration of external resources	52. Natural resource management

APPENDIX 2: Intercoder reliability assessment (sample)

Pollution Prevention Capabilities

1. Continuous innovation
2. Process innovation
3. Employee involvement & skills/ Internal knowledge & expertise
4. Cross functional integration
5. Organisational commitment & learning
6. Technological know-how
7. Human resource management/ personnel management
8. Reputation
9. Political acumen
10. Continuous improvement
11. Proactive approach to the environment
12. Managerial competence
13. Stakeholder integration
14. Higher order shared learning/ organisational learning
15. Interpretation of environmental issues as opportunities
16. Resource reconfiguration/ management
17. Environmental measurement
18. Operational measurement (ISO 14001, eco-efficiency, lean, just-in-time)
19. Financial measures
20. Transforming environmental changes into action
21. Internal environmental policy/ management procedures
22. Use of environmentally friendly materials
23. Substitution of questionable materials
24. Consideration of environmental criteria
25. Process optimisation to reduce solid waste
26. Internal recycling
27. Environmental total quality management
28. Advanced prevention and safety methods
29. Internal & external cooperation
30. Identification & implementation of new processes & technologies
31. Organisational capacity
32. Consideration of externalities
33. Entrepreneurial leadership, foresight & insight
34. Information/ knowledge management
35. Reconfiguration of processes & technologies

Sensing	
Processes to direct internal R&D & select new technologies	1, 2, 10, 17, 30, 32, 33, 34, 35, 6
Processes to tap supplier and complementor innovation	1, 2, 5, 6, 10, 14, 27, 29, 30, 32, 33
Processes to tap developments in exogenous science & technology	1 ,2, 6, 12, 15, 17, 21
Processes to identify target market segments, changing customer needs and customer innovation	1, 2, 3, 4, 10, 13, 30, 32, 33, 34
Seizing	
Delineating the customer solution & business model	13, 15, 16, 20, 27, 33, 21
Selecting decision making protocols	3, 4, 11, 12, 17; 31, 33, 34, 21
Selecting enterprise boundaries to manage compliments & control platform	3, 4, 7, 13, 29
Building loyalty and commitment	3, 8, 7, 31, 12, 33
Transforming	
Decentralisation and near decomposability	1, 2, 3, 4, 5, 16, 29, 30, 35
Governance	4, 7, 8, 9, 12, 13, 29, 31, 33
Cospecialization	3, 4, 14, 29, 32, 33, 35
Knowledge management	1, 2, 3, 5, 7, 14, 15, 31, 32, 33, 34

APPENDIX 3: Conceptual capability intercoder reliability results

Table 5.1 Conceptual definition of dynamic pollution prevention capabilities

Pollution Prevention Capabilities	
Sensing	➢ Actively seeking environmental opportunities ➢ Continuous improvement to maximise environmentalism in internal operations ➢ Process innovation to maximise environmental processes & technologies ➢ Process optimisation to reduce solid waste ➢ Seeking out environmentally friendly materials ➢ Identification of new environmental processes ➢ Internal & external cooperation in seeking environmental opportunities ➢ Stakeholder integration to tap supplier & complementor innovation ➢ Cross functional integration & learning to direct internal R&D ➢ Managerial aptitude to select new technologies & identify target markets, changing customer needs & customer innovation ➢ Environmental, operational and financial measures to highlight opportunities ➢ Technological know-how surrounding environmental technologies ➢ Entrepreneurial foresight & insight of environmental issues ➢ Advanced prevention & safety measures to direct R&D & select new technologies ➢ Consideration of environmental criteria ➢ Consideration of external environments ➢ Seeking a reputation of environmentally sound company ➢ Resource reconfiguration
Seizing	➢ Interpretation of environmental issues as opportunities ➢ Implementation of new environmental processes ➢ Organisational capacity to manage environmental processes ➢ Managerial competence of internal environmental operations ➢ Environmental policy & management systems to manage internal behaviours ➢ Environmental, operational & financial measures to assist decision making protocols ➢ Employee involvement, skills and expertise in internal environmental operations ➢ Personnel management to maximise environmental behaviours & build commitment ➢ Advanced prevention & safety methods ➢ Evidencing reputation of environmentally sound company ➢ Entrepreneurial leadership of environmental behaviours ➢ Information & knowledge management
Transforming	➢ Proactive approach towards environmental issues ➢ Transforming environmental changes into action ➢ Organisational commitment to environmental management ➢ Higher-order shared learning ➢ Internal & external coespecialisation surrounding environmentalism ➢ Organisational capacity to create environmental processes ➢ Environmental, operational and financial measures to guide future progress ➢ Environmental total quality management ➢ The creation of environmental policies and procedures ➢ Avoidance/ substitution of non-environmentally friendly materials ➢ Internal recycling ➢ Political acumen surrounding environmental issues ➢ Concern for external environments ➢ Reconfiguration of processes & technologies ➢ Entrepreneurial leadership, foresight & insight surrounding environmentalism

Table 5.2 Conceptual definition of dynamic product stewardship capabilities

Product Stewardship Capabilities	
Sensing	➢ Lifecycle analysis to highlight environmental opportunities ➢ Environmental, operational & financial measures in supply chain ➢ Corporate social responsibility assessments to highlight opportunities ➢ Entrepreneurship throughout the supply chain ➢ Proactive approach to stewardship & environmentalism throughout supply chain ➢ Development of new, lower impact operations throughout supply chain ➢ Seeking the creation of sustainable products, processes and packaging ➢ Employee awareness of environmental issues & behaviours throughout supply chain ➢ Incentive systems for environmental ideas ➢ Stakeholder integration to select technologies, direct R&D & tap joint innovation ➢ Cooperation with suppliers for environmental objectives ➢ Joint sustainable innovation throughout the supply chain ➢ Bringing together suppliers to share problems, know-how & seek resolutions ➢ Pressuring suppliers to take environmental action ➢ Eco-labelling to tap developments in exogenous science & technology ➢ Avoidance of hazardous materials ➢ Risk taking ➢ Remarketing
Seizing	➢ Lifecycle analysis to assist decision making protocols ➢ Environmental, operational & financial measures to assist decision making ➢ Environmental auditing ➢ Corporate social responsibility to assist decision making and control platform ➢ Choice of suppliers by environmental criteria ➢ Guiding suppliers to set up environmental programmes ➢ Informing supplier about the benefits of cleaner production ➢ Restructuring business models ➢ Entrepreneurial business model design, decision making & control ➢ Cross-functional management ➢ Employee training surrounding environmental behaviours ➢ Management of uncertainty or change ➢ Waste segregation at source ➢ Recovery of end-of-life product and packaging ➢ Resale, recycling or remanufacturing of unwanted goods ➢ Incentive systems for environmental behaviours ➢ Network design to support stewardship
Transforming	➢ Cradle-to-cradle approach ➢ Transforming environmental changes into action throughout the supply chain ➢ Use of recycled of reused material throughout supply chain ➢ Use of renewable energies throughout supply chain ➢ Environmental improvement of packaging ➢ Stakeholder integration ➢ Vertical coordination ➢ Environmental audits for suppliers' internal management to support governance ➢ Suppliers' ISO certification to support governance ➢ Second tier supplier environmentally friendly practice evaluation ➢ Corporate social responsibility to support governance & manage supply chain ➢ Supply chain leadership ➢ Holding awareness seminars for suppliers & contractors ➢ Bringing together suppliers in the same industry to share know-how ➢ Promoting the benefits of cleaner production ➢ Creating business models to maximise environmentalism and stewardship ➢ Entrepreneurship surrounding stewardship & environmental policy ➢ Top management support ➢ The construction of mutual goals throughout the supply chain ➢ Co-evolution with customers & suppliers

Table 5.3 Conceptual definition of dynamic clean technologies capabilities

Clean Technologies Capabilities	
Sensing	➢ Continuous improvement of environmental impacts ➢ Seeking the advanced development of new, clean processes and products ➢ Seeking the advanced reduction of energy and material consumption ➢ Green research & development ➢ Eco-design ➢ Product acquisition ➢ Entrepreneurial activities to identify new clean technologies ➢ Technological & quality management systems to identify new clean technologies ➢ Environmental, financial & non-financial measures to identify new clean technologies ➢ Resource impact assessment to identify new clean technologies ➢ ISO to identify new clean technologies ➢ Compliance ➢ Consumer & environmental consultation to tap new technologies, ideas & market needs ➢ Supply chain aptitude to identify new, clean technologies ➢ Employee awareness of clean technologies ➢ Supplier audits of environmental impact of operations ➢ Organisational know-how surrounding clean technologies ➢ Future visioning of clean technologies ➢ Technological & managerial innovativeness ➢ Ecological leapfrogging to tap developments in exogenous science & clean technologies ➢ Strategic planning for clean technologies
Seizing	➢ Entrepreneurial approach to business models & decision making ➢ Organisational capacity for clean technologies ➢ Technological abilities ➢ Technological management systems to assist decision making protocols ➢ Environmental, quality and lifecycle assessments and auditing to assist decision making protocols ➢ Environmental, financial & non-financial measures to assist decision making protocols ➢ Resource impact assessment to assist decision making protocols ➢ Resource allocation ➢ ISO to assist management of clean technologies ➢ Employee awareness of scarce resources ➢ Employee skills surrounding clean technologies ➢ A closed-loop approach to business models & processes ➢ Network design to support clean technologies
Transforming	➢ A global, lifecycle perspective of operations & environmental impacts ➢ Investment in innovations of the future ➢ Aptitude for disruptive change ➢ Future positioning of clean technologies ➢ Commercialization of clean technologies ➢ Governance of clean technologies ➢ Political acumen surrounding clean technologies ➢ Desire to go beyond compliance ➢ Concern for scarce resources ➢ Technological management systems to guide future progress ➢ Environmental, financial and non-financial measures to guide future progress ➢ ISO to guide future progress ➢ Knowledge transfer & capacity building ➢ Stakeholder integration ➢ Supplier guidance surrounding clean technologies & positive impact operations ➢ The creation of environmental & political regulations ➢ A closed-loop supply chain approach ➢ Creation of environmentally sustainable production & distribution systems

Table 5.4 Conceptual definition of dynamic base of the pyramid capabilities

Base of the Pyramid Capabilities	
Sensing	➢ Entrepreneurial approach to seeking new market opportunities ➢ Integration of internal resources to direct R&D & identify new markets ➢ Monitoring external environment to identify markets, customer needs & innovations ➢ Use of social media in base of the pyramid markets ➢ Non-traditional collaboration with stakeholders & externalities to identify opportunities ➢ Fair trade ➢ Firm & supplier assessment and auditing ➢ Employee awareness of social improvement in base of the pyramid markets ➢ Aptitude for new technologies & innovations ➢ Aptitude for strategic market entry at the base of the pyramid ➢ Aptitude for radical or architectural innovation of new markets, systems and outcomes ➢ Flexible approach to innovations ➢ Awareness of social sustainability benefits ➢ Access to information ➢ A global perspective of business markets & social issues
Seizing	➢ Entrepreneurial approach to customer solutions, business models, decision making, enterprise boundaries & control platforms ➢ Scaling & replication to create systematic social change ➢ Creating less costly or simpler products that are of value to base of the pyramid markets ➢ Product or process customisation ➢ Natural resource management ➢ Measurement of social sustainability benefits ➢ Fair trade to support decision making protocols ➢ Firm & supplier assessment and auditing ➢ Awareness of social sustainability practices throughout the supply chain ➢ Supplier training of social issues ➢ Support of supply chain partners ➢ Building loyal & committed relationships via non-traditional collaboration ➢ Embedded innovation ➢ Joint planning for social objectives ➢ Translating innovations into business proposals ➢ Entrepreneurial power of employees ➢ Employee commitment to social improvement in base of the pyramid markets ➢ Top management support ➢ Consumer concern for social issues in base of the pyramid markets ➢ Use of social media to delineate the customer solution ➢ Generating resources from donations, grants, volunteers or intellectual property
Transforming	➢ Entrepreneurial approach to bottom of the pyramid markets ➢ Relationship with externalities in base of the pyramid markets ➢ Awareness of regulatory framework in base of the pyramid markets ➢ Co-invention & spread of resources with base of the pyramid markets and stakeholders ➢ Joint planning for social objectives ➢ Firm & supplier assessment and auditing to support social alleviation ➢ Supplier selection to maximise social alleviation & support base of the pyramid markets ➢ Supplier certification to ensure social governance ➢ Supplier training & capacity building to ensure social governance ➢ Rewards & penalties to ensure social governance ➢ Entrepreneurial power of employees & individuals ➢ Vertical integration to ensure social governance ➢ Maximisation of human and working rights ➢ Information transparency ➢ Aptitude for social media ➢ Third-party auditing ➢ Risk mitigation

APPENDIX 4: Interview Guide

- How would you describe the company to me?

Pollution Prevention

- Can you tell me about the company's approach to waste management?
- Are there any specific benefits of this approach?
- How does this impact on the day to day running of operations?
- What would you say are the core capabilities the company employs in the management of waste/pollution?
- Can you tell me about your company's internal environmental strategies?
    - Prompts: policies; management systems; consideration of environmental criteria; process optimization; employee communication; training; decision making

Product Stewardship

- How do you manage sustainability throughout the food chain?
- From your company's perspective, what is considered the beginning and end of the lifecycle?
- Can you control the lifecycle of a product? How?
- Does the company maintain any responsibility for a good before it enters or after it leaves your facility?
- Can you tell me about your company's external environmental strategies?
- Can you tell me about the kind of relationships you have throughout the supply chain?
    - Prompts: supplier seminars, guidance or training; share know-how; accreditation; supplier selection; distribution; waste/pollution in the supply chain; reusability or recovery; closed-loop supply chain

Clean Technologies

- How does technology play a role in sustainability for the company?
- Can you tell me about any technologies you have that support sustainability? What was the motive for them?
- Where do you find new technologies? How do you decide which technologies to invest in?
- Are there any complexities with the management or adoption of these technologies
    - Prompts: employee expertise & training; qualifications; joint innovation; renewables; offsetting; measurement; closed-loop approach

Base of the Pyramid

- Can you tell me about the company's approach to social sustainability?
- To what extent do you think the company can have an impact on social issues? On what scale (local/ global)?
- Why are these issues important?
- How does this play a role in the day to day running of the organisation?
- Are there any particular benefits of this approach for the company?

- Prompts: emerging markets; customisation; market entry; clean technologies; external collaborations; certifications or affiliations; innovation

- What are the core capabilities that support the company's sustainability strategies?
- What is next for the company?
- With regards to sustainability, how do you think you compare with other food companies?

APPENDIX 5: Phase 2 Sample Data

Pollution Prevention Capability Data	
Sensing Internal	Environmental, operational & financial measures
	- '*We measure pulses of energy throughout the factory to find ways to cut money*' (FC1) - '*We measure what each tractor uses on a daily basis'* (FC2) - '*We assess invoices on a weekly basis to see where we need to be keeping costs down'* (FC2) - '*If your electricity bill is rising year on year, you think surely there must be something you can do, or at least you have to try*' (FC6) - '*We are monitoring what water is used on a daily basis'* (FC12) - '*We measure all utilities with a big focus on electricity and gas'* (FC12)
	Continuous improvement & optimization of processes, machinery & technologies
	- '*You have to keep looking for better things. We have just replaced three old freezers with three new ones, because we looked and we thought we could do better in terms of energy and efficiency'* (FC4) - '*We are always looking for ways to optimise our operations, you know, reinventing parts of the business so we can reduce waste further. We seek out the best solution for our business and we constantly revisit that to make sure it is the best solution'* (FC18) - '*We are looking to improve on* [waste] *all the time'* (FC19) - '*We are always looking within the factory for new techniques for washing, cutting and packing that are innovative'* (FC19)
	Cross-functional integration & learning towards environmental objectives
	- '*We have an environmental team that represents every department'* (FC1) - '*Being green is the responsibility of everyone in the company. For it to work everyone in the company has to be on board'* (FC5) - '*It's not really something any one person can take credit for. It's a team effort'* (FC6) - '*Key people from engineering, environment, sustainability, health and safety get together and look at their metrics from the previous month and discuss where the water is, where the waste is and discuss projects they have underway to try and meet new targets'* (FC16) - '*Our ideas come from a team angle rather than from individuals, anyone with good ideas can come in and discuss them'* (FC19)
Sensing External	Entrepreneurial foresight & insight of environmental issues
	- '*Because we know we're in a nitrate vulnerable zone we know we have to be really careful'* (FC3) - '*Trust me, we have been there are got the tshirt when it comes to things like disease and damage. I think that changes how you approach things, and that is why we look to be the best we can be all the time'* (FC4) - '*You have to use all the information you can. You adapt and make the best use of the resource'* (FC19)
	Analysis of external environmental, target markets & changing customer needs
	- '*Working with them has genuinely been great for us. We are lucky that they help us keep our carbon footprint tidy'* (FC8) - '*It's from working with Sainsbury's that we were actually able to get a good picture of potato waste'* (FC9) - '*From an external perspective we are actively benchmarking ourselves in terms of water'* (FC12) - '*It's a lot of paperwork to take on but that is how you meet certain standards with ethical, sustainable and environmental issues'* (FC19) *'from looking outward I know we are in a good position when it comes to waste* [....] *in comparison to more traditional producers'* (FC19)

Seizing Internal	Capacity to implement & manage new environmental processes
	- *'80% of my savings are through lean manufacturing and improvement* […] *from that I can see where the air leaks and pressure leaks are and stop that'* (FC1) - *'KPIs give us that clear internal procedure that we really need'* (FC12) - *'For us it was important to have a system in place to support prevention. We've been installing all sorts of controls'* (FC16)
	Environmental management systems
	- *'We have ISO 14001. That for us has been an effective management system'* (FC4) - *'ISO 26001 makes us measure and manage sustainability, giving us a strong grasp on waste in all its various definitions'* (FC9)
	Advanced prevention & safety measures
	- *'We full maintenance records of every bit of kit* [….] *environmentalism and health and safety are closely linked'* (FC1) - *'You need to stay on top of things and that really involves anything with a malfunction being fixed or replaced straight away'* (FC2) - *'Thank god for Hazard Analysis. That has saved us a lot of time with those issues, both in terms of food safety and waste. That's were critical control points come in'* (FC10)
	Employee involvement, skills & expertise
	- *'We want the right people and so we want to nurture experience over time and get the profession right'* (FC9) - *'The guys on the floor all know that waste costs money'* (FC12) - *'We get them all trained up so that they are being as sustainable as possible'* (FC16) - *'We have ten university graduates a year who come in and look at different projects. We have had some real big successes with that. Honestly some of our best ideas have come out of that, it's a really great thing'* (FC16) - *'I think if you weren't into sustainability you wouldn't want to work here. And we wouldn't want you to. I suppose it's about like-minded people. So yes, we do actively seek people who are passionate and who have ideas that work alongside the business'* (FC17)
	Entrepreneurial leadership
	- *'Some of the guys are given specific areas that they look after so they almost become the grower for that sector of the crop'* (FC1) - *'It is my job personally to look at the bigger picture. It's not always easy to be that person who argues the case for being green and get that pushed through'* (FC6) - *'I think we have sort of a scientific approach* [….]*' we have our own major projects on reducing the amount of packaging'* (FC16)
	Information and knowledge management
	- *'All staff have a copy of our five-year plan and annual plans with reviews of the last year and what to expect in the coming year'* (FC4) - *'We have sustainability conferences within the organisation whereby people present their sustainability stories and achievements and introduce new ways of doing things'* (FC16) - *'We do a lot of sessions from production managers explaining why environmental stuff needs to be done'* (FC19) - *'Actually you can see that there is documentation all around the place explaining it all and why it is important and driving it'* (FC19).
Seizing External	Evidencing reputation of environmentally sound company
	- *'Some of our environmental policies and quality policies are more for our customers*' (FC1) -*'Good environmental background and credentials are appreciated and consumers do want to know about them*' (FC4) - *Once people know you are determined and passionate and you know what is right* [....] *they start to listen* [….] *our internal sustainability programme is the external tangible evidence of our values'* (FC12) - *'I guess we do it because so we can constantly communicate those commitments to our customers and to the outside world. We want everyone, including our competitors to know that we use 100% renewable energy, that we use a waste disposal company that doesn't send any waste to landfill, that all our packaging is responsible'* (FC18)

Transforming Internal	Organisational commitment to the environment
	- *'We really, really care about the soil we are working with and the burns and rivers that flow through the land'* (FC2) - 'For us it's *about direction, it's our decision to do these things because we know what direction we want to go* [....] *we have a shared philosophy if you like*' (FC7) - *'The company's strong values keep us strong and committed in strategy and vision, that drives change'* (FC12) - *'The environment is at the core of our business values, it has always been something that is really important to us* [….] *it's part of the ethos of our business'* (FC18) - *'Sustainability is a major part of company life'* (FC19)
	Organisational capacity to create new environmental processes & technologies
	- *'We put it in to manage water in a sustainable way* [….] *before it flows off and is lost'* (FC13) - *'We now have low water usage because we're in a closed-loop and we're reusing that water and creating value from it'* (FC18) - *'In some situations the output of one process might be normally considered waste but if you can use it in another process you stop it from being waste'* (FC18)
	Creation of environmental policy & criteria
	- *'We created a building management system that monitors half hourly data for the full site, it's made a huge difference in terms of what we can do and what we now know we want to do'* (FC1) - *We have an internal charter, with our 'doing more for less', which is a resource efficiency programme that acts as a roadmap'* (FC16) - *'You need these internal policies that cover different motivations and objectives* […] *about protecting our business and the wider environment'* (FC19)
Emergent Capabilities	Internal waste segregation
	- *'We have systems in place to make sure every member of staff knows how to recycle and segregate waste'* (FC4) - *'Once you've organised all that waste it can bailed on farm and then sent for recycling* [….] *honestly you can make thousands'* (FC13) - *'When we looked at waste a lot of that was looking at all our processes and identifying waste, segregating the waste, weighing it, looking at contamination classifications, going through all the materials and working out what we could recycle'* (FC16)
	Demand Forecasting
	- *'Whenever we can we order last minute on a day to day basis'* (FC1) - *'We're avoiding a huge amount of surplus that ends up getting tipped into a hole in the ground, that reduces produce waste massively'* (FC2) - *'Predicting crop availability* [….] *takes food waste out of the equation'* (FC10) - *'We don't order anything in until it is needed, we know it is needed because we are in communication with our customer and work closely with suppliers so that everything can happen really fast'* (FC15)
	Zero Waste Philosophy
	- '*We have zero-waste, which for us and for the environment is one of the most important things with keeping waste down and definitely one of the top ten topics in our five-year environmental plan*' (FC4)
	Family management principles
	- *'Because we need to think about the kids, the next generation, its less of a 10 year thing* (FC6) - *'Why would you not want to sustain your soil if as a farmer, you're probably going to be there for generations and probably you already have been there for generations'* (FC13) - *'Wanting to make a difference comes party from being a family business'* (FC15)
	Financial capacity to invest in new practices

	- *'We were lucky that you could get some real financial help from the government if you could show you could lower pollution'* (FC4) - *'Sustainability in a big way comes down to profitability, if you're not profitable you basically can't be sustainable because you can't carry out all these environmentally sustainable goals* [because] *you need to be able to invest money in them'* (FC6)

Newly emergent capabilities	Personal motivations
	- *'In my personal life I am an environmental person* [….] *it would be difficult to separate that from the business'* (FC1) - *'Our passion' and experience in marine ecology encourages us to want to protect coastal ecologies'* (FC6) - *'I think in my personal life I try to be quite sustainable* [….] *my business partner and I are fairly environmental people in the sense that that was one of the main drivers in setting up the business'* (FC18)
	External Partnerships
	- *'By luck there's an on-farm recycling facility nearby* [….[*that was certainly better than going to landfill'* (FC6) - *'We partnered with them simply because it is more expensive to get rid of non-recyclable waste which of course acts as a driver to recycle as much as you can'* (FC7)

Product Stewardship Capability Data	
Sensing	Lifecycle measurements & analysis of products and processes
	- '*We need to assess the effects of the actual processes on the environment'* (FC1) - '*We look at everything from where the seed was produced to being grown and fed and raised'* (FC2) - '*It's from looking at all those processes that we find an opportunity to look again and try to improve'* (FC10)
Sensing External	Bringing together suppliers in the same industry to share problems & know-how
	- '*We have regular farmers' meetings where farmers come in and talk to the owners about common issues'* (FC1) - '*The forums really help the suppliers to encourage each other and try and find out about LED lights, or solar panels, or wind turbines. If there are certain things you are unsure of you can post on that and ask people for advice'.'* (FC4) - '*We try to get all the suppliers together so they can share all their difficulties with us'* (FC7) - '*We are interested to learn about any issues our farmers have, but at the same time they are the farmers and we respect that they know what they are doing'* (FC8) - ' *The whole point of the supplier seminars is to go over different aspects* with *quality, cost and efficiency, sustainability* [….]'*we see companies as well, along with farmers, it's a sort of cooperative'* (FC12)
	Stakeholder integration to select new technologies & direct joint innovation
	- *We've come up with new environmental things from sharing ideas, working together'* (FC7) - *'A lot of thing have come from working with our farmers in particular'* (FC10) - '*We're now looking into substrate technology because we got with our suppliers'* (FC12) - '*We do find our younger growers are more switched on and do suggest ideas that will be taken up'* (FC19) - '*We have some suppliers with great ideas and we benefit from that'* (FC20)
	Seeking out professional memberships
	- *'It was those audits that enforced a discipline that was genuinely for the good rather than the bad of the business. Because of them we wanted to invest in environmental things'* (FC13) - '*The good thing with all those accreditations is they do give you a holistic assessment of what's happening environmentally'* (FC16)
Seizing Internal	Employee training surrounding environmental behaviours
	- *'Credit where credit is due, our logistics guy really knows his stuff and gets why we want to do what we're trying to do'* (FC1) -*'They all need training in full scale traceability ….] scalable production, accreditations, state of the art production'* (FC5) - *'Actually that is a real strength. Having the right people and expertise so we can operate a sustainable potato supply chain'* (FC9)
	Choice of suppliers by environmental criteria
	- '*Our growers are all accredited and meet certain regulations* [….] *if they are doing what we are doing, IS0 14001, we assume they are the same and that is a good indicator'* (FC1) - *'The farms we work with have interests in things like wildlife conservation, they avoid pesticides so they aren't polluting that way and they do things things like soil fertility is really important'* (FC8) - '*We are starting to push and look at what they are engaged with, so if it's a plastics company if they are involved in the latest sustainability initiatives in plastics'* (FC12) - *'If they have various certifications and stuff then we know they are in a programme looking at carbon footprint and looking at waste and how to improve their footprint year on year'* (FC16) - '*We don't have a sustainable sourcing policy per say, but we will always take sustainability into consideration. We will always take sustainability into consideration, look to understand what the credentials are of a supplier that we're working with and we will always choose the most sustainable option available'* (FC18) - '*I am looking for the ones that are progressive and eager to go forward with new ideas and concepts'* (FC19) - '*When we select suppliers to work with sustainability plays a big role in that* [….] *I want a responsible attitude towards environmental sustainability'* (FC20) - *'We look for accreditations that ensure locality and sustainability'* (FC20)

Seizing External	Environmental, operational and financial supply chain measures
	- '*Our lorries are all tom-tom monitored and fuel Tran monitored which means I monitor idle times, I monitor everything, miles per gallon, everything you can imagine. From that you get a variety of big reports so you can get those environmental improvements'* (FC1) - '*There are rigorous monthly checks to make sure they aren't putting out too many dirty emissions'* (FC9) - '*We are actively measuring the footprint of all the farms'* (FC16) - '*You have to stay on top of distribution, things like fuel and congestion matter. It is more environmental and it also makes more sense business wise'* (FC17)
	Building relationships throughout the supply chain
	- '*We're big in to partnerships. Getting to that point is all about partnerships'* (FC2) - '*Being collaborative or partnership-working is very much about sustainability'* (FC9) - '*A lot of the farmers we work with have long term relationships with, 25 or even 40 years* [….] *Partnership is key to delivering sustainability* [….] *farmers need to be successful so partnerships are the big thing for the future'* (FC10) - '*The pockets of the business where we have more of a partnership relationship are the strongest with that. I think we need to focus heavily on those relationships'* (FC12)) - '*We're in regular communication, almost daily communication with all of them'* (FC19)
	Cooperation with suppliers for environmental objectives & new, lower impact operations
	- '*With them we have a project that is all about energy recovery and heat recovery'* (FC4) - '*It can be a two-way process. We've done things like packaging, pushing things like technology in terms of packaging'* (FC10) - *'Sometimes it's when you get together you're able to actually impact change and develop innovation in a very satisfactory way'* (FC12)
	Assisting suppliers with environmental programmes
	- '*What is the point in us having this knowledge and experience and not sharing it?'* (FC9) - '*We encourage our suppliers to get accredited and we help them and talk them through paperwork and all the things that are a part of that process'* (FC9) - '*We spend a lot of time with our farmers working out where their emissions come from'* (FC10) - '*We give* a *a lot of support, going in and seeing the growers on a weekly basis, helping them with everything from agronomy through to advice on ethical issues, farm assurance issues, sustainability issues, environmental issues'* (FC19)
	Environmental audits for suppliers' internal management
	- *'Everything you can think of on a farm we look into, like soil moisture, biodiversity'* (FC1) - *'Each supplier must do their due diligence with certain paperwork* [….] *there is a lot of auditing going on* [….] *and we need five years of record keeping'* (FC2) - '*We do look down through the process of some of our suppliers* [….] *so we know what is coming from where and how it is made'* (FC4) - '*We also find auditors to audit third party for various schemes'* (FC12) - '*We do visit our suppliers and we audit them'* (FC20)
	Capacity for resale, recycling or remanufacturing throughout supply chain
	- '*Waste is transferred around between all of us to find the best method to use it, whether it is animal feed or putting it to process instead of wasting it or leaving it lying around'* (FC1) - '*We swap straw with local cattle farms and get dung back, you know it balances out and works quite well, giving organic matter for soil'* (FC6) - *'Circularity is also important, particularly in food waste; so this idea that everything can be reused or reincorporated, like anaerobic digestion and feed stock'* (FC8) - *'Our Turkish factory has an AD plant that takes all the waste from local guys and produces electricity'* (FC10)
	Investment in cooperative resources and activities
	- *'If they have solar panels of what have you it, can become a win-win situation'* (FC1) - '*We got them a harvester because they couldn't afford to go and buy one and it was vital to us to have them so it's turned into a growing partnership'* (FC2) - *'Our suppliers often have solar panels, wind turbines and electric vans, and so to some extent that is embedded in the finished product'* (FC20)
	Eco-labelling

	- *'Your accreditations allow you to say all at once to a customer that you are sustainable'* (FC6) - *'SEDEX lets you demonstrate ethics and values from a company perspective and throughout the supply chain, its great to regulate how we deal with retailers'* (FC12) - *'ISO 14001 helped us to get a programme for water stewardship, giving us holistic assessment of our water profile from use, to reuse, to disposal'* (FC16)
Transforming Internal	Creation of environmental supply chain policy
	- *'There is now a league table for environmental targets. No one wants to be at the top of that table'* (FC2) -*'We had to create a governance measure for sustainability'* (FC8) - *'We are driving recyclability through our KPIs in terms of water, plastics and cardboards. It means we can move our contracts on to a position where zero to landfill is a given'* (FC12) - *'We have our own systems based approach to deliver sustainability, it's like roadmaps that they all can follow and utilise'* (FC16)
	Vertical integration
	- *'We do everything from sourcing the product, harvesting the product, drying and milling it, branding it, packing it, everything'* (FC5) - *'We are a vertically integrated company so we have a lot of processes that are interconnected and that we control, for that reason we have good supply chain control. Because we are so vertically integrated the farmer comes in the front gate and the tray comes out our back gate to the retailer, that all happens on one site nearly'* (FC16) - *'That lets us be genuinely sustainable, not just in an environmental way but ensures sustainable living, a livelihood for our fishermen that is economically and socially sustainable'* (FC17) - *'We are vertically integrated from a supply chain point of view, we do everything ourselves from production through to distribution so that really makes it easy for us to maintain the entire chain'* (FC18)
	Creation of recyclable or reusable products
	- *'We've shifted from use-once containers to reusable containers to get that waste down'* (FC6) - *'In the long term we are considering new technologies in packaging'* (FC12) - *'Packaging is a big thing for us. We all have a role to provide alternatives for the market that are more sustainable'* (FC16)
Transforming External	Entrepreneurial leadership in the supply chain
	- *'We would describe ourselves as a leader in sustainability and that is engrained in our R&D and everything we do, but it is about working together'* (FC10) - *'We want to ensure that the farmers and the producers and the fishermen are doing their jobs in harmony with the marine environment and providing a real quality product'* (FC17) - *'We are driving sustainability down through the supply chain* [….] *we kind of push it because sustainability it is at the heart of our business model'* (FC18) - *'90% of the ideas around sustainability come from us'* (FC19)
	Informing suppliers about the benefits of cleaner production & encouraging environmental action
	-*'Once you tell them you get two more hectares per acre, that you save 20litres per hectare in fuel […] suddenly their ears prick up and its worth listening to'* (FC2) - *'We are keen to promote zero waste practices. We want to get out there and talk to them'* (FC8) - *'We've certainly encouraged them not to be shy when it comes to things like accreditations. I would say we've encouraged it in the past even when it has made operations harder for us'* (FC9) - *'When you show them the results and its saving them money and helping long term sustainability on their farms by reducing environmental impact you'll find they get on board fairly quickly. As soon as the growers know there is no stopping them'* (FC10) - *'We have some responsibility to discuss with them the benefits of reduced nitrogen application in soils and so forth'* (FC11)
	Co-evolution with customers and suppliers
	- *'We all need to carry on with R&D, that is the most important thing if we are to stand up to the challenges of sustainable supply'* (FC9) - *'Really we are all reliant on each other and are working together to get the best outcome'* (FC14) - *'We as a company took the decision to move into the sustainability arena with great speed and haste and investment because we want to compliment some of the work the retailers do, so we have a joined-up story for our customers'* (FC16)

Emergent Capabilities	Carbon Measurement & Management
	- '*You really have to take responsibility for the carbon weight of all the food products sent out. You should always work to minimise'* (FC8) -*'Carbon surveys are now a regular thing'* (FC9) -*'Carbon measurement is the latest thing with all that, and the focus has to be on the supply chain'* (FC11) - '*We have a carbon footprint navigator tool that we use on all farms to determine the carbon footprint of the farms'* (FC16)
	External Collaboration
	- *'It helps there being individual drivers, little bits of industry pushing you in different directions'* (FC2) - '*We also work with other harvesters around Scotland and parts of Ireland, we do a lot of collaborations'* (FC5) - '*We worked a lot with another company, an external company'* (FC7)
Newly Emergent Capabilities	Communicating sustainability out-with the supply chain
	- *'It is every bit about getting the* green *message across to the farmers as it is getting the message across to the public. As an industry we are missing a trick by not controlling what goes on in the home'* (FC2) - '*We all need to do what we can to support a sustainable society'* (FC8) - '*You have to spread the word with the customers'* (FC16) - '*We need to get people to approach things differently, the whole way we eat and supply food is completely out of whack with how it should be. If we can make small changes here and there and influence the way people buy and consume things we can have a genuine impact'* (FC17) - '*We like to get people to get on board and consume and dispose of food in a more responsible way. Getting people to approach things differently, to make small changes here and there, to have a genuine impact'* (FC20)
	Supply Chain Technologies
	- *'Technology, innovation, access to that technology and uptake is so important if you want to get to a good place. As much technology as we can bring together and the more work we can do with everyone the better'* (FC10) - '*We have a lot of tech that we look at all the time and see how we can make improvements'* (FC12)

Clean Technologies Capability Data	
Sensing Internal	Continuous assessment & improvement of environmental impact
	- '*We are all the time looking for something new'* (FC3) - '*Continuous improvement is integrated in the way we work with our yearly reviews and things* [….] *we have a commitment that we want to find new things'* (FC4) - '*You need to keep things moving on, nothing stays the same. I think we have an enthusiasm to improve and keep making strides forward'* (FC6) - '*With every season there are new products and ideas, we're definitely not standing still'* (FC13) - '*We can't just carry on the way we are going if we want to become more efficient and sustainable* [….] *That is why we are constantly scanning for new ideas'* (FC19)
	Resource impact assessment
	- '*Being in food we do have a vested. We do need to look and see what there is to reduce impact on the land'* (FC3) - '*People think water is free, that it falls out the sky and we'll always have enough of it, but we do get water shortages.* [….] *the world uses three times the resources available* [….] *we need to reduce climate change'* (FC4) - '*Those species are rare and when we started out we really had to discuss what we could take and what we couldn't'* [….]'*at the moment we're ok, we can take it, but in the future we will need to look into different ways to harvest that product to make sure we remain sustainable, it can be problematic'* (FC5) - '*Our driver getting that I suppose was resource utilisation in terms of the resources that we were consuming* [….] *we needed to control these resources in a more effective manner'* (FC8) - '*Wasting food is adding to scarcity and is hugely damaging to the environment'* (FC20)
	Environmental, financial and non-financial measures
	- '*Its when things like your energy prices, water and other consumables were increasing in price* [….] *so you have to think there are economic incentives to produce your own electricity* [….] *it all needs to make sense for both the sustainable route and the financial route of the company'* (FC4) -'*We would have all the figures out on the table and see if it would be worth it'* (FC6) - '*You can't forget about pounds and pence, sustainability is a synergy between financial sustainability and environmental sustainability, you can't have one without the other'* (FC6)
	Employee awareness of clean technologies
	- '*It comes from a combination of employee thought processes, what we can do and the experience of the company'* (FC1) -'*We might go out to the factory floor and ask people for ideas, often it is someone in the factory who has a great idea'* (FC2) - '*I'd say they are about finding the best solutions from the experience of the past plus the technology of the future'* (FC13) - '*We've sort of given them the opportunity to go off and do things, trial things and see how they work and they've spent a huge amount of time recording those results and the improvements we have seen is quite incredible, you know we're quite fortunate that they are all interested in that type of thing'* (FC14) - '*Our staff spend a lot of time going to meetings with various advisory bodies and committees'* (FC19)
Sensing External	Consumer & environmental consultation of new technologies & innovations
	- '*We like to meet new consumption trends* [….] *so sometimes you have to install equipment* [….] *that can mean you change the whole process'* (FC3) - '*You need to keep moving and react to the end customer'* (FC6) - '*You can get ideas from the farming press, normal press and just issues in farming'* (FC6) - '*Knowledge comes from the desire to find out things, so because we have a desire to find out things that makes us want to go out and investigate things and speak to people and learn'* (FC8) - '*We are committed to NGO commitment, actually a huge amount of stuff comes from our industry commitments'* (FC12) - '*I think things for us we've got really interested in have come from TV* [….] *things that are on the news have influenced things we've done with panels and glass'* (FC14) - '*From time to time we go abroad where we see new ideas and can pick up new ways of doing things'* (FC19)

Seizing Internal	Organisational capacity to implement, manage & create clean technologies
	- '*It certainly helps to be closely linked with the engineering department'* (FC1) - '*It was important to develop a clear energy strategy so that we can really focus on our operational efficiencies'* (FC12) - '*We've got a small management team so we are able to take on ideas and implement them quite quickly'* (FC14)
	Employee technological know-how & skills
	- '*The boy that runs the design room is one of these magicians, he thinks outside the box and he is unbelievable, he's thought of a few things over the years* [….] *he won't put anything in that he doesn't think is at the forefront of technology'* (FC2) - '*I am a firm believer that when you are bringing in something new you have to consult the people of the floor, they can give you the problems that need to be tackled'* (FC2) - '*We give them as much info as we can so when they head out in the field they've got a really good feel of what is happening'* (FC10) - '*The students bring in expertise to show us new ways to be innovative and drive the business forward, they are our future and they will manage us in the long term'* (FC16) - '*Those kids come in with fantastic ideas and new technologies we can use in the fields'* (FC19)
	Investment in innovations of the future
	- '*Normally we are interested putting money into anything that is at the forefront of technology'* (FC1) - '*There were a lot of talks focused on funding and finding the best way to get help from government schemes'* (FC1) - '*When it comes to these technologies, it's a no-brainer when its £15,000 but with a two-year payback'* (FC2) - '*Medium term investments are perfectly fine providing you are confident in the technology and the capital or balance sheet gain you get'* (FC9) - '*We are a hugely invested company you know, we invested about £400m 5 or 10 years ago, we pride ourselves on having the latest tech and innovation'* (FC12) - '*It is a long-term investment, although it does stack up commercially, you could think of it as another income stream'* (FC13) - '*There is a lot more we could do but sometimes it is difficult having the resources we need to do these things, I'm sure that is a challenge most companies have in reality, but sustainable reinvestment remains a key activity of the business and doing that responsibly'* (FC14) - '*We invested £20m in the last two years and as a result we reduced our water footprint by about 50%'* (FC16) - '*It kind of has to be a bit of both because when we need to finance the business investors want to see financial returns within a few years, but we do see the business as something that is intended to have an impact far beyond finances and far into the future'* (FC18)
Seizing External	Sharing & creating new technologies throughout the supply chain
	- '*A lot of technologies come from working with the farmers'* (FC5) - '*You might have an idea, but you only have 20% of that idea, so you bounce it off other companies and somebody else has another 20% of that idea, or someone comes in with a totally different way of looking things and that gets us 60% of the way there'* (FC6) - '*When you look at it that way there are joint collaborators'* (FC9) - '*Technology is not about working in isolation but about working together'* (FC10)

Transforming Internal	Aptitude for disruptive change
	- *'The thing we've never been frightened of is taking a risk with something'* (FC4) - '*Conventional thinking will not be good enough to get us to where I think we want to be* [….] *it's healthy to have a disruptive attitude towards day-to-day activities* [….] *people understand and they know you can't stand still so they know I'm not being disruptive for the sake of being disruptive'* (FC12) - '*I think we are the savvy ones, the early adopters who pay attention to the innovators'* (FC13)
	Strategic planning for the future
	- *'Our vision for the future is to be a Scottish global brand from the greenest company in Britain* [….] *we want to be 100% self-sufficient in renewable energy'* (FC4) - *'Part of decision making is guessing what the future will hold'* (FC6) - *'You have to look at doing things differently for the future'* (FC10) - '*It all depends on having a long term perspective* [….] *we talk about the future* [….] *we take a 25-year view'* (FC12)
	A global, lifecycle perspective of operations
	- '*We feel we're doing our own little bit for the world or the climate'* (FC4) - *'It is about leaving the world in a state for our children that isn't completely impossible for them to manage. Its something that our species as a whole needs to start thinking about, and thinking about the way we interact with this planet in an entirely different way'* (FC17)
	Creating closed-loop systems
	- *'That system is now ten years old it was still the most innovative on the market* [….] *it saved more water than could possibly be used'* (FC1) - '*Its our designer chain* [….] *we have our own electricity directly linked to the farm to make our own ice cream'* (FC4) - '*We now have a dream farm* [….] *completely self-financing and sufficient'* (FC8) - '*We are actively pursuing self-generation technologies within the business'* (FC12) - '*Our greenhouses are designed to capture run-off because all crops are suspended from the ceiling so anything that is not absorbed by the crop itself is collected, sterilised and reused'* (FC14) - '*We use hydroponics and aquaculture to farm fish in water without soil* [….] *it's the fish poo that creates nutrient rich water which we then pump to the roots of the plant to support their growth, the plants in turn then purify the water which is sent back to the fish* [….] *its essentially a closed-loop system'* (FC18)
	Ecological leapfrogging
	-*'We like to buck the trend'* (FC2) - *'We wanted to be different and see what we were doing as adding value'* (FC7) - *'We have been ahead of most companies for a long time'* (FC8) - *'We adopt tech quickly ahead of the curve because it gives us an advantage'* (FC13) - '*We were one of the first to get into that we managed to do something quite different'* (FC14)
	Eco-design
	- *'When and if we do look at new sites* [….] *we should be making those sites sustainability sites so that is where we will end up in the future'* (FC12) - '*We completed our £26m facility last year, that has 40% recycling rate, 100% carbon neutral and a load of innovation and technology* [….] *it's the most sustainable beef abattoir ever built because it was built from a sustainability point of view'* (FC16)

Transforming External	Commercialization of clean technologies
	- *'That design selling all over the world'* (FC2) - '*Because of all that we really are an energy producer now'* (FC4) - *'I was drawn to aquaponics because no one had really commercialised it yet'* (FC18)
	Knowledge transfer and capacity building throughout industry
	- *'I think really you want to ensure the overall industry environmental impact is reduced as well'* (FC3) - '*Although we want to be the greenest company we don't want that to be at the expense of everyone else, the more you share the greener the country will be'* (FC4) - *'It is better to work together than to compete against each other* [….] *I don't see us as being an insular farm'* (FC6) - '*We are keen to promote what we've learnt and I think that is really valuable* [….] *on the wider scale as an industry and as society'* (FC8) - '*We have farm walks and have 60 or 70 growers that come', they like to see somebody else's farm and then have them explain how they do things and go over their ideas'* (FC14) - '*We all need to work together to stop the mentality we've got into, we need new laws about what we can do with food waste and new technologies to support that'* (FC20)
Emergent Capabilities	External Partnerships
	- *'We have all sorts of people working with us on tech, the scientific community, the civil society, the government, NGOs'* (FC10) - '*We've been working with the university with creating fuel cells and prototypes which can potentially be used to convert slurry into hydrogen as a source of power'* (FC11) - *'Your partners help you decide on a commitment and that drives the strategy of the business'* (FC12) - *'The owner does a lot of collaborations, he gets really excited about what new companies are doing and how people are creating better, more sustainable food'* (FC20)
	Environmental Off-setting
	- '*We are offsetting for every for every kilowatt of electricity'* (FC4) - *'There is an on-site compost hub that we have at the factory which about 150 tonnes of compost goes through every year'* (FC8) - '*At this point we are looking to be offsetting travel emissions'* (FC16)
	Family Management Principles
	- *'We have three kids, so we do expect to make long-term investments* [….] *we've had four generations here already and there is no reason we can't keep in shape for another four generations, it's all about that, all about building for the next generation* [….] *the family thing is definitely the driver, you make some seriously different decisions'* (FC4) - *'My children are going to benefit from what we do now* [….] *you have to leave it as you found it, if not better'* (FC7) - '*Coming from a family place, we may take a slightly different view to other companies, I think we may take perhaps a longer-term view'* (FC14)
Newly Emergent Capabilities	Personal Interests in Clean Technologies
	- '*We do have some excitement about trying new things, when something becomes available we want to try it'* (FC4) - '*I started this business* [….] *and I would still want to operate as sustainability as I could* [….] *I do have strong personal beliefs when it comes to sustainability'* (FC8) - *'I think the company ethos is that we are trying to do the right thing and we try to maintain a bit of perspective on the whole business and the impact we have'* (FC14)
	Evidencing expertise in clean technologies & positive impact operations
	- '*getting those in place is a big appeal, you've got to be seen to be ticking the right boxes'* (FC2) - '*Consumers like to see us doing our bit for the planet'* (FC4) - '*That's why we have turbines and cows and stuff on our packaging. It sends that message out'* (FC4) - '*We produce a quarterly wildlife report that goes on our website* [….] *we find it delivers some real positives within our business and actually the conversations we are able to have with people'* (FC14)