

Evolution of the U.K. Agri-food Supply Chains: A Systems Analysis

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by

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Abstract

The agri-food industry has great importance to the UK economy while at the same time proven to give rise to significant socio-environmental problems. The UK agri-food chains have faced several crises and undergone extensive change since the 1990s. However, so far, many improvement attempts in this sector have adopted point analysis of single issues rather than a systems view of the interrelated web of concerns. This thesis recognises a lack of systemic understanding and systemic improvement approaches within the UK agri-food supply chains and adopts a systems perspective. Therefore, the theoretical background in this thesis is influenced by systems and cognate theories. A review of systems thinking literature is carried out which is subsequently narrowed down focusing on supply chain management and sustainable chain management literature leading to the identification of two gap areas in the body of knowledge.

The first gap relates to the improvement of supply chain consumer focus which is identified as a key emerging area in the field of supply chain management. The second gap is about simultaneous improvement of the environmental and economic performance of the UK agri-food chains. The research begins with contextual investigations providing evidence of the misalignment of the UK agri-food chains with the consumer value. Moreover, the contextual research clearly shows that the UK agri-food chains disproportionately pollute the environment and that the existing body of knowledge around the second research gap is in its infancy. The thesis follows by the proposition of a conceptual framework of the evolution of the UK agri-food chain management body of knowledge encapsulating the theoretical propositions of the thesis as well as serving as a guide for the data collection and directing the analyses throughout the thesis. The four rings model of the evolution of the UK agri-food chain management shows how the state of knowledge has evolved in the past and how it should continue to evolve in the future. The rest of the thesis *explores and explains how to* move the boundary constraints of knowledge within this framework.

A multiple case study research strategy is deployed, in line with the research questions posed, the nature of the study and the philosophical approaches underpinning the thesis (the research is argued from a critical realist viewpoint), enabling the author to develop rich, detailed and contextual knowledge about the UK agri-food chains. In a purposive sample, five case studies have been selected based on the research objectives and in a way to best enable addressing the research gaps. The first research question is addressed through four case studies whereupon significant knowledge is developed about how to improve the consumer orientation of the UK agri-food chains by leveraging the inter-organisational potentials in each case. To that end, a new approach is developed (i.e. the Supply Chain Kano-QFD approach) which is linked to the value stream mapping method. Moreover, the findings of the four case studies are compared and contrasted, and case specific contingencies are discussed.

The second research gap is addressed by means of one case study which discusses the challenges ahead in terms of improving the environmental sustainability of the UK agri-food supply chains. The case study challenges the conventional views about the eco-friendliness of the biofuels, provides valuable insights about analysis of the environmental sustainability of the agri-food chains and puts forward key recommendations for future investigation.

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"All words are pegs to hang ideas on"

Henry Ward Beecher

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Glossary of Terms

3PL – Third Party Logistics	NPD – New Product Development
CLM – Council of Logistics Management	NVA – Non Value Adding (time)
CO₂-eq. – CO ₂ -equivalent	OEE – Overall Equipment Effectiveness
CSCMP – Council of Supply Chain Management Professionals (US)	OSR – Oilseed Rape
DEFRA – Department for Environment, Food and Rural Areas	OTIF – On Time in Full
DfT – Department for Transport (UK)	PAM – Process Activity Mapping
DIF – Dairy Industry Forum	PDCA – Plan-Do-Check-Act (cycle of continuous improvement)
Dti – Department for Trade and Industry	PPM – Parts per Million
EC – European Commission	QCD – Quality, Cost and Delivery
ECR – Efficient Consumer Response	QFD – Quality Function Deployment
EDI – Electronic Data Interchange	RDC – Retail Distribution Centre
EEA – European Environmental Agency	RL – Recommended List
EPOS – Electronic Point of Sales	RMIF – Red Meat Industry Forum
ERP – Enterprise Requirement Planning	RTFO – Renewable Transport Fuel Obligation
EU – European Union	SCM – Supply Chain Management
GDP – Gross Domestic Product	SD – Sustainable Development
GHG – Green House Gases	SKU – Stock Keeping Unit
GST – General Systems Theory	SME – Small and Medium Enterprises
GWP – Global Warming Potential	SSM – Soft Systems Methodology
HGCA – Home Grown Cereals Authority	T/Ha – Tonnes per Hectare
IE – Industrial Ecology	TOC – Theory of Constraints
IGD – Institute of Grocery Distribution	UoA – Unit of Analysis
IPCC – Intergovernmental Panel on Climate Change (United Nations)	UK – United Kingdom
KPI – Key Performance Indicator	ULSD – Ultra Low Sulphur Diesel
LCA – Life Cycle Analysis	UN – The United Nations
MPG – Miles Per Gallon	US – United States
MRP – Material Requirement Planning	VA – Value Adding (time)
MtOE – Million tonnes Oil Equivalent	VCA – Value Chain Analysis
NDC – National Distribution Centre	VMI – Vendor Managed Inventory
NDC – National Distribution Centre	VoC – Voice of Customer
NFU – National Farmers Union (UK)	VSM – Value Stream Mapping
NGO – Non Governmental Organisation	WCED – World Commission on Environment and Development

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Chapter One

1 Introduction

This chapter delineates the scope of the thesis, explains the research problem and provides a brief overview of the structure, objectives and the subject matter of each chapter. It also explains the title and the key phrases used throughout the study, e.g. what is meant by systems analysis and agri-food chains.

1.1 Background to the Research and the Research Problem

The background motivation for this work was the author's general interest in supply chain management, sustainable development and his involvement in various agri-food management research projects. The UK food and retail supply chain employs around 3.2 million people, 12.5% of the total UK workforce including a significant number of part-time jobs in retail and foodservice (Bourlakis and Weightman, 2004), and accounts for over 8% of the GDP or nearly £148 billion of consumer expenditure (DEFRA, 2006). The Gross Value Added¹ of the UK food chains (beyond farm gate) in 2004 was £70.6 billion and its contribution to the UK's social, environmental and economic

¹ Gross Value Added is the difference between a sector's sales and the value of its inputs. The estimate here is based on basic prices.

sustainability is significant (IGD, 2005). For example, a recent European study shows that the food supply-consumption system accounts for 42% of the global warming potential across the EU-25 countries (Tukker *et al*, 2005) while the UK agri-food system is estimated to contribute at least 19% of the total UK greenhouse gaseous emissions (Garnett, 2007). The farming sector (agriculture and fisheries) alone contributes around 9% of the total UK global warming potential while representing a mere 0.7% of the GDP (Cabinet Office Strategy Unit, 2008; Garnett, 2007). Moreover, a recent report by the Cabinet Office Strategy Unit (2008) shows that the social impacts of the UK food chain, such as congestion and road accidents, are equally as significant as its environmental footprint.

However, according to Christopher (2004), despite its importance the subject of *agri-food chain management* has received sparse attention outside a small group of specialists working in this area. A recent advancement in food supply chain management is the Efficient Consumer Response (ECR) movement which advocates a more modern and collaborative environment between brand owners and non-discount retailers. Yet, the author estimates that nearly 70% of the UK food chain is currently excluded from the ECR club, i.e. 70% of the UK food chain in terms of value added per employee constituting most of the farmers, wholesalers, caterers, and smaller food manufacturers and retailers [*see Appendix A*].

Besides their significant economic and socio-environmental impacts, the UK agri-food chains have faced several crises and undergone extensive change such as reforms in the subsidy regimes, concentration of nearly 90% of grocery retail in the hands of multiples, globalization of trade and penetration of cheap agricultural produce suppliers, consumer behavioural changes in favour of convenience, the BSE² epidemic during the 1990's, and outbreaks of Foot and Mouth disease in 2000's (IGD, 2005; Defra, 2006; Hingley, 2005; Simons *et al*, 2003; Hornibrook and Fearne, 2001).

In the light of many issues surrounding the UK agri-food sector, in 2001, a parliamentary policy commission, the Policy Commission on the Future of Farming and Food (also known as the Curry commission), was assigned to advise the government on

² Bovine Spongy Encephalopathy commonly known as Mad Cow disease.

ways to achieve profitable farming and sustainable rural economy. In its report published in January 2002, the commission argued that the industry is in a state of flux and that it suffers from many fundamental problems: *“taxpayers are handing over huge subsidies every year for a policy which is destroying economic value. Consumers are paying more for their food than world prices. The environment is being degraded. Farming incomes are on the floor”* (Curry *et al*, 2002 p. 109). The report urged all stakeholders to embrace imminent change, called for the government to systematically introduce reforms and made a series of detailed suggestions for systemic improvement of the industry which are subsequently discussed in Chapter 5. This report together with many other eminent studies (RMIF, 2002; Rickard, 2004; Hingley, 2005; Baxter, 2003; Fearn and Hughes, 1999) illustrated that improvement attempts needed to adopt a whole systems approach rather than point solutions which do not address the interconnectedness of the web of problems the industry faced, forming the research problem and serving as the starting point for this thesis. Thus, the research problem is defined as *lack of systemic³ understanding and systemic improvement approaches in the UK agri-food supply chains.*

The Curry report’s recommendations broadly fall under three key areas, i.e. reducing waste and improving efficiencies along the food chain, de-commoditisation of goods and adding more value to the end consumers (e.g. reconnecting farmers with their market and the rest of the food chain) and finally preservation of the natural environment. The research problem in this thesis spans across all these areas emphasising the importance of the interrelationships amongst them. Nonetheless, many initiatives in the UK agri-food sector so far, remain squarely focused on one aspect of supply chain improvement failing to adopt a systems view. Since the publication of the Curry report several seminal research projects have been launched to assess the situation, including the Value Chain Analysis programme which informs the data collection and analysis in this thesis (FCC, 2007). Moreover, the extent of the economic, environmental and social problems related to agri-food has been addressed in several seminal publications such as the Cabinet Office Strategy Unit (2008), Garnett (2007), Garnett (2008), Defra (2006), Foster *et al* (2006) and WRAP (2008).

³ Systemic refers to the whole system

Much of the recent management research is grounded in the works of the industrial systems thinkers (Ackoff, 1971). Most recent management theories and models, such as Lean (Womack and Jones, 1996), Total Quality Management (Juran, 1988), Balanced Scorecard (Kaplan and Norton, 1993), Competitive Advantage (Porter, 1985), Business Process Re-engineering (Hammer and Champy, 1993), and Learning Organization (Senge, 1990) reflect the influence of the new age systems thinkers. Moreover, the research problem posed in the above necessitates a systems approach to analysis and improvement of the agri-food chains. Therefore, the literature review begins by looking at systems thinking literature and follows by introducing sustainable development as a body of knowledge which extends the boundaries of economic systems thinking to include socio-environmental factors. The review is then narrowed down focusing on supply chain management (SCM) and sustainable supply chain literature which perpetuate systems analysis within the operations management discipline. It is notable that, the focal body of knowledge informing both literature review and data analysis in this thesis is logistics and operations management. The literature review leads to the identification of gap areas in the body of (operations management) knowledge, in turn informing the research questions and fashioning the focus of the study.

The unit of analysis in this study is the *whole supply chain* reflecting the systemic nature of the research problem. This means that the thesis adopts an holistic view of agri-food chains looking at processes from farm to consumption (or point of sales). Data analyses and discussions address operational opportunities for improvement within the UK agri-food supply chains, tackling the complexities and interdependencies of various aspects of agri-food chain management.

As mentioned above, this thesis argues that a true systems analysis of agri-food chains needs to consider the concept of sustainable development and to take the socio-environmental impacts of food chains into account alongside the economic issues. The new management paradigms increasingly embrace the metaphor that the firm and its supply chain are a single organism living in a wider environment on which they depend for survival (Morgan, 1986). Nonetheless, this organism metaphor, so prevalent in the management literature, is often restricted to only the human factors of the organization and the human-related exchanges with the surrounding environment reflecting a general lack of focus on issues lying in the domain of sustainable development and sustainable

industry in management literature. Galdwin *et al* (1995) refers to the problem as the shared unwritten rule of the management theory reflecting '*an overarching anthropocentric paradigm*' and call for a collective paradigm shift towards a '*sustaincentric paradigm*'. Similarly, David Ehrenfeld refers to this rather bold disassociation between human economic activities and the remainder of the natural world as the '*arrogance of humanism*' (Ehrenfeld, 1981). The paucity of attention to the fact that any economic organization is embedded in the context of the natural environment and the injudicious neglect of the ecosystem services (Costanza *et al*, 1997) is also cited, inter alia, by Robert (2002), Hawken *et al* (1999), Graedel and Allenby (2003), McDonough and Braungart (2002) and Sarkis (2001). More specifically, agri-food chains have a huge impact on natural environment contributing, depending on the economic area, anything between 20% to 50% of global warming potential (Garnett, 2007; Tukker *et al*, 2005) and more than 70% of the freshwater annually withdrawn by humans (Wood *et al*, 2000).

1.2 Research Framework and Structure of the Thesis

Figure 1.1 provides an overview of the structure of the thesis. As illustrated in the diagram, the first step in the thesis was to define the research problem and the scope of the study. As already discussed in the previous section, the research problem is anchored in seminal academic, practitioner and policy literature together picturing the systemic problems that the UK agri-food supply chains faced in the early 2000's (Curry *et al*, 2002; Baxter, 2003; Rickard, 2004; Bourlakis and Weightman, 2004). The author's involvement in agri-food chain research prior to this study, also helped shaping his understanding of the challenges facing the UK industry and provided useful background in defining the research problem (Hofstetter *et al*, 2005).

Having defined the research problem, a literature review is carried out in Chapters 2 and 3 leading to the identification of two gap areas in the body of knowledge in relation to the research problem. Chapter 2 looks at the background literature, i.e. systems thinking and sustainable development, addressing the underpinning theories which lay the foundation for systems analysis of the UK agri-food chains. The review is then narrowed down in Chapter 3 focusing on supply chain management (SCM) and

sustainable supply chain literature. Review of the SCM contributions reveals that this field of study is evolving beyond efficiency and physical aspects to look at consumer enrichment and more subtle ways of differentiation – termed as supply chain effectiveness in this thesis. Accordingly, the first gap relates to the improvement of supply chain consumer focus (or supply chain effectiveness) identified as a key emerging area in the field of SCM. Moreover, the review of the supply chain sustainability literature in Chapter 3, identifies the significance of becoming environmentally sound without compromising economic competitiveness along the chain and shapes the second gap, i.e. simultaneous analysis and improvement of environmental and economic performance of supply chains. These gap areas in turn form the research questions and ultimately shape the focus of the thesis.

Next, in Chapter 4, the research design and the methodological approaches are developed, in line with the research questions posed, the nature of the study, philosophical underpinnings of the researcher, practical requirements and research limitations. It is explained that this thesis deploys a *multiple case study* research strategy to develop rich, detailed and contextual knowledge about agri-food supply chains. Moreover, Chapter 4 assesses the rigour of the study against criteria drawn from literature. The next stage following the methodological design is to contextualize the research questions within the UK agri-food sector. The gaps identified in Chapter 3 are not specific to any industry since the literature review covers general supply chain literature. Chapter 5, therefore, assesses the extent of the relevance of the research problem / questions within the UK agri-food sector through what can be regarded as *contextual research*. The research questions are as follows:

Research question 1) How can the effectiveness of the UK agri-food supply chains (i.e. consumer focus of the chains) be improved, without compromising the efficiency of the supply chain?

Research question 2) How can the environmental sustainability of the UK agri-food supply chains be improved, i.e. practical solutions for enhancing the sustainability of the system, without compromising the economic efficiency and effectiveness performances?

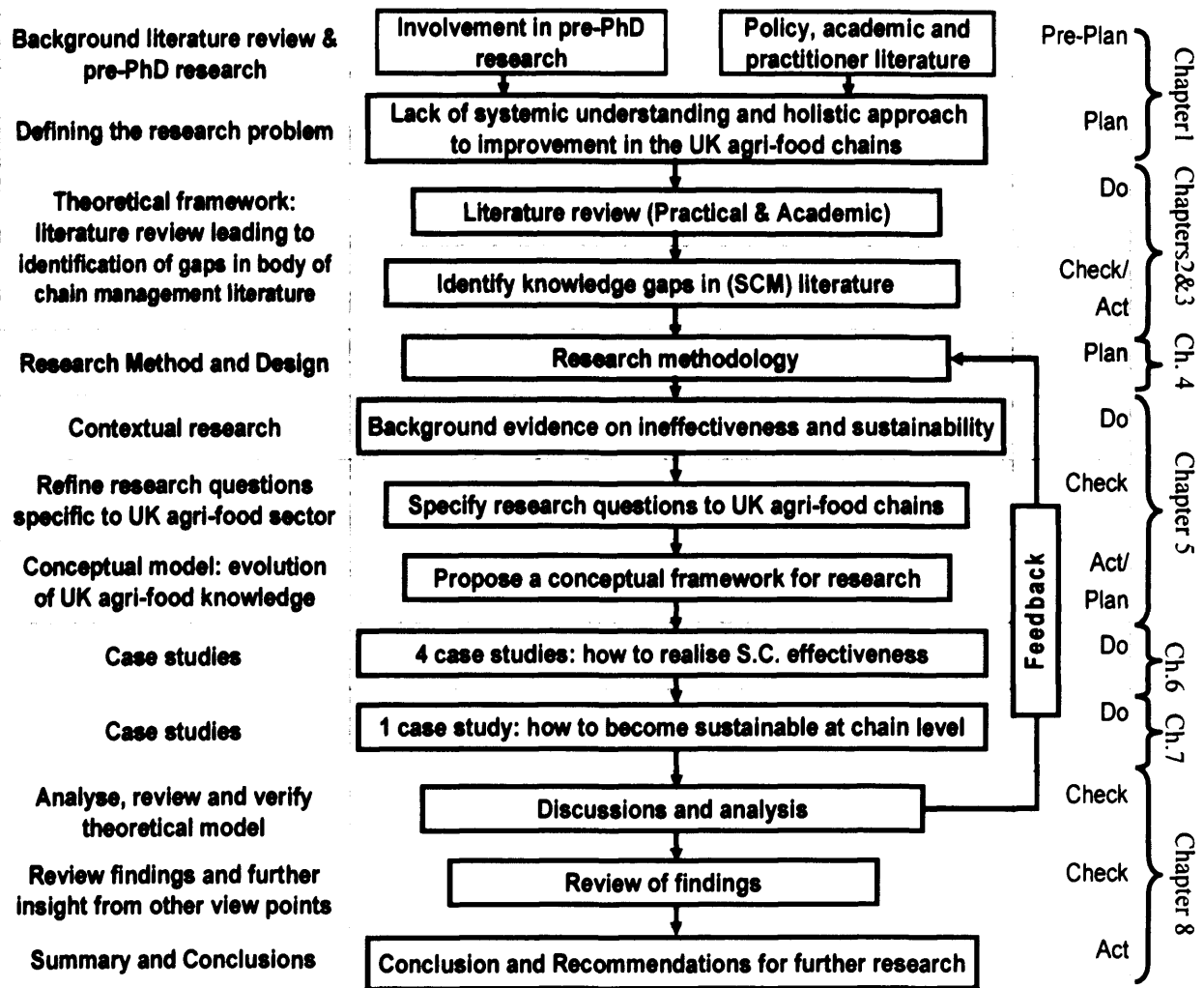


Figure 1.1 Research Structure
(Source: Author)

Furthermore, the contextual research leads to the proposition of a conceptual framework for the evolution of the UK agri-food supply chain management body of knowledge encapsulating the theoretical propositions of the thesis and serving as a guide to organise and direct data collection and analysis in Chapters 6 and 7 (i.e. the four ring model of the evolution of the UK agri-food chain management). Chapter 6 addresses the first research question drawing on four case studies from the UK agri-food sector while Chapter 7 discusses the second research question presenting one *exploratory* case study. The thesis is *explanatory* for the main part (i.e. addressing the first research question in Chapter 6).

Chapter 6 compares and contrasts the results of four cases making it possible to develop significant knowledge about the theoretical propositions put forward in the preceding chapters and to analyse the causal relationship between phenomena. On the other hand the case study presented in Chapter 7 largely *explores* how sustainability of the UK agri-food chains can be improved at the same time as retaining and maximising their competitiveness. Therefore, the thesis is mainly *exploratory* when it comes to the second research question. The reason is that the second research question is much broader and less mature requiring a great deal of empirical work. The findings in Chapter 7 lay the foundations and provide powerful insights for future investigations. Chapter 8 discusses the empirical findings of the thesis against the theoretical propositions put forward in Chapters 2, 3, 4 and 5, explaining the original contributions and practical implications of the study, and recommendations for future research. As illustrated in Figure 1.1, the thesis has been organised in PLAN-DO-CHECK-ACT cycles (Imai, 1997) which is discussed in more detail in Chapter 4.

Chapter Two

2 Background Literature Review

2.1 Introduction

The literature review for this thesis is carried out at two distinct levels, the background literature review which is presented in this chapter and the focal literature review outlined in the following chapter. The background literature review looks at the underpinning theories which lay the foundations for systemic study of the UK agri-food sector, such as systems theory, processual research and sustainable development. Reviewing the background literature provides multiple theoretical perspectives through which the focal literature can be better understood and analysed. The focal literature review, on the other hand, covers those bodies of literature which specifically address the field of enquiry and directly relate to the research problem, such as supply chain management literature and sustainable supply chain literature. The review of the focal literature leads to identification of two key gaps in the body of knowledge in relation to the research problem which in turn fashion the focus of the study and inform the data collection and analysis.

The terms 'background' and 'focal' literature are employed just to reflect the proximity to the core research problem and not to show how well established the presented bodies of literature are. Then again, it can be broadly argued that the background literature is broader in scope while the focal literature represents a narrower focus. Figure 2.1 illustrates the relationships between different bodies of literature reviewed in this thesis. Although the literature review is mainly presented in Chapters 2 and 3 and discussed in a controlled structure, in practice it was an open-ended process of research and literature review taking place in several iterations.

This chapter explains some of the most fundamental concepts underlying the study. As explained in Section 1.2, the research problem posed for this thesis is the lack of systemic understanding and systemic improvement approaches in the UK agri-food supply chains. Systems thinking (von Bertalanffy, 1968; Kast and Rosenzweig, 1985) is the basic framework for guiding systemic investigation and systemic improvement and the fundamental conceptual framework in this thesis. In the following, four closely related bodies of literature are reviewed to understand systems thinking, i.e. general systems theory, contingency theory, process theory and soft systems methodology. Section 2.3 then adds to the discussions on systems thinking and related theories by emphasising the demarcation between system efficiency and effectiveness. According to systems thinkers, in order for the serving system to be truly effective, its form and functions must be dictated by the system being served (Checkland, 1999). Section 2.4 takes the discussions around systems thinking and systems performance beyond the economic systems approach by introducing the concept of sustainable development which is an holistic approach to understanding the organisation and its interactions with the natural environment and human society. Sustainable development is a systems approach aiming to marry economic prosperity and wealth generation with the needs to protect the planet and the welfare of the human society. Growing challenges to the sustainability of our planet entail that industrial activities should be examined in an holistic rather than a narrow context. Sustainable development is about a paradigm shift from one-dimensional economic thinking towards systemic understanding of the impacts of the organisation on economy, society and the natural environment.

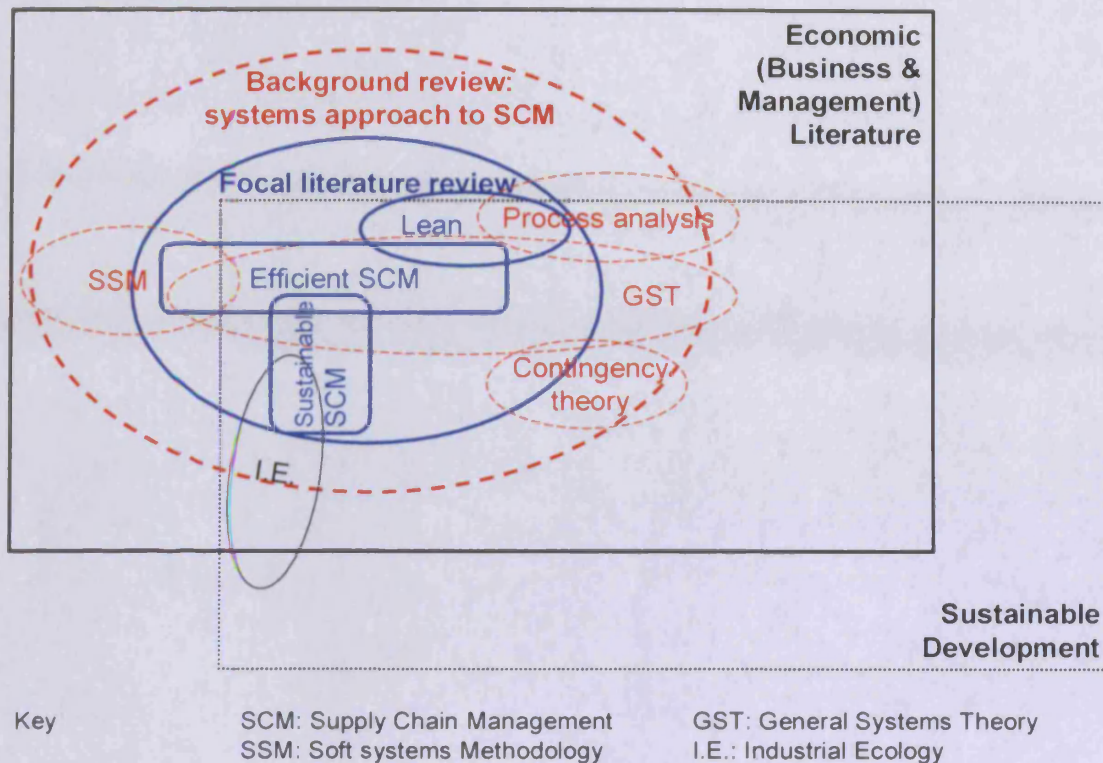


Figure 2.1 The Relationships between the Main Bodies of Literature
(Source: Author)

In Figure 2.1, the background bodies of literature are illustrated by dashed red lines and the focal literature by solid blue lines. As illustrated, all the reviewed literature can be categorised under the general topic of business and management studies. However there is a considerable overlap with sustainable development literature which is slowly establishing itself as an independent but multi-disciplinary subject area. The sustainable development literature stretches beyond economics and management studies into Corporate Governance, Law, Politics, International Relations and Sociology. Although the diagram provides a powerful tool for classifying different bodies of literature and visualising their relationships, it only captures part of the complex interactions between different schools of literature. One must be aware of the inherent oversimplification in any conceptual model; according to Carter (1997, p.124) “[conceptual modelling and] simplification can aid understanding, but if interpreted too literally, they exert confining or diversionary hold on imagination as interest in the classificatory ‘map’ replaces interest in the ‘territory’.”

2.2 Systems Thinking and Systemic Approach

This section explains systems thinking and systems theory. It is first important to define the terminology used in this section. The word system is widely deployed in everyday speech in various capacities. It often refers to a phenomenon or a constellation of phenomena which operate in an organised fashion to achieve a certain goal. Further delineation of a system and its characteristics are provided in Section 2.2.1. The word systemic refers to holism, a condition where the whole picture is accounted for. The word systematic, on the other hand, signifies a set of logically ordered procedures (Waring 1989). Four cognate bodies of literature, i.e. general systems theory, contingency theory, process theory and soft systems methodology, are reviewed in the following which collectively provide a rich picture of systems thinking and systemic approach. General systems theory is the corner stone of what is commonly referred to as systems thinking or systemic approach. The other three debates are variants of the original approaches of general systems theory and somewhat more recent. (Kast and Rosenzweig, 1985; Emery, 1981; Checkland, 1999)

2.2.1 General Systems Theory

Until about the middle of the 20th century the dominant method of scientific inquiry into an organised system was to reduce it into separate elements and to study each component individually (Checkland, 1999). Underlying this *reductionist* approach is the notion that the whole is no more than the total sum of its parts. Nevertheless, during the 1930s and 1940s, an understanding gradually emerged amongst both scientists (Koehler, 1938; von Bertalanffy, 1940 & 1950; Wiener, 1948) and philosophers (Fries, 1936) that in order to provide a complete understanding of a system not only the individual constituents of the system but also their inter-linkages and the relationships with the wider system must be studied in an holistic method. Underlying this *systemic* approach is the concept that additional characteristics emanate from the whole which are not attributable to any particular part of the system; in other words the system is more than just the total sum of its components.

In 1940s the biologist von Bertalanffy (1940) generalized *systemic thinking*, or as he initially called it “*the system theory of the organism*”, which later culminated in the introduction of the “*General Systems Theory*” (von Bertalanffy, 1950; 1968) and

foundation of the Society for General Systems Research in the 1950s. From a general systems theorist's view point, an organism is an irreducible entity which ought to be studied from an holistic perspective. *"General Systems Theory, then, is the scientific exploration of 'wholes' and 'wholeness' which, not so long ago, were considered metaphysical notions transcending the boundaries of science"* (von Bertalanffy, 1972, p. xviii). Although, initially introduced in biology, general systems theorists extended the *organismic* metaphor not only to other natural systems (e.g. the eco-system) but also to include the social and human-made entities. This new approach to academic inquiry initially met considerable resistance on the side of the scientific community. However, soon systemic thinking was accepted and diffused into various disciplines such as management (Ackoff, 1971), industrial dynamics (Forrester, 1958), philosophy (Laszlo, 1972), and engineering and cybernetics (Wiener, 1948).

So systems theory, and more specifically General Systems Theory (GST), argues that the structure and pattern of wholes do not lend themselves to the reductionist manipulation and that the whole is more than the total sum of its components (Emery, 1981). This approach is regarded as holism or systemic analysis. Clearly, the definition of the system itself is critical to systems thinking and systemic approach. Waring (1989) provides a useful *"baseline definition"* of the system: *"a system is a recognizable whole that consists of a number of parts (called components or elements) that are connected up in an organised way (the system's structure); the components interact, i.e. there are processes going on"* (p. 6). Similarly, Kast and Rosenzweig (1985) define a system as *"an organised, unitary whole composed of two or more interdependent parts, components, or subsystems and delineated by identifiable boundaries from its environmental supra-system"*. These definitions broadly delineate the key aspects of the system, i.e. the boundaries, the sub-system supra-system division, the goal seeking characteristic, etc. To complement these definitions and to advance discussions about GST and systems thinking, Table 2.1 summarises some of the main features of systems theory widely cited in the literature.

Table 2.1. The Main Concepts of Systems Theory

Concept	Description
Holism (systemicity)	Systems thinking is about the study of the whole. Reductionism only yields partial understanding of the system. The full understanding comes from looking at the whole picture, the interconnections between components and with the environment. The system can only be explained in its totality.
Synergy	The whole is greater than the total sum of its components.
System boundaries and system levels	A system has two or more parts often regarded as sub-systems. Outside the system boundaries is the system environment sometimes referred to as the supra-system. It is critical that the systems thinker states what level has been chosen to be that of the system being studied. Researchers choose the relevant layer for the system (i.e. the boundaries) based on their own world-view (or Weltanschauung in the systems language). Whatever level is taken by the investigator to be that of the system, the level above (the system environment) and the one below (parts) must be taken into consideration.
An idea not object	Systems do not exist in an absolute sense. A system is a mental state or idea.
Hard system vs. soft system	Hard systems are characterised by clearly defined processes and structures with readily quantifiable features. Soft systems on the other hand are characterised by hard-to-quantify features; largely concern human activities. Hard systems are far more predictable and controllable than soft systems.
Open system vs. closed system	Systems can be considered as either closed or open. Open systems exchange matter, energy or information with their environment. Natural and biological systems are inherently open while engineered and mechanical systems can be thought of as closed systems. Systems theory is concerned with open systems
Emergent properties	Since the system is not just a collection of interconnected units, and that their interaction as a whole generates behaviour which cannot be understood by studying the individual parts (principle of synergy), it is said that systems have emergent properties which are beyond prediction. The emergent properties in closed systems are towards disorganisation (entropy) while open systems move in the direction of internal elaboration and higher level of organisation (natural mutation and evolution).

(Collected by the author from the following sources: von Bertalanffy, 1956; Kast and Rosenzweig, 1985; Emery, 1981; Waring, 1989; Checkland 1999)

Modern management science is indebted to systems theory. Systems thinking provided a new outlook for the study of organisations and their management. It facilitated analysis in complex and dynamic contexts and provided means for understanding the interrelationships between system components, their interaction with the wider environment and the synergistic characteristics of the whole (*see* Table 2.1). However, in the same way as many other branches of knowledge, the management science was dominated by reductionism and resisted holism for some decades. In the following the author provides an overview of how management science has evolved from Taylorism which is characterised by a reductionist approach (Taylor, 1911) to holism (Ackoff, 1971). This historical overview helps to understand the extent of the influence of systems thinking on management science.

The introduction of management as an independent scientific discipline is often dated back to the publication of *"The Principles of Scientific Management"* by Fredrick Taylor in 1911. Taylor (1911) focused on efficiency improvements at an operative level aiming to maximise the output while minimising the inputs. He called his method "scientific management" and defined it as rationalised fragmentation of individual jobs into different tasks and standardisation/optimisation of each. Taylor (1911) presented elaborate time and motion studies, for example by describing how to increase the efficiency of shovelling activity by breaking it down into different motions and using a stopwatch to study the time (and load) of each activity. The scientific management movement of Taylor (1911) and his disciples (Gilbreth, 1911) is characterised by the reductionist method as in the shovelling case. Inherent in the time and motion studies is the view that the worker is a powerless adjunct to the machine studied in mechanistic ways and treated the same as a physical asset, a point which has become a central theme in criticism of scientific management and later industrial engineering (as an extension of the same mentality) for nearly a century (Doray, 1988).

Management theorists, however, have proposed alternative perspectives to the scientific management ever since its conception. One of the early criticisms came from the study of the Hawthorne telephone equipment plant between 1924 and 1932. The Hawthorne study drew attention to the significance of the psychological and social aspects of management and highlighted the artificial nature of the time and motion studies (Roethlisberg and Dickson, 1939; Mayo, 1949). The Hawthorne studies disproved

treatment of workers as physical assets and the narrow mechanistic approaches adopted by Taylor (1911). Hawthorne studies showed that Taylorism through its reductionist lens fails to capture the impacts of human dynamics, such as motivation and social norms, on productivity. Contrary to the scientific management which adopts a reductionist approach through time and motion studies and remains limited to the shop-floor, systems theory looks at the whole picture and can deal with the human issues as a psycho-social sub-system within the whole organisation (Kast and Rosenzweig, 1985).

Another two key moments, which came soon after the scientific management movement, were the 'administrative management theory' (Fayol, 1949) and the 'bureaucratic organisation model' (Weber, 1924). Henri Fayol (1949) tried to develop universal guidelines and principles for organising management structures and relationships. He established a series of 14 principles which were, primarily, broad guidelines for managerial decision making. While Taylor adopted a bottom-up angle to management, the administrative management theory approached productivity improvements from the top-down and emphasized the management function and the organisational structure over and above the other sub-systems such as the technical (e.g. the operative level as in scientific management) and psycho-social (e.g. the Hawthorne effect) sub-systems. Although, Fayol initially published his work in 1916 it was not translated into English until 1929 and had limited influence in shaping the management theories until it was made widely available in 1949.

Another thread in the classical management theory is Weber's (1924) 'bureaucratic model of organisation' which was developed in sociology but later diffused into organisational management literature (Kast and Rosenzweig, 1985). In his model, Weber not only studied the management of the single organisation but also was interested in the broad economic and political structure of society. Rational-legal authority and power are the basic concepts in Weber's bureaucratic model. Within the bureaucratic structure each member of the administrative staff takes a position with specific delineation of power, different positions are organised in a hierarchy of authority and the organisation is controlled by rules and regulations. Weber proposed that the bureaucratic model of organisation is the most appropriate form of administration for large organisations and provides the most efficient tool for management. The core concepts of Max Weber's bureaucratic model (Weber, 1924)

have many parallels in scientific management. Both scientific management and the bureaucratic model see management as a science rather than an individualistic approach based on the rule of thumb (Kast and Rosenzweig, 1985). It is implicit in Taylorism that management itself should be governed by rules, measures and procedures which have been developed through scientific observation and empirical experiments just as much as workers' tasks are controlled by rigorous standards (Taylor, 1911). Therefore, both models require greater scientific rigour to underlie managerial decisions.

The review of the key classical schools of management (i.e. the scientific management movement, the administrative management theory, the teachings of the Hawthorne researchers and the bureaucratic model of organisation) shows that each theory adopts a different perspective on organisational management with seemingly sound and applicable conclusions. Each model is valid in its own right, especially when the researcher shares the same perspective. However, none of the above theories look at the whole equation of organisational management. In fact, they all have been criticised by systems thinkers for employing unrealistic closed-system approaches and limited perspectives to the organisation (Kast and Rosenzweig, 1985).

Today management science has evolved to embrace systems theory as an integrative framework for understanding different aspects of organisational management (Ackoff, 1971). One well known model of organisation as a system is illustrated in Figure 2.2. In this model, Kast and Rosenzweig (1985) offer that systems theory provides a basis for integration of different sub-sets of management theory into one unified framework. Accordingly, the systemic view of the organisation is a grand overarching theory rooted in scientific management, administrative management theory, psycho-social findings of the Hawthorne studies and Weber's bureaucratic model. The model shows the organisation as an open system (i.e. inter-linkages with its environment) and composed of a number of sub-systems.

The basic premise in this model is that the organisation, as part of the wider social environment, must accomplish certain goals and demonstrate certain values which are determined by the broader system. Therefore, the goals and values sub-system is one of the key sub-systems. As illustrated in Figure 2.2, a major contribution to this model comes from the scientific management movement and generally those management

schools of thought which have contributed to shape our understanding of the economic/technical sub-system. Also, the behavioural sciences which initiated in the psychological and social findings of the Hawthorne studies have contributed to the understating of the psycho-social sub-system. Moreover, the bureaucratic model has contributed by shaping our understanding of the structural sub-system which provides for the formalisation of relationships between the technical and psycho-social sub-systems, e.g. defining roles, authority, work flows, and work procedures. The managerial sub-system, in the model, spans the entire organisation and plays the central role in setting, planning and controlling activities between the sub-systems as well as relating the organisation to its environment. (Kast and Rosenzweig, 1985)

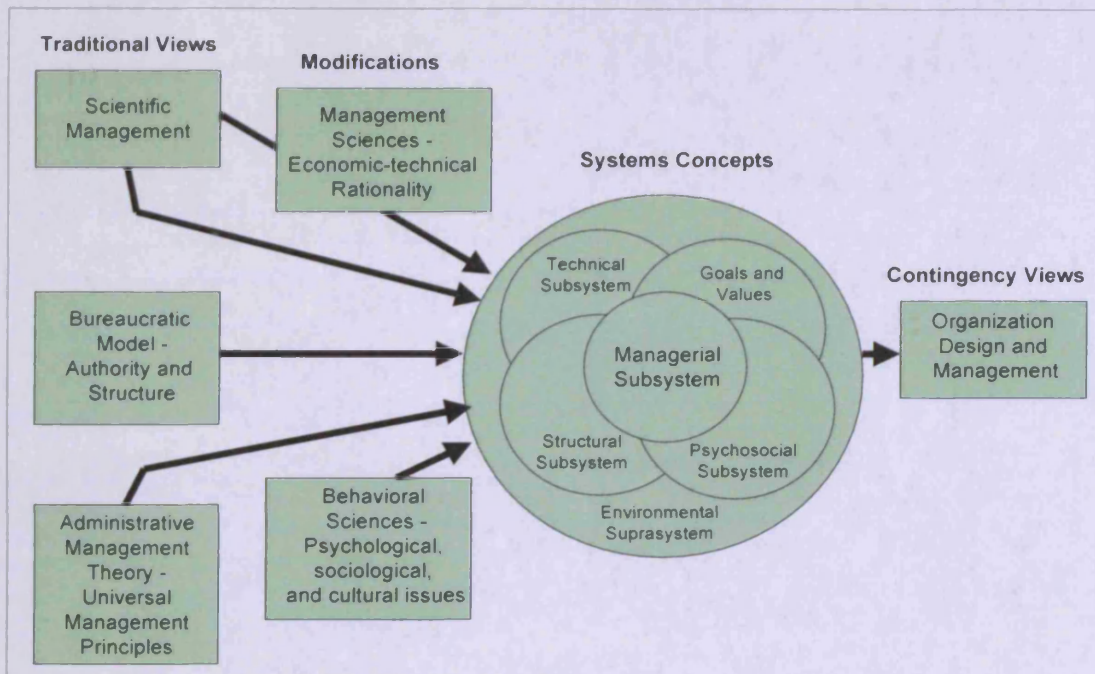


Figure 2.2 Evolution of Organisational and Management Theory towards Systems Concepts
(Adapted from Kast and Rosenzweig, 1985)

The following discussions look into three key theoretical lenses which effectively are more recent extensions of general systems theory. Contingency theory builds on the integrated view of organisation (Figure 2.2) and argues that organisational performance correlates to the fit among the sub-systems and between the organisation and its environment; the best fit is contingent upon organisational situations and the role of

contingency theory is to explore and unravel the relationships between fit and performance (Donaldson, 2001). Process theory emphasises the importance of temporal orientation in studying systems (Pettigrew, 1997). Soft Systems Methodology (SSM) expands GST by shifting the focus of systemic thinking from the research object to our research and cognition process. The following explains each theory in detail.

2.2.2 Contingency Theory

Contingency theory is a subset of systems thinking which embraces the principles of general systems theory and extends it in search of more practical and situational solutions for improving the performance of organisations (systems). Contingency theory emerged during the 1960's owing to the seminal contributions of Burns and Stalker (1961) and Lawrence and Lorsch (1967) who argued that the efficiency and effectiveness of an organisation depend on the fit between the characteristics of that organisation and the contingencies that reflect the particular situation of the organisation itself and its environment. Contingency theory argues that there is no one best way for managing organisations and that no single management model is inherently more effective than others (Donaldson, 2001). This goes against the arguments of the classical schools of management theory, such as scientific management and administrative theory, that there are universal principles for best management practice and that the role of management researcher is to discover those principles. Contingency theory broadly aims to establish the fit-performance commonalities among organisations based on the patterns of relationships and congruencies among sub-systems as well as congruency with the wider environment (Kast and Rosenzweig, 1985). The aim is to find the most appropriate managerial actions for specific situations. Once the best fit is achieved and high performance is actualised, organisations are encouraged to retain adaptability in order to avoid the misfit which happens when the contingencies change (Donaldson, 2001).

General systems theory provided a framework for understanding the organisation as components and supra-environment. From a contingency theory perspective, the natural consequence of systemic understanding of the organisation is the rejection of universal principles in management practice, since different organisations could have

varying degrees of fit among the components as well as between the system and the environment. The contingent view of organisation aims to go beyond merely generalising organisations as systems towards more detailed understanding of the inter-relationships among variables. According to Kast and Rosenzweig (1985) *“the appropriate fit between the organisation and its environment and the appropriate internal organisational design will lead to greater effectiveness, efficiency and participant satisfaction”* (p. 116). *“Systems and contingency concepts facilitate more effective diagnosis of complex situations and increase the likelihood of appropriate managerial action”* (p. 120).

Kast and Rosenzweig (1985) argue that contingency theory is a middle-ground between the view that there are universal principles of management and the view that each organisation is unique and must be analysed separately depending on individual circumstances. The criticism against this argument is the ambiguity of the extent of generalisation or particularisation. The practicality of the propositions of contingency theory is therefore questioned. Some management models, such as Lean Thinking (Womack and Jones, 1996) and Theory of Constraints (TOC) (Goldratt and Cox 1984; Dettmer, 1997), have avoided limited propositions by creating principles which are universal and not situational. For example lean uses the principles of ‘value’ and ‘continuous improvement’. Similarly, TOC puts forward the principle of ‘aligning all local actions to support the holistic system’. Such principles are seemingly universal and have been applied in many contexts and numerous environments challenging the contingent perspective. Contingency theory is, however, very helpful for the study of supply chain systems since it highlights the importance and the contingent nature of the context of the study and the environment in which supply chain systems operate. Contingency theory also helps to understand the potential short-comings of only taking into consideration one sub-system and ignoring the rest of the system, e.g. only focusing on the ‘technical and economic’ sub-system.

2.2.3 Process Theory and Processual Research

General Systems Theory (GST) described organisations as systems – consisting of components and operating in the context of the supra-environment. GST demonstrated that reductionism is essentially flawed and that the only appropriate way to study organisations is through holism. Contingency theory, then, took a step further in terms of explaining the fit-performance contingencies and relating organisational efficiency and effectiveness to the fit among the organisational sub-systems as well as between the organisation and its environment. Process theory aims to take the systems debate forward by showing that systems (with the inclusion of all sub-systems and the system environment) are dynamic and time-related rather than static and time-independent. Process theory emphasises temporal orientation in analysing systems, i.e. longitudinal study of processes as opposed to the point analysis of the outcomes of systems (Tuttle, 1997; Pettigrew, 1997; Garnsey, 2003). *“A theory of process consists of statements that explain how and why a process unfolds over time”* (van de Ven, 1992 p.174).

In order to get a grasp of process theory it is, firstly, important to define process and, secondly, to explain process analysis or processual research. Ackoff (1971, p.666) defines a process as *“a sequence of behaviour that constitutes a system and has a goal-producing function. In some well-definable sense each unit of behaviour in the process brings the actor closer to the goal which it seeks. [...] Production processes are a similar type of sequence whose goal is a particular type of product”*. According to this definition, processes are the constituent parts of the system. Van de Ven (1992) compares a system to a river basin where the sub-systems are the currents and streams flowing into one another, dependent on one another and shaping and being shaped by the terrain which is an analogy for the supra-environment. He peruses a large number of literatures and identifies three category meanings for process as follows:

- A logic that explains a causal relationship between independent and dependent variables. In this meaning, the process is not directly looked at; instead the inputs and outputs of the process are compared in a ‘variance theory’ approach (Garnsey, 2003). That is comparing the outputs with the inputs and stipulating a logic that can best explain the behaviour of the process in the middle.
- A category of concepts or variables that refers to actions of individuals or organisations. This is the most frequently deployed meaning of process as a

category of actions within the organisation which are conceptually distinguished from other actions, e.g. strategy formulation and policy deployment, work flows, information flows, etc. This is the closest concept of process to the supply chain process as it is commonly understood.

- A sequence of events that describes how things change over time. This definition of process explicitly deals with the process in action and thereby capable of describing – and ideally explaining – how and why an entity deals with an issue over time. The focus is on the sequence of events that unfold during the presence of a subject – or concept – in organisation.

Tuttle (1997) concurs with the temporal notion of systems and processes and defines processual analysis *“as research concerning any process that exists between two points in time, regardless of whether actual processes are observable. This definition assumes that even seemingly empty time (time without noticeable events, occurrences, or processes) is created by processes existing at a level of measurement or analysis that is beyond the focus of the researcher. Thus this definition provides a very general, inclusive and simple notion of process”* (p.350). Process analysis or processual research is the method of inquiry which aims to *“catch reality in flight”* (Pettigrew, 1997, p.347). Pettigrew stipulates a set of characteristics that a study should possess in order to qualify as processual research. Based on the contributions of Pettigrew (1997) and Pettigrew and Whipp (1991) the key characteristics of processual research can be summarised as the following:

- Social processes are deeply embedded in the contexts that produce them and are influenced by them. Therefore, processual analysis is concerned with contexts and is a contextual mode of analysis.
- Processual analysis aims to unravel the temporal interconnectedness of phenomena, to understand the flow and sequence of events over time. That is, the ‘how’ and ‘why’ of the occurrence of events.
- Processual research recognises the role of the human intervention (human agency) in shaping the processes over time. History is not pre-determined and humans can influence events against the forces of the context.
- Process theory embraces systems thinking and aims to provide holistic understanding of processes rather than linear explanation of the outcomes. The contribution of process theory is to add the dimension of time into systems analysis.

Process theory and processual research are very relevant to the study of supply chains since a supply chain is a process (or a series of processes) and time dependent. However, it can be concluded from the above discussions that process theory is a *theory of method* for research into management rather than a theory of management science. Process theory elucidates the appropriate mechanisms and research characteristics for systemic understanding of processes. Process theory is often epitomised by proposition of a research strategy or research methodology, for example Pettigrew (1997) and Pettigrew and Whipp (1991) put forward the 'longitudinal comparative case study' method which has been developed in the UK at Warwick University as a distinctive research strategy for observing phenomena over time and answering how and why questions about the occurrence of those phenomena. Therefore, in this thesis, process analysis is dealt with in Chapter 4 where the research methodology is discussed demonstrating that the key characteristics of processual research are reflected in the case study method deployed in this thesis. The key characteristics of systems thinking and processual research discussed in the above are embodied in research methods and strategies adopted for this thesis.

2.2.4 Soft Systems Methodology

Soft Systems Methodology (SSM), which has been developed by Peter Checkland and his colleagues at Lancaster University in the UK, is a recent development of the orthodox systems thinking from the 1950s. The difference between GST and SSM is in the way the system is understood and defined. Whereas, in GST the word system applies to an external reality (e.g. defining a supply chain as a system), in SSM the word system is applied to the process of the inquirer's dealing with the world. There is a shift in the focus of systemicity from the research subject to the research process. This is equally the fundamental difference between soft systems thinking and hard systems thinking. (Checkland, 1999; Checkland and Scholes, 1990; Checkland, 1994; Beer, 1972)

As already discussed in Table 2.1, in the literature hard systems are characterised by clearly defined processes and structures which can be readily quantified, while soft systems are known to be ill-defined, fuzzy and difficult to quantify. The definition of hard systems often applies to man-made and physical systems whereas soft systems

largely concern human and social activities. Although, these definitions of systems thinking are not incorrect, they do not signify the more subtle difference between soft systems methodology and hard systems approach. Hard systems approach, which is associated with General Systems Theory (GST) and the early systems thinking of the 1950's, assumes that the world is a set of systems and adopts a systemic approach to the subject of research. On the other hand, SSM assumes that the real world problems are complex and adopts a systemic approach to the process of understanding the real-life situations. Therefore, the real distinction between SSM and GST lies in the attribution of the systemicity. (Checkland, 1999)

SSM challenges the orthodoxies of 'systems/contingency theory' dominating the literature since 1950's by offering that the organisation is a continually changing object – of social reality and human intervention – which requires a continuous system of learning as the only appropriate method of understanding it. In SSM the researcher, and inevitably researcher's actions, are integrated parts of the systemic process of learning. SSM *"is taken to be a process of social inquiry which aims to bring about improvements in the areas of concern by articulating a learning cycle (based on systems concepts) which can lead to action"* (Checkland, 1999 p. A40). Therefore, SSM on one hand verges on action research (see Chapter 5) since it advocates *"not simply to observe the action as external watchers but to take part in the change process which the action entailed"* (Checkland, 1999 p. A39). In fact Checkland is often referenced as one of the key contributors to action research since he himself contends that *"this [being part of the change process] puts the research [SSM research] into the 'action research' tradition stemming from Kurt Lewin's views, developed in the 1940's, that real social events could not be studied in a laboratory [or by being detached from the change process if its social science research such as business and management]"* (p. A39). On the other hand, SSM resembles process theory since it emphasises the process of inquiry and the temporal notion of understanding (Checkland and Scholes, 1990).

Soft Systems Methodology, processual research and action research have many similarities. Most importantly they are all equally theories of method for conducting management research rather than theories of management *per se*. Thus, it is concluded that it is most appropriate to deal with SSM and processual analysis in the methodology chapter. Chapter 4 is dedicated to explaining the methods of inquiry in this thesis; action

research is elucidated in this chapter and linked into the background theory, i.e. process theory and soft systems methodology. Moreover, in the same way that SSM emphasises cyclical thinking in the conduct of research, Chapter 4 shows that this research has been organised in PLAN-DO-CHECK-ACT iterations (Imai, 1997) which is consistent with SSM approach.

This section set out the four pillars of systems thinking and provided an historic overview of the evolution of management science in light of the contributions for systems thinkers. The following section discusses the key dimensions of performance measurement of a system and the demarcation between systems efficiency and effectiveness. Section 2.4, then, puts forward the concept of sustainable development which is a systems (systemic) approach to management and to the problems of industry.

2.3 Systems Efficiency vs. Effectiveness

Systems theory defines a system as a constellation of goal-seeking elements or processes. The performance of a system is defined in relation to this goal-seeking function: the degree to which the system achieves its goal(s) and the resources it consumes over time to get to that point. As illustrated in Figure 2.2, in systems and contingency theories the 'goals and values' sub-system is one of the most important sub-systems of all and the whole system's success depends on alignment to this sub-system. Alignment of various sub-systems to the system goal, or in other words the system performance, is a function of ability, effort and opportunity (Kast and Rosenzweig, 1985). However, this research only deals with the output measures of performance rather than the substantive precursors of success (i.e. ability, effort and opportunity).

Even though there is no universally accepted definition for performance and its constituents in the literature, a number of influential authors have argued that the key output measures of performance are efficiency and effectiveness (Mentzer and Konrad, 1991; Nielsen and Levy, 1994). In other words system's performance is two dimensional. Mentzer and Konrad (1991) argue that measurement of the performance of any system is an analysis of both effectiveness and efficiency for given tasks. Likewise,

Kao *et al* (1995), Young *et al* (1988) and Frokjer *et al* (2000) adopt an effectiveness – efficiency approach to inter-firm performance analysis. Kast and Rosenzweig (1985) endorse this approach but also add a third dimension to system performance, i.e. participant satisfaction. Participant satisfaction is a futuristic measure which looks at the sustainability of the system in long-term, i.e. unless process owners are satisfied with their jobs within an organisation the organisation cannot sustain its performance. This thesis is only concerned with the current measures of performance while the measures of sustainability are discussed in the next section.

Mentzer and Konrad (1991) define efficiency as the ratio of resources utilized against the results derived and define effectiveness as the degree to which a goal is achieved. Young *et al* (1988) take the same definition for performance effectiveness and argue that effectiveness increases when deviation from a production goal decreases. On the other hand, Young *et al* (1988) propose a slightly different definition for performance efficiency: “*producing the desired quantity with the minimum amount of effort and waste*” (p. 609). So, efficiency relates to the objective performance of processes where efficiency indicators measure an output level against an input level, e.g. productivity which is defined as the ‘units produced’ against the ‘labour time’ (Nielsen and Levy, 1994). Effectiveness on the other hand relates to the extent that the target has been achieved by a system and its sole indicator is goal satisfaction. In summary, efficiency is about doing things right and effectiveness is about doing the right things. Clearly both dimensions of performance can contain an actual measurement contrasted with a standard measurement. For example job efficiency can be measured in terms of the number of man-hours required to carry out a task versus the actual hours spent. Effectiveness could also, for example, be measured in terms of the number of completely satisfied consumers of an organisation versus the target number of fully satisfied consumers.

There is a whole body of literature on organisational effectiveness (Steers, 1976 and 1977) closely related to the efficiency-effectiveness debate. Steers (1977) draws on systems theory to discuss and analyse organisational effectiveness. He defines organisational effectiveness in relation to an organisation’s attainment of its – predefined – goals. In this approach various factors within the system and in the external environment are examined as they relate to each other and as they ultimately

affect the goal-seeking efforts of the system. Steers (1976) contends that system effectiveness (organisational effectiveness) is *“best judged against an organisations ability to compete in a turbulent environment and successfully acquire and use its resources”* (p. 56). In fact, he is suggesting that there are subtle linkages between efficiency and effectiveness in the context of an organisation and that the concept of efficiency is a necessary yet insufficient ingredient of effectiveness. Efficiency is defined as output/input and output can be linked to effectiveness. However, it is often very difficult to have simple output measures linked with the system’s goal, especially for soft complex systems such as supply chains. Amongst others in the field of organisational effectiveness, Ostroff and Schmitt (1993) and Steers (1977) believe that effectiveness and efficiency are two separate dimensions of system performance. While accepting the distinction between efficiency and effectiveness the ‘organisational effectiveness’ school of thought aims to find potential relationships between the two at the organisations level.

This section argued that system’s performance is two dimensional consisting of efficiency and effectiveness and defined the meaning of each. The next chapter will further delineate each dimension in the context of supply chains. The concept of effectiveness, and more precisely supply chain effectiveness, is very central to this research and duly dealt with in Section 3.2.2.

2.4 Sustainable Development

Systems theory is an integrative approach to the study of the organisation and its interactions with the wider environment. Systems theorists invariably adopt an holistic approach to study and conceptualise the relationships between different sub-systems and with the supra-environment. Nevertheless, the scope of the system under study varies significantly from one researcher to another. For example most of the management literature which adopt a systems perspective merely investigate the economic dynamics of the sub-systems and neglect wider issues such as interactions with the natural environment and the human society. However, this thesis adopts a broader perspective by proposing that the socio-environmental impacts of the agri-food system must also be taken into account.

In his landmark contribution, the ecologist David Ehrenfeld (1981) contends that a prevalent shortcoming in the management literature is the narrow economic focus and the isolation of the human activities from the natural environment and the human society. Many social and environmental challenges have accrued since the industrial revolution severely constraining the purely economic developmental conceptions of the human kind. Much progress on many economic fronts is compromised by entrenched corruption and environmental degradation. As a result, there is a profound concern amongst both academics and policy makers regarding the world's natural capacity to cope with the existing economic rates of growth. This rather bold disassociation between the economy and the natural ecosystem is what Ehrenfeld (1981) refers to as the "*arrogance of humanism*". Such a short-sighted *dualistic* economic view inherited from the time of enlightenment, externalizes the costs imposed by the industry onto the natural environment and the non-contemporary and non-proximate human beings (Gladwin *et al*, 1995). The paucity of attention to the fact that any economic organization is embedded in the context of the natural environment and the injudicious externalisation of the economic services provided by the ecosystem (Costanza *et al*, 1997) is widely cited in the new wave industrial literature (Hawken *et al*, 1999; Robert, 2002; McDonough and Braungart, 2002; Graedel and Allenby, 2003).

Concerns regarding the planet's capacity to deal with the global economic growth were especially heightened during the 1960s and 1970s (Carson, 1962; Meadows *et al*, 1972) and led to the adoption of a resolution in 1983 by the United Nations' General Assembly to establish a commission for seeking ways forward. Hence the World Commission on Environment and Development (WCED) was established and chaired by the former Norwegian Prime Minister Gro-Harlem Brundtland. The WCED in its concluding report "*Our common future*" (WCED, 1987) (also known as the Brundtland report) introduced the concept of Sustainable Development (SD) as "*development which meets the needs of the present without compromising the ability of future generations to meet their own needs*".

The WCED's definition of SD implies a state of harmony which aims at preserving the vital assets of the future generations, i.e. sound ecosystem and balanced human society. It means that economic expansion should not be at the cost of eroding our medium or long-term capitals. A seminal report published in 2006 demonstrates that the climate

change – resulting from human activities – could shrink the global economy between 5% and 20% now and forever (Stern, 2006). Sustainable Development entails a paradigm shift from solely pursuing economic prosperity towards creating economic wealth at the same time as preserving the natural environment and the well-being of society. That is, going beyond the pure economic conceptualization of organisations and taking into account the interactions with the natural environment and human society (Daly and Cobb, 1994; Gladwin *et al*, 1995). Therefore, sustainable development is a systems approach to industry and society and systems thinking perpetuates the sustainability field of inquiry (Shrivastava, 1995).

An accepted model for conceptualising sustainable development is the three pillars model (Figure 2.3). This is also referred to as the triple bottom-line model or people, planet and profit (Elkington, 1998). In this model the organisation's interactions with the outside world are classified under the three dimensions. Each pillar in Figure 2.3 embodies one aspect of the interactions with the wider environment. The notion of sustainability often refers to the middle of the diagram (the overlap between the three pillars) stressing the long term compatibility of the economic, social and environmental aspects of human activities while acknowledging potential trade-offs in the short-term (Dalal-Clayton and Bass, 2002). Industrial and non-industrial organisations should aim to create balance between the three key dimensions of sustainable development.

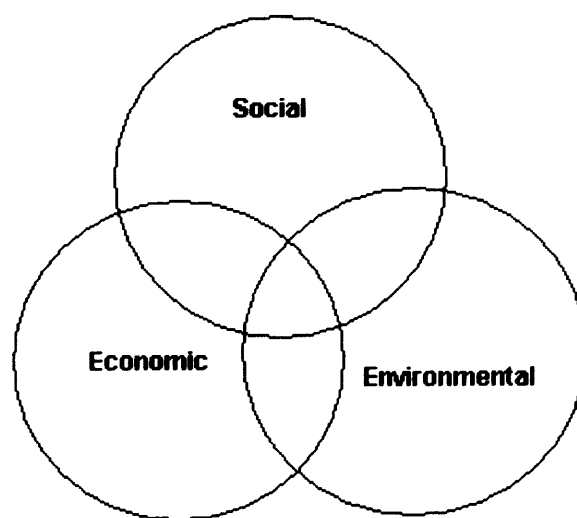


Figure 2.3 The Three Dimensions of Sustainable Development

Source: (OECD, 2001)

The modern management paradigms increasingly embrace the metaphor that the firm and its supply chain are a single organism living in a wider environment on which they depend for survival (Morgan, 1986). Nonetheless, this – organism – metaphor, so prevalent in the management literature, is often restricted to only the economic factors of the organization and the human-related exchanges with the surrounding environment (Gladwin *et al*, 1995) reflecting lack of focus on issues lying in the domain of sustainable development and sustainable industry. The following first briefly discusses the crises which have brought about the need for environmental and social considerations and then explains the challenges which have given rise to the concept of sustainable development. Subsequently, Section 2.4.1 provides an overview of the evolution of sustainability concepts up to the present, especially those related to the domain of business management. Section 2.4.2 reviews some of key schools of thought which aim to picture a sustainable future for industry.

Our economic and industrial practices are profoundly disturbing the ecological balance of the planet in many different ways at the same time as disparities are widening in human society. Some of these challenges are climate change, eutrophication, ozone layer depletion, loss of bio-diversity and deforestation, extreme poverty, mal-nutrition and under-nourishment, widespread of diseases and acute social inequality (Zokaei, 2003). Full review of these challenges is beyond the scope of this thesis. However, there is a general consensus amongst environmentalists that climate change is the most pressing environmental crisis of all and that Global Warming Potential (GWP) of human activities is the best measure forward (Foster *et al*, 2006; Garnett, 2007). Therefore, this thesis focuses on climate change and more specifically on GWP measured in terms of total Green House Gas (GHG) emissions. The United Nation's Intergovernmental Panel on Climate Change (IPCC) defines climate change as “*any change in climate over time whether due to natural variability or as a result of human activity*” (IPCC, 2001). Figure 2.4 visualises the correlation between rising global temperatures and human interventions post industrial revolution. Although one such correlation remains as a theory and is not scientifically proved, there is a strong consensus amongst scientists that most of the global warming observed over the last 50 years is attributable to the increase in the concentration of greenhouse gas emissions due to human economic activities (IPCC, 2007; Stern, 2006). According to the most recent IPCC report, warming of the climate system is unequivocal and it is more than 90%

likely to be due to the increase in anthropogenic greenhouse gas concentrations. Scientists believe that unless urgent and strenuous mitigations are put in place now, it is almost certain that by the end of the century, global temperatures will rise by between 1.1°C and 6.4°C above the current levels (IPCC, 2007).

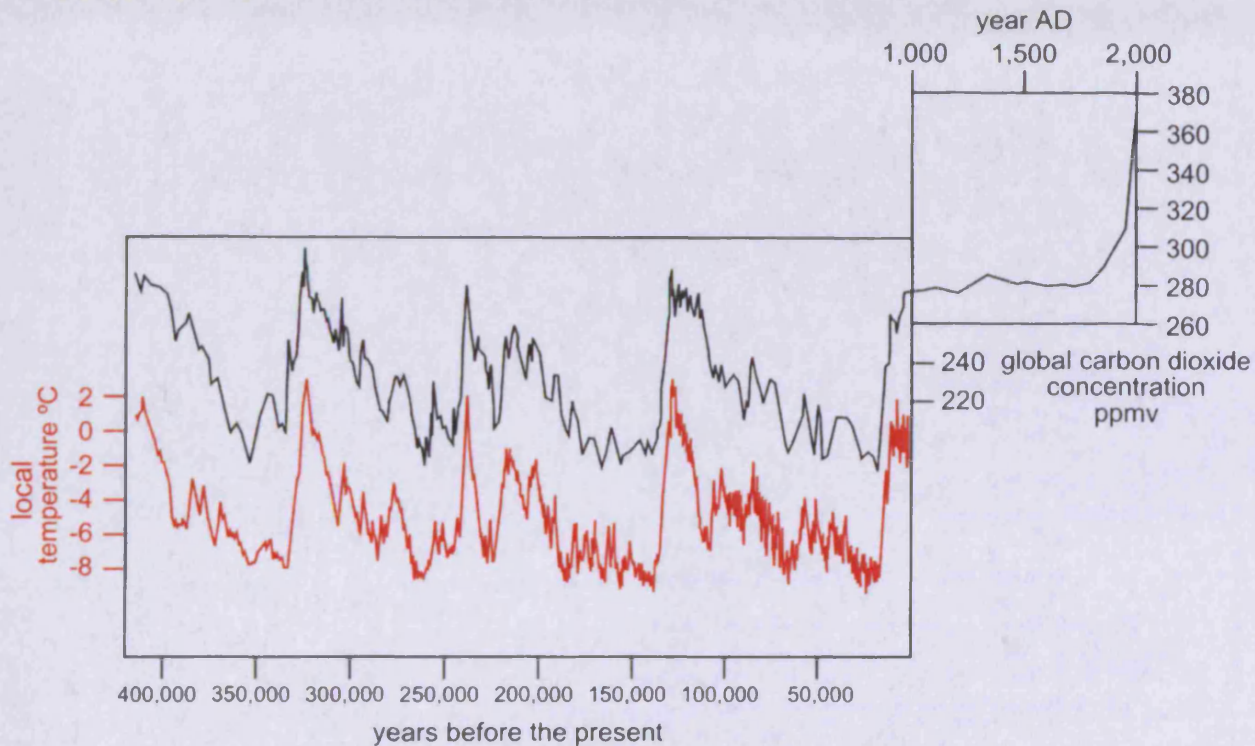


Figure 2.4. Global Temperature vs. Carbon Dioxide Concentration

Source: (IPCC, 2001)

The global ecological crises are tightly interconnected with the human social problems. The two can even sometimes become mutually reinforcing. For example global warming and other ecological crises are coupled with the increasing rate of global population growth which is forecasted to increase to more than 9 billion by 2050 (World Bank, 2007) meaning that more people will be competing over fewer natural resources. At the same time, often, the burden of soil erosion and water and air pollution falls on the disadvantaged who have no choice but to rely on depleting natural resources and to continue to over exploit those resources.

2.4.1 An Overview of the Evolution of Corporate Sustainability Paradigms

A number of eminent management theorists have discussed the severe social and environmental constraints which have emanated from humankind's colossal economic expansions since the industrial revolution (Ehrenfeld, 1981; Shrivastava and Hart, 1995; Porter and van der Linde, 1999). Corporate social and environmental responsibility paradigms have evolved over time, from the early concerns regarding the influences of industry on the natural environment – in the wake of Rachel Carson's '*Silent Spring*' (1962) – to the conception of sustainable development (WCED, 1987) in management theory and its wide acceptance by academics and practitioners around the world. The concept of sustainable development is well received, but rarely implemented by industry. Although significant opportunities for win-win-win solutions exist, preservation of nature and the well-being of society are seldom considered by managers when strategising.

This section provides an overview of the evolution of the social and environmental responsibility theories as proposed by management theorists, international organisations and various think tanks around the world. The following does not aim to review the evolution of sustainability strategies within companies, such as the ones carried out by Hoffman (1997) and Welford (2000), but to understand the evolution of environmental paradigms in the literature. Hoffman (1997, p.31) shows that environmental concepts such as SD are influencing corporate decisions as "*a response to external pressures for legitimacy rather than internal demands for efficiency*". According to Hoffman (1997) sustainability concepts have profoundly altered the form and function of organisations; the origins of this change lie beyond the boundaries of firms and in the supra-environment. The actual evolution of firms' responses to environmentalism as a force in the external environment is beyond the scope of this research.

Figure 2.5 discusses the shape and key attributes of the external pressures over nearly five decades capturing the overarching characteristics of the corporate sustainability theories in decades since the 1960s. However, while many authors have attempted to put environmental concepts into an evolutionary context, the eminent difficulty remains that no one single model can capture all developments in one envelope. There is no such claim that an exhaustive list of theories and philosophies has been presented. For

example there is a significant body of literature discussing the development of environmental regulatory frameworks and policies (Welford, 2000) [for further details see Appendix B].

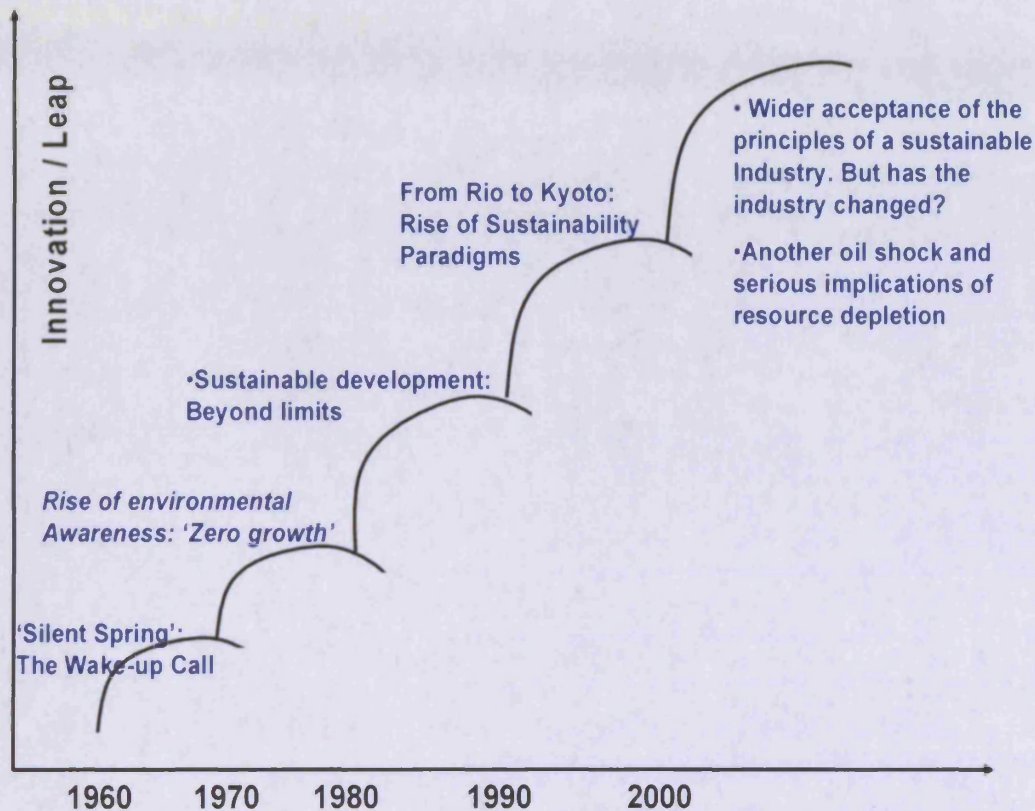


Figure 2.5 Evolution of Corporate Sustainability Paradigms

(Source: Author)

Publication of Rachel Carson's seminal book, *Silent Spring*, (Carson, 1962) was a wake-up call for both the industry and green activists by drawing attention to the precarious conditions of the natural environment and portrayed a dark yet scientifically sound picture of the impacts of chemicals on the wildlife. The 1970s then witnessed the rise of the concept of *Zero Growth* advocated by a group of academicians and policy makers recognised as the Club of Rome whose tenet of their belief was that the rate of human growth is beyond the capacities of the planet (Meadows *et al*, 1972). By the 1980s the conflict between economic development and the limits of the natural environment and human society in sustaining human growth had already created

massive problems leading to the appointment of the UN World Commission on Environment and Development. In its landmark report WCED (1987) introduced the concept of SD denoting a paradigm shift from extreme environmentalism towards a more industry friendly environmental stance by putting forward the vision of industry pursuing economic prosperity in harmony with the long-term well-being of nature and society.

During the 1990s many business and management solutions emerged mostly aiming to marry the goals of industry with the long-term considerations of sustainable development, for example, Natural Capitalism (Hawken, *et al* 1999), Factor Four (von Weizsacker, 1998), Eco-efficiency (Schmidheiny, 1992), Eco-effectiveness (McDonough and Braungart 2002), and The Natural Step in early 2000s (Robert, 2002). The Kyoto Protocol was adopted in 1997 in Kyoto, Japan and has been ratified by 160 countries to date. The significance of the Kyoto agreement is in that it has been the first real practical step in battling the climatic change upon which developed countries have committed to reduce their Green House Gas (GHG) emissions by around 5.2% below their 1990 levels by 2010 or otherwise to engage in emissions trading as an alternative mechanism. By mid-2008 resource depletion is once more challenging the prospects of global economical developments with oil prices soaring to a \$140/barrel record. Many analysts predict a global recession partly due to high oil prices. It is evident from the UN Secretary-General's opening address to the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, that the anti-industry tone of the environmental movements of the past decades has evolved into a much more realistic stance seeking to engage businesses in the greening of the industry. *"Today, there is growing recognition that lasting and effective answers can only be found if business joins in partnership and working together with other actors including government and civil society and of course trade unions and we all have to remain fully engaged. We now understand that both business and society stand to benefit from working together"*. The notion of our decade is that business is good for sustainable development provided that appropriate management practices are adopted. At the same time, following the publication of the fourth IPCC report (IPCC, 2007) and the Stern Review (Stern, 2006) a strong consensus has been shaped that profound global warming due to increase in anthropogenic greenhouse gas concentrations is taking place.

2.4.2 Visions of a Sustainable Industry: An Overview of Key Schools of Thought

Without a vision of a sustainable future for industry and without a clear understanding of the favourable conditions of a sustainable industry portrayed by industrial visionaries, it is not possible successfully to implement the provisos of sustainable development in the context of business management. This section provides an overview of some of the key schools of thought in the field of management for sustainable development which together picture a “*new industrial era*” (Hawken *et al*, 1999) where the natural environment and the industry can co-exist in harmony as presented in Table 2.2. What is common amongst these schools of thought is the acceptance of the economic and developmental needs of society and a free market – yet ethical – economic model. Sustainable industry is radically different from conventional industry both in terms of the actual product or service delivered to consumers and the order fulfilment processes by questioning the consumer value as well as every step along the value stream (Hawken *et al*, 1999; McDonough and Braungart 2002; Robert, 2002).

It is notable that the schools of thought in Table 2.2 are largely theoretical and that the notion of a sustainable industry is essentially in its infancy with little empirical evidence on how it can be implemented. Chapter 3 will demonstrate that there is a gap in the body of literature relating to implementation and application of visions of sustainable industry. Then again, each model draws upon a number of best practice examples in an attempt to illustrate its applicability. Study of these models is the best way – if not the only way – to gain a practical understanding of sustainable industrial management. What is shared amongst these models is a *systems approach* and the idea that industry should be understood in the context of the natural environment. Whilst dissimilar in terms of implementation strategies, they all describe very similar favourable conditions for a sustainable system backed up by case-studies and examples of best practice.

Table 2.2 Sustainable Industry: An Overview of Different Schools of Thought

School of Thought	Key Contributions	Key Principles
Industrial Ecology	<i>Arrogance of humanism</i> (Ehrenfeld, 1981) <i>Industrial Ecology</i> (Graedel and Allenby, 2003)	Industrial Ecology (IE) is a framework for thinking about and organizing human economic and social systems in ways that resemble the natural ecosystems (Ehrenfeld, 2000). IE is the study of the flows of materials and energy in industrial and consumer activities to investigate the effects of these flows on the environment, and the influence of economic, political, regulatory and social factors on the flow, use and transformation of resources. The uniqueness of IE is that it aims to show how environmental concerns can be integrated into economic activities. At the application level, IE offers tools for analysis of the interface between industry and environment, and provides a basis for management of environmental impacts.
Eco-efficiency	<i>Changing Course</i> (Schmidheiny, 1992)	The concept of eco-efficiency was introduced by the World Business Council for Sustainable Development (WBCSD) in Schmidheiny (1992). Since then eco-efficiency has gained increasing attention across businesses as well as in academic literature. The concept is based on creating more while using fewer resources and creating less waste and pollution. The seven critical factors for Eco-Efficiency: reduction of the material intensity of goods and services, reduction of the energy intensity, reduction of toxic dispersion, enhancing material recyclability, maximizing sustainable use of resources, reduction of material durability in nature, increase the service intensity of products.
Eco-effectiveness	<i>Cradle to Cradle</i> (McDonough and Braungart, 2002)	Eco-effectiveness is based on a cradle-to-cradle or closed-loop design strategy rooted in the systems of the natural world, which are not necessarily efficient, but effective since there is no waste in the whole natural system whereas each individual sub-system is creating waste. The principles of eco-effectiveness are: waste equals food (create a closed loop industrial system), use the current solar income and celebrate diversity. Eco-effectiveness calls for transformation of human industry through ecologically intelligent design. It seeks to design industrial systems that emulate the nature where waste from one sub-system is food for another. So, the tenet of eco-effectiveness is that waste equals food. Eco-effectiveness argues that eco-efficiency works with the same system that caused the problem in the first place, merely slowing it down with moral proscriptions and punitive measures.

Natural Capitalism	<i>Natural Capitalism</i> (Hawken et al. 1999) <i>Factor Four</i> (von Weizsacker, 1998) <i>Ecology of Commerce</i> (Hawken, 1994) <i>The Value of the Ecosystem Services</i> (Costanza et al. 1997)	Natural Capitalism is based on four strategies (Hawken et al, 1999): 1. Radical Resource Productivity: obtaining same amount of utility from a product or process while using less material and energy in order to slow resource depletion and pollution at the same time. Radically increased resource efficiency – at least in theory – lowers costs for business and society. 2. Bio-mimicry: Reducing the waste from product life-cycles can be accomplished by redesigning products and processes as biological analogues. There is no waste in nature; waste from one process is food to another. Bio-mimicry means imitating natural processes and products. This changes the nature of industrial processes and products, enabling the constant reuse of materials in continuous closed cycles, more use of compostable products and eliminating toxicity. 3. Service and Flow Economy: This strategy calls for a fundamental change in the producer-consumer relationship wherein services replace physical goods where possible. In this situation service provider is responsible for the product after use and it is to the benefit of suppliers to make products lasting longer. So, less waste is generated in this type of relationship. Also, more jobs are created since service industry is more labour intensive. In a service economy customers have more choice since changing service providers is easier and cheaper than obtaining new goods. 4. Investing in Natural Capital: reversing world-wide planetary destruction by reinvestments in sustaining, restoring, and expanding stocks of natural capital, so that the ecosphere can produce more abundant ecosystem services and natural resources. Natural Capitalism pictures a new industrial system based on a very different mindset and values than conventional capitalism. <i>Natural capital</i> refers to the natural resources and ecosystem services that make economic activities possible. “<i>Capitalism as practiced is a financially profitable, non-sustainable aberration in human development. What might be called “industrial capitalism” does not fully conform to own accounting principles. It liquidates its capital and calls it income. It neglects to assign any value to the largest stocks of capital it employs – the natural resources and living systems as well as the social and cultural systems that are the basis of human capital</i>”. (Hawken et al, 1999 p.5).
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The Natural Step	<i>The Natural Step</i> (Robert, 2002)	The Natural Step (TNS) framework's definition of sustainability includes four system conditions (scientific principles) which must be met in order to create a sustainable world. The first three principles are defined as the following: in a sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the earth's crust, concentrations of substances produced by society and degradation by physical means. The fourth principle argues that in a sustainable society human needs are met worldwide. According to Robert (2002) sustainability is fundamentally about maintaining human life on the planet and, thus, addressing human needs is an essential element of creating a sustainable society. Complying with the above system conditions should be the aim of organisations and they must adopt a systems approach to understand their position against each.
	<i>Tools and concepts for sustainable development</i> (Robert, 2000)	
	<i>Dancing with the Tiger: Learning Sustainability Step by Natural Step</i> (Natrass and Altomare, 2002)	The work on TNS framework was initiated by Professor Robert in the 1980's and received wide attention from industry and policy makers during the late 1990's and 2000's. TNS deploys a systems approach to describe the whole biosphere-society system in a way relevant to businesses and governmental decision makers. The systems approach helps to avoid misunderstandings and disallows intellectual escape routes. TNS looks at SD at three levels: principles of ecosphere governed by natural laws of physics, principles of sustainability (the four system conditions in the opposite) and the principles for a 'process' to meet principles for sustainability (the transition towards sustainability, and then the safe development thereafter).

(Derived by the Author from various sources)

The above discussions explain what sustainable industry is or what it might look like. However, despite attempts to suggest alternative strategies for sustainable industry through case illustrations, these concepts have gained little impetus within businesses. There remains a great disconnection between the vision of a sustainable industry and realisation of SD. Gladwin *et al* (1995) recognize that “*operationalisation and measurement of sustainability remain in their infancy*”; since this statement, arguably little progress has been made. This is dealt with in Chapter 3 where it is explained that the implementation of sustainable industry should be integrated into day-to-day management activities rather than becoming a separate function. Therefore, a truly

systemic approach is required. Chapter 3 explains the gap in the management literature in terms of improving economic and environmental aspects of supply chains simultaneously. Saving the natural environment should become part of the day-to-day operations of supply chains and not a separate function. Chapter 5 will then contextualise this gap by highlighting the significant impacts of the UK agri-food supply chains on the environment and the urgency of implementing more sustainable practices. This thesis integrates environmental improvement actions into economic improvement through a systemic approach in Chapter 7.

2.5 Conclusions

The chapter began by discussing literature review design for the thesis (Figure 2.1). It was explained that this chapter is a review of the background literature providing the foundation for the focal literature review in Chapter 3 which in turn leads to identification of gaps in the body of literature. The central theme in the background literature is systems thinking in management. This chapter shows how management theory has evolved to embrace the concepts of systems thinking and sustainable development. An in-depth analysis of systems theory and cognate approaches was provided. The systemic view of the organisation is a grand overarching theory rooted in scientific management and many other concepts. A systems view of the organisation was illustrated in Figure 2.2 explaining that the organisation can be viewed from the perspective of different subsystems. Since the research questions are derived by looking at the literature through a supply chain management lens and since supply chain management is rooted in logistics and operations management (*see* Chapter 3), the thesis is arguably biased on the economic/technical sub-system. This issue is discussed and dealt with in Chapter 4 as part of the research limitations.

This chapter also discussed contingency theory which emphasises the fallacy in proposing universal managerial solutions by focusing on isolated sub-systems. It is the author's belief that greater system performance (efficiency and effectiveness), which is the subject of discussion in the case studies in Chapters 6 and 7, stems from appropriate fit between the organisation and its environment. Therefore, a contextual mode of inquiry (i.e. case study approach) has been selected to enable understanding of the

contingent fit between the system and its environment. Moreover, two further cognate bodies of literature were reviewed which are closely linked with the discussions on research methods in Chapter 4. They illustrate that systems thinking does not end with the research subject and needs to be ingrained in the way the research itself is carried out. Process theory/processual research explains the temporal notion of systems analysis. Process analysis is the method of inquiry which aims to catch reality in flight (Pettigrew, 1997). Section 2.2.3 stipulated a set of characteristics that a study should possess in order to qualify as processual research. Chapter 4 will show that the research strategies adopted in this thesis possess all those characteristics. Section 2.2.4 then described Soft Systems Methodology which is different from the orthodox systems approaches in the way it defines the system. Whereas in GST an external reality is taken as the system (e.g. supply chain as a system), in SSM the enquirer inevitably becomes part of the system as soon as they try to enquire about the system in question. SSM is the process of research which aims to bring about improvements in the system through a hands-on learning cycle leading to action (Checkland, 1999). Similarly, the research strategies adopted in Chapter 4 possess many characteristics of SSM.

This chapter, furthermore, introduced the concept of sustainable development explaining that SD is a systems approach to management theory where the socio-environmental consequences of economic activities are taken into consideration. It was explained that SD extends even beyond the economic and management literature into areas such as law, politics and engineering. A number of futuristic concepts were reviewed that together depicted route ways to more sustainable industry. The following chapter will build on systems theory and sustainability paradigms to identify two gaps in the body of management literature in relation to the research problem. It will also be discussed that a truly systemic approach to supply chain management requires taking environmental sustainability into consideration.

Chapter Three

3 Focal Literature Review

3.1 Introduction

As already discussed, the literature review in this thesis is carried out at two levels (see Figure 2.1). Chapter 2 reviewed the underpinning theories and laid the foundations for the review of the focal literature in this chapter. It also illustrated that a truly systemic analysis of organisations requires taking the three pillar sustainability issues into consideration. The purpose of the background literature review was to provide the necessary theoretical lenses through which the focal literature could be analysed and understood. On the other hand, the review of the focal literature is intended to identify specific gaps in the body of knowledge – in relation to the research problem – which will in turn fashion the focus of the study and inform data collection and analysis in the following chapters.

The research problem posed for this thesis was centred on the lack of systemic understanding and systemic improvement approaches in the UK agri-food supply chains. The literature review therefore, began with understanding systems thinking and related theories as basic frameworks for guiding systemic investigation and systemic improvement. However, the background literature review remained somewhat general and did not specify gaps to form the focus of the thesis. In order to identify gaps in the body of knowledge, this chapter reviews the key bodies of literature which specifically deal with the research problem at a detailed and applied level, i.e. supply chain management literature and sustainable supply chain literature.

In Figure 2.1 (in Chapter 2) the background literature is illustrated by dashed red lines and the focal literature by solid blue lines. Three distinctive bodies of literature were identified under focal literature, i.e. supply chain management, lean thinking and sustainable supply chain management. Obviously SCM is at the core of this thesis since the research problem is about agri-food chains. Section 3.2 addresses the supply chain management (SCM) literature which carries a profound notion of systems thinking and is characterised by applying and implementing systems theory across whole chains, e.g. supply chain integration, supply chain collaboration and whole chain alignment. This section identifies a gap in the body of knowledge in terms of creating effective supply chains. Section 3.3 focuses on lean thinking since the Japanese management philosophies in general and lean in particular, have had great influence in shaping our knowledge of supply chain management. Moreover, a number of tools and techniques deployed during data collection in this thesis are rooted in lean thinking. Section 3.4 reviews the literature on sustainable supply chain management and identifies a gap in the body of knowledge in terms of addressing economic and environmental sustainability simultaneously in the context of supply chain management.

3.2 Supply Chain Management

Supply Chain Management (SCM) is a fairly new concept which started to make a significant appearance in the management literature in the 1980's (Oliver and Webber, 1982; Houlihan, 1985; Stevens, 1989) and has, since, been popularised by several authors as an independent field of study (Cooper and Ellram, 1993; Cooper, Lambert and Pagh, 1997; Christopher, 2005; Skjoett-Larsen, 1999; Mentzer *et al*, 2001; Gibson, Mentzer and Cook, 2005, Cousins, Lawson and Squire, 2006). However, much of the underlying thinking dates back several decades. In fact, the roots of SCM can be traced to systems dynamics and analysis (Forrester, 1958), integrated logistics management (Bowersox *et al*, 1959) and the idea of forming cooperative relationships with suppliers (Farmer and Macmillan, 1976). Moreover, some argue that the key authors in the field of Purchasing and Procurement Management, such as Kraljic (1983), have equally contributed to shape up the existing knowledge of SCM (Cousins, Lawson and Squire, 2006).

The term supply chain management is typically deployed in the literature referring to management of the entire flow of goods (and services) and therefore carries a profound notion of systems thinking. Although it is not clear whether SCM is sufficiently developed to be regarded as an independent discipline, the general consensus amongst academics is that SCM is a general problem domain represented by a significant – yet diverse – body of knowledge in the literature (special issue on supply chain management *International Journal of Operations and Production Management*, 2006; Croom *et al*, 2000; Giannakis, Croom and Slack, 2004). This section aims to provide a rounded understanding of SCM concept and its evolution in the management literature through review of some key contributions since 1950s. Section 3.2.1 reviews the definitions of SCM presented in a chronological order in Table 3.1 explaining how SCM has evolved from a narrow focus on physical aspects of the chain into a broad multifaceted discipline. This evolutionary trend is then discussed further leading to the categorisation of various aspects of SCM into a single framework. In light of this trend analysis and categorisation, Section 3.2.2 underlines a gap for further research in SCM, i.e. supply chain effectiveness.

3.2.1 Evolution of Supply Chain Management in the Management Theory

Along with the growing attention to SCM in the management literature, over the past two decades, there has been an increasing divergence in the way the supply chain and supply chain management are understood and defined by management theorists. Table 3.1 provides an overview of some of the most frequently cited perspectives on supply chain management and supply chain, covering the related constructs such as value stream, supply network and value chain. In Table 3.1, SCM literature since 1950s have been perused and those proposing an original or significant delineation of supply chain or SCM have been presented in a chronological order. The review is not intended to yield a generic definition for SCM or to seek consensus amongst academic views on SCM but to focus on different perspectives and discuss the way in which these views have evolved over time. In fact, the key purpose is to open new horizons in current SCM research rather than normalising various definitions and perspectives of SCM. The review shows the trends and the evolving concepts in SCM; it concludes by highlights those gaps in the body of knowledge which require further attention.

Table 3.1 An overview of key contributions in SCM where a significant delineation is proposed

Contributor(s)	Proposed delineation for supply chain, SCM or related constructs	Key features of the contribution
Forrester (1958)	Forrester fostered the dynamic study of whole systems as opposed to the study of separate functions or companies. <i>"company [and supply chain] will come to be recognised not as a collection of separate functions but as a system in which the flows of information, materials, manpower, capital equipment, and money setup forces that determine the basic tendencies towards growth, fluctuation, and decline. I want to emphasise the idea of movement here because it is not just the simple three-dimensional relationships of functions that counts, but the constant ebb and flow of change in these functions – their relationships as dynamic activities."</i>	Forrester aims to show the importance of the interrelationships between company functions and between the company and its network of suppliers and customers. Forrester emphasises that the dynamics of relationships between the flows of information, materials, human-power, finances and capital equipment should be studied and standard management methods should be extracted from such studies. The definition in the opposite box demonstrates a true systems approach to the study of the organisation and its supply chain.
Houlihan (1985)	The whole supply chain is a single business process. SCM can be defined as having the following key characteristics: 1) <i>"The supply chain is viewed [and managed] as a single process..."</i> 2) <i>"SCM calls for and in the end depends on strategic decision making. Supply is a shared objective of every function in the chain..."</i> 3) <i>"SCM calls for a different perspective on inventories which are used as balancing mechanism of last, not first, resort."</i> 4) <i>"A new approach to systems is required – integration rather than interfacing" (p. 26).</i>	Characterises the differences between SCM and the traditional materials and manufacturing control science. Houlihan argues that, on account of the new economy, the traditional logistics and materials management approaches, which sought trade-offs among various conflicting key functional objectives of purchasing, production, distribution and sales, do not work very well any longer. It is necessary to adopt a new approach: supply chain management.
Jones and Riley (1985)	The entire supply chain must be managed as a single entity. <i>"SCM deals with the planning and control of total flow of materials from suppliers through end-users" (p. 19)</i>	The key to managing a supply chain efficiently is to plan and control the inventories and activities as an integrated single entity.

Porter (1985)	Michael Porter proposed the concept of the Value Chain (and the Value Chain model) as a means of analysing intra-firm competitiveness. In addition he introduced the Value System model, which effectively is an extension of the Value Chain model to the whole supply chain, for analysis of inter-firm competitiveness. The Value Chain and Value System models are activity based views of the firm and its supply chain. According to Porter, every firm/supply chain is a collection of value activities (processes) performed to create a product valuable to buyers (p. 38).	The Value System model is probably, today, recognised as the 'value stream map'. The Value System model disaggregates the supply chain into strategically relevant activities (processes) in order to understand the sources of competitive advantage. More importantly, the value system and value chain models emphasise the importance of the linkages between the activities along the chain.
Stevens (1989)	Stevens defines the supply chain and SCM as follows: <i>"The supply chain is the connected series of activities which is concerned with planning, coordinating and controlling material, parts and finished goods from suppliers to the customer. It is concerned with two distinct flows through the organisation: material and information"</i> (p. 3). <i>"The objective of managing the supply chain is to synchronise the requirements of customer with the flow of materials from suppliers in order to effect a balance between what are often seen as conflicting goals off high customer service, low inventory management, and low unit costs"</i> (p. 3).	Stevens (1989) provides one of the earliest clear cut definitions of supply chain and supply chain management. He puts customer service at the heart of SCM and defines it as a bundle of delivery service, pre and post sales service, technical support and financial packages. Stevens (1989) proposes a structured framework for developing an integrated supply chain strategy which is even applicable to today's supply chains. This framework has three stages: 1) Identifying the customer needs 2) Diagnosing supply chain opportunities 3) Developing an action plan for implementation.
Christopher (1992)	<i>"Supply chain is a network of connected and interdependent organisations mutually and cooperatively working together to control manage and improve the flow of materials and information from suppliers to end users"</i> (p. 6). SCM is <i>"the management of upstream and</i>	Takes into account more organisational aspects and not just physical aspects. Also, argues that the industry is entering an era of supply chain competition as opposed to single firm competition, i.e. individual firms can't compete in isolation anymore.

	<i>downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole" (p. 5).</i>	
Towill et al (1992)	<i>"A supply chain is a system, the constituent parts of which include material suppliers, production facilities, distribution services and customers linked together via the feed-forward flow of materials and the feedback flow of information."</i>	Towill et al (1992) focus on the supply chain efficiency and largely on information flows. This contribution applies the laws of systems dynamics to the supply chain; it proposes that the efficiency of the system can be improved through free exchange of information concerning true market demand, i.e. supplier control systems must operate on real orders rather than responding to distorted demand.
The Industrial Marketing and Purchasing Group (IMP), and the Industrial Networks School of Thought Hakansson (1987); Johanson & Mattsson (1987); Hakansson & Snehota (1995)	The basis of Industrial Networks model is that buying and selling in markets could not be understood as a series of dis-embedded and serially independent transactions but as episodes in often long-standing and complex relationships between buyers and sellers. A key premise in this approach is that each individual firm is part of a network of suppliers and customers. An industrial network is thus a web of relationships where one actor is connected directly and indirectly to other actors through exchange relationships. This model takes SCM from chain level to network level. Moreover, the model studies the supply networks in three distinct layers, i.e. activities, resources and actors (ARA). (Hakansson, 1987; Hakansson and Snehota, 1995)	Whereas conventional SCM is largely concerned about activities and, to some extent, actors, the industrial networks school of thought (Hakansson, 1987; Johanson and Mattsson, 1987; Hakansson and Snehota, 1995) takes three units of analysis into account to analyse the relationships and material linkages between businesses, i.e. actor bonds, activity links and resources ties (Jahre and Fabbe-Costes, 2005). A fundamental assumption in this perspective is that individual firms depend on resources controlled by other firms. The industrial networks approach draws attention to long-term interrelationships and resource ties for forming transactions in supply chains / networks. This theory complements the classic SCM concepts rather than rejecting it.

Cooper and Ellram (1993)	A supply chain is an integrated business process, from the end-user through different tiers of suppliers to the raw material producer. SCM is <i>"An integrative philosophy to manage the total flow of distribution from the supplier to the ultimate user"</i> (p. 13)	Cooper and Ellram (1993) stipulate a set of characteristics for SCM as a modern concept: 1) Coordination across the entire chain 2) More long-term orientation 3) Joint reduction of inventories 4) Presence of a channel leader 5) Long-term share of the risks and rewards 6) Compatibility of corporate philosophies 7) Channel-wide approach to cost efficiency
Hewitt (1994)	Hewitt defines the supply chain as a single business process which should be managed as whole. Hewitt contends that this approach is sharply distinct from the conventional logistics management since it simultaneously addresses all aspects of the operation in the whole chain. Hewitt regards this level of logistical evolution as <i>"integrated intra-company and inter-company supply chain management"</i> (p.4).	Hewitt defines SCM as the final stage in the evolution of logistics management. Successful SCM depends on the recognition and management of three critical dimensions in the chain: 1. Physical flow (work activity) 2. Information flow 3. Decision/authority flow.
Lalonde and Masters (1994)	This contribution defines SCM as an emerging logistics strategy. <i>"This strategy [SCM] involves expanding the integrated logistics concept beyond the corporate borders of the firm to include the logistics operations of the vendors and customers"</i> (p. 37).	The authors <i>"refer to the strategy of applying integrated logistics to all elements of a supply chain as supply chain management"</i> (p. 38).
Womack and Jones (1996)	<i>"The Value Stream is the set of all the specific actions required to bring a specific product (whether a good or service or increasingly a combination of the two) through the three critical management tasks of any business: the problem-solving task running from concept through detailed design and engineering to production"</i>	The first principle of Lean Thinking (Womack and Jones, 1996) is about understanding the consumer value. Womack and Jones (1996) bring consumer satisfaction, and subsequently the New Product Development process, to the heart of SCM argument.

	<i>launch, the information management task running from order-taking through detailed scheduling to delivery, and the physical transformation task proceeding from raw materials to a finished product in the hands of the customer” (p. 19).</i>	Womack and Jones (1996) introduce the notion of ‘value stream’ which is essentially a ‘value system’ looked at from a single product point of view (Porter, 1985). Whereas Porter contends that “<i>the relevant level for constructing a value chain [and value system model] is a firm’s activities in a particular industry (the business unit)</i>” (p. 36), lean thinkers (Womack and Jones, 1996) propose that the appropriate level of analysis is disintegration of the supply chain into processes/activities at single product (family) level.
Cooper, Lambert and Pagh (1997)	<i>“SCM is the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers” (p. 2).</i> <i>“A new and broad understanding of SCM seems to be emerging ... At the heart of this emerging new understanding are two significant changes. First, today’s widely acknowledged and implemented process-orientation of business work activities de-emphasises the functional structure within and between organisations. Second is the significant change in the perception of SCM as being more than just logistics. It can be management of all business processes ... business processes become supply chain business processes” (p. 13).</i>	This contribution raises the question whether SCM is a new brand for integrated logistics. The authors argue that SCM is integration of all business processes and not just logistics across the whole chain. The authors contend that SCM is emerging into a notion broader than logistics embracing all business processes cutting across all organisations within the supply chain. Authors then, propose a three pillar conceptual framework which is in agreement with this new emerging SCM notion. The three tiers of the model include: supply chain business processes, Supply Chain structure and supply chain management functions.

Council of Logistics Management (CLM) (1998)	<i>"Supply Chain Management is the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."</i> Therefore, SCM is a philosophy for synchronisation of all activities/capabilities (not just logistics) to create consumer value.	CLM distinguished SCM from logistics management and acknowledged that logistics is one of the aspects of SCM in 1998. This distinction led to CLM changing its name to the Council of Supply Chain Management Professionals (CSCMP) in 2004. According to CSCMP, SCM extends the research on logistics to take into account issues of governance, multi-firm relationships and innovation in the chain to create consumer value.
Ross (1998)	<i>"SCM is a continuously evolving management philosophy that seeks to unify the collective productive competencies and resources of the business functions found both within the enterprise and outside in the firm's allied business partners located along intersecting supply channels into a highly competitive, customer-enriching supply system focused on developing innovative solutions and synchronising the flow of marketplace products, services, and information to create unique, individualised sources of customer value" (p.9).</i>	According to Ross (1998), SCM has become one of the most important concepts in today's industry for competitive advantage enabling companies to exploit new realities and dynamics of the transforming marketplace.
Croom et al (2000)	<i>"The supply chain should be seen as the central unit of competitive analysis ... In short, the contention that it is supply chains, and not single firms, that compete is a central tenet in the field of supply chain management."</i> (p. 68) <i>"Supply chain management and other similar terms such as network sourcing, supply pipeline management, value chain management, and value stream management have become subject of increasing attention in recent years" (p. 67)</i>	The paper sets out to <i>"establish the general problem domain of supply chain management"</i> (p. 67). It maps and evaluates SCM research and provides a topology of the domain which confirms a profound lack of theoretical research, i.e. SCM is not theoretically and conceptually well-researched. Given the central role of SC to competitiveness, the paper points to the need for greater theoretical work to inform our understanding of chain phenomena.

		The authors contend that <i>"whilst supply chain management as a concept is a recent development, much of the literature is predicated on the adoption and extension of older, established theoretical concepts"</i> (p. 68) such as transaction cost economics and competitive strategy.
Mentzer <i>et al</i> (2001)	<i>"a supply chain is defined as a set of three or more entities (organisations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer"</i> (p. 4) <i>"SCM is defined as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purpose of improving the long-term performance of the individual companies and the supply chain as a whole"</i> (p. 18). <i>"SCM is concerned with improving both efficiency (i.e. cost reduction) and effectiveness (i.e. customer service) in a strategic context (i.e. creating customer value and satisfaction through integrated SCM) to obtain competitive advantage that ultimately brings profitability"</i> (p. 15).	Implicit in this definition of supply chain is that supply chains – as phenomena of business – exist whether they are managed or not. Thus, the authors draw a definitive distinction between supply chain as a given phenomenon and supply chain management as the science and art of managing supply chains. Mentzer <i>et al</i> (2001) distinguish between SCM philosophy and implementation. The philosophical view that companies across the supply chain constitute a potentially coordinated entity is regarded as a management philosophy and branded as 'Supply Chain Orientation'. Subsequently, SCM is defined as the implementation of a 'Supply Chain Orientation' vision and an upshot of 'Supply Chain Orientation'. This contribution addresses the importance of both chain efficiency and effectiveness.
Giannakis, Croom and Slack (2004)	<i>"In the literature a consensus on the meaning of supply chain management does not exist. A profusion of different terminologies can be found ...These definitions do have different meanings or emphasis, but they at least share one common theme – they all refer to</i>	This contribution provides a review of the main theoretical antecedents that have informed research behind the current body of supply chain management knowledge such as systems thinking, transaction cost economics, and game theory. The

	<i>phenomena relating to the management of operations across organizational boundaries" (p. 1)</i> <i>"Research relating to the management of supply chains is undoubtedly diverse and multidisciplinary... founded on a heritage of different antecedents bases." (p. 2)</i>	authors argue that research in SCM addresses a wide range of problems. They also identify a number of institutions which have significantly contributed to development of SCM concept. It is notable that the author has been associated with two of these institutes during the course of this research, i.e. the Lean Enterprise Research Centre and the Department of SCM at Michigan State University.
Giannakis and Croom (2004)	<i>"Supply chain management is an increasingly important topic ...However, the literature concerning supply chains is patchy and unconnected." (p. 28)</i> <i>"Research in the field of SCM has evolved from its core concerns around logistics/operations processes through the incorporation of theoretical concepts and research in strategic management, industrial organizations, institutional and production economics (transaction costs), inter-organizational relationships, knowledge management and systems theory." (p. 29)</i>	The authors attempt to provide a foundation for the conceptual grounding of a cognate SCM discipline and contribute to development of a potential SCM paradigm. They propose that the problem domain of SCM can be described and delineated through the 3S framework, i.e. Synthesis (physical structure of supply chains), Synergy (human interaction and relations in the chain), Synchronisation (coordination and control of operation processes). The authors also show that SCM is much broader than just physical aspects of product flow and operational issues.
Gibson, Mentzer and Cook (2005)	<i>"Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence Supply Chain Management integrates supply and demand management within and across companies" (p. 22).</i>	This contribution reports on the results of a Council of Supply Chain Management Professionals (CSCMP, formerly Council of Logistics Management) survey of its members' views of SCM. The survey proposed two potential definitions for SCM. Based on the results of this study, the authors conclude that the verified definition (in the left box) is not definitive and further refinement and evolution of the definition are both possible and desired.

Burgess <i>et al</i> (2006)	This contribution deploys the definition given by Mentzer <i>et al</i> (2001) for supply chain management as quoted above. However, the authors use a “fairly liberal” (Burgess <i>et al</i>, 2006 p.704) interpretation of this definition. They carry out a structured review of 100 randomly selected papers on SCM. The review shows that SCM contributions are mostly in manufacturing and consumer goods industries. Also, shows that 58% of the reviewed articles have not presented a definition and an additional 30% have used existing definitions of SCM or incrementally changed one. Moreover, the review reveals that different conceptual framings of the SC exist in the literature, i.e. supply chain as an activity such as an individual function of a process, process (chain of related activities), system (series of related processes) and other deeper levels of analysis such as sociological and philosophical concepts. More than 80% of contributions framed SCM as a process or system. Authors suggest that the predominance of the process view of SCM can be explained by the suggestion that SCM has emerged from operations management and has been greatly influenced by Japanese management philosophies (e.g. lean). The authors argue that while the hardcore of SCM is focused on logistics and operations management, other emerging areas should be given due attention.	The authors create a classification framework with 11 dimensions under 4 main categories: 1. Descriptive trends in SCM literature (i.e. time of publication, journal and sector) 2. Territories covered by SCM (i.e. ways SCM is defined, conceptual framing of the supply chain, constructs of SCM and discipline base of SCM) 3. Theoretical concerns (i.e. what theoretical perspectives are adopted and what is the purpose of theory development) 4. Research methodological concerns (i.e. paradigm and research methods) Analysis of SCM constructs shows that relational and operational (logistics, process improvement and information systems) constructs are overwhelmingly the dominant constructs in SCM literature. Analysis of SCM literature disciplines shows that operations/purchasing/logistics is by far the dominant discipline and that only 5% of the reviewed articles fall under the marketing discipline (out of which only 3% are purely marketing focused). This shows a potential gap in terms of expanding SCM into marketing. The review, also, reveals the lack of theoretical underpinnings (20% have no discernable theory and 52% rely on transaction cost economics or competitive advantage as a theoretical perspective). In summary, there is great diversity in SCM literature in terms of definitions, framing and constructs while theoretical perspectives and methodologies are narrow.
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Harland et al (2006)	<i>"Supply management and SCM researchers are converging on the need for integration across organisation and functional boundaries, though there is still little evidence of measured benefits of such integration. SCM and Supply management have emerged as dominant terms for this integration but contributors to each stream have provided insufficient theory to underpin this development, and perhaps paid too little attention to disciplinary and theory debate."</i> (p. 746)	The paper principally addresses this research question whether or not SCM may be called a discipline. The paper deploys structured literature review and concludes that there is insufficient evidence to suggest SCM is an independent discipline mainly due to lack of discipline debate in the literature and limited theory base. However, it suggests that SCM is an emerging discipline in need of strong academic leaders, and broadening of theory base and paradigm stances.
Storey et al (2006)	<i>"Supply [chain] management can be viewed as both an emergent field of practice and an emerging academic domain. Neither perspective is fully mature but each has considerable promise. The future progress of each will be enhanced and indeed is ultimately dependent upon the other."</i> (p. 754)	This contribution distinguished between SCM theory and practice and reports substantial gap between them. The authors argue, in order for SCM to develop, this gap must be closed through redrawing the boundaries of SCM theory to lead practice into new domains. <i>"The challenges facing SCM as theory and practice stem from their interplay and misalignment."</i> (p. 769)

(Source: Author)

The above literature review confirms the hypothesis at the beginning of this chapter that there is little consensus over the scope and meaning of supply chain or supply chain management. One reason for this is that supply chain has been viewed and studied from different theoretical perspectives (Skjoett-Larsen, 1999; Giannakis, Croom and Slack, 2004). Burgess et al (2006) carry out a systematic review of one hundred randomly selected journal papers and maintain that from a conceptualisation perspective the definition of SCM is unclear. Cousins, Lawson and Squire (2006) argue that SCM can be viewed as an overarching field of study covering differing theories used to study a variety of phenomena and situations. Another reason for diversity of opinions around

SCM is that different researchers have used different units of analysis in their approach. These units of analysis include relationships covering the issues of trust, power and collaboration (Hines and Samuel, 2006), resources including manufactured means of production and human resources (Bowersox and Closs, 1996; Håkansson and Snehota, 1995) and flow of information, material or economic-value (Forrester, 1958; Hines and Rich, 1997). Finally, the concept of SCM has re-emerged in many different variations and under different names in a range of management streams such as, Co-Makership (Merli, 1991), Value Chain Competitiveness (Porter, 1985), Industrial Networks (Håkansson, 1987; Håkansson and Snehota, 1995), Relationship Marketing (Berry, 1983; Gummesson, 1996) and Financial Value Chain Analysis (Shank and Govindarajan, 1993).

The aim of this chapter is neither to ascertain the appropriateness of the aforementioned delineations of the supply chain and SCM (Table 3.1) nor to discuss whether SCM is a discipline in its own right. In fact, the above contributions are all apt in the capacity of the industry or the historical background from which they have emerged. This chapter looks at the evolution of SCM in the management literature and discusses areas which have been less explored as SCM has emerged as an independent problem domain. Table 3.1 is indicative of the fact that over the past two decades SCM has evolved from a one-dimensional subject with a rather narrow focus on logistics and physical aspects of material flow into a multi-faceted theory encompassing a broad range of subjects from strategic management to human resource management to new product development. Internationalization of trade, sophistication of technology and markets (La Londe and Masters, 1994), increased global competition, and the rise and dominance of the Japanese production philosophies (Womack and Jones, 1996; Hines, 1994; Lamming, 1993) have immensely contributed to the evolution of SCM and its constituent concepts.

Studying Table 3.1 shows that the early conceptions of SCM (Houlihan, 1985; Jones and Riley, 1985; Stevens, 1989) emphasise the importance of holism as opposed to single firm optimization. In fact, SCM begins with showing the potentials which lie beyond the boundaries of the firm. However, the original supply chain contributions, largely, focus on the physical aspects in the supply chain such as the dynamics of information and material flows (Forrester, 1958; Towill *et al*, 1992) and inventory management and transportation (Jones and Riley, 1985). The narrow focus of the early

SCM contributions has inspired several authors to compare and contrast SCM with integrated materials and logistics management (Cooper, Lambert and Pagh, 1997; Hewitt, 1994; Christopher, 1992; Houlihan, 1985). These authors have generally come to the same conclusion that SCM is a much broader concept encompassing issues beyond the logistics sub-system.

The later accounts of SCM in the literature (Table 3.1), however, transcend this narrow focus by taking account of broader issues such as long-term performance of the whole chain (CLM, 1998), whole chain competitiveness (Croom *et al*, 2000; Mentzer *et al*, 2001; Christopher, 2005), consumer enrichment (Ross, 1998), New Product Development (Womack and Jones, 1996) and human interactions and relations (Giannakis and Croom, 2004). For example, Hewitt (1994) contends that modern SCM simultaneously addresses “*all aspects of the operation of the supply chain, including work practices, information flows and authority/decision making structures*” (p. 7). Ross (1998) describes SCM as synchronization of competencies along the whole chain to create unique, innovative and individualised sources of consumer value. Womack and Jones (1996) describe value stream management as the integration of the problem solving and new product development task, management of the information task, and the physical transformation and transportation task. Moreover, Giannakis and Croom (2004) propose the 3S model (*see* Table 3.1) which also takes into account the human aspects of interactions and relationships (i.e. one of the three S is for Synergy which covers the human relational dimension of SCM).

Clearly, SCM is a multifaceted theory; and every single one of these aspects are evolving in their own right. However, according to Burgess *et al* (2006), while interest in SCM is immense, knowledge about SCM resides in narrow functional silos such as logistics and operations management, purchasing, and information technology. Although Table 3.1 is useful in terms of trend analysis, for this trend analysis to lead to identification of gaps in SCM literature it is necessary to identify those areas where literature is less developed. Burgess *et al* (2006) explain that SCM literature comprises a core largely consisting of operations and logistics literature and an emerging protection belt less developed and in need of further research. The trend analysis presented in this section defines key emerging gap areas in the protection belt to form the research questions.

Table 3.2 introduces a framework for categorisation of existing SCM literatures which is useful in terms of further identification of the less developed areas and the potential gaps. Thus far, a number of other contributions have also attempted to classify supply chain literatures using a range of taxonomies. For example Cooper, Lambert and Pagh (1997) classify literature in relation to: the scope of the supply chain; inter-organisational integration; objectives and evolution towards an integrated supply chain. Mentzer *et al* (2001) contend that SCM definitions can be classified into three categories: a management philosophy (or supply chain orientation as explained in Table 3.1), implementation of a management philosophy (policies that carry out the philosophy such as cooperation) and a set of management processes (the processes of managing relationships, information flow and physical flow). Similarly, Cooper and Ellram (1993) propose that the focus of SCM literature fall into three types: the concept of supply chain, advantages of forming supply chains over other alternatives, and management of supply chains. In a more recent contribution Burgess *et al* (2006) provide several original classifications of SCM literature based on various approaches derived from a thorough structured literature review. Their categorisation of SCM literature constructs closely matches that of Table 3.2.

Table 3.2 suggests that the existing supply chain literature fall into five key streams, i.e. Logistics Management, Supply Chain Financial Analysis and Management, Relationships Management, Systems Analysis and Improvement, and Strategic Supply Chain Competitiveness. This table was constructed before the publication of Burgess *et al* (2006); however, construct categories are similar. ‘Leadership’, ‘Intra-organisational relationships’ and ‘Inter-organisational relationships’ constructs from Burgess *et al* (2006) are covered by the single category of Relationships Management in Table 3.2. The ‘Business results and outcomes’ construct is closely linked into the Supply Chain Financial Analysis and Management category. Moreover, ‘Process improvement’ and ‘Information systems’ constructs from Burgess *et al* are covered in Systems Analysis and Improvement. The only important point of difference is introduction of Strategic Supply Chains Competitiveness as an independent construct category in Table 3.2. Several authors, such as Giannakis and Croom (2004), Mentzer *et al* (2001) and Croom *et al* (2000), suggest that strategic SCM is a principal component body of SCM literature.

The importance of Table 3.2 is its introduction of a single framework for categorisation of existing SCM literatures. It not only assists understanding by giving a topology of the field but also highlights potential gaps for further research. The fact that the framework is consistent with recent categorisations conducted by Burgess *et al* (2006), Giannakis and Croom (2004) and Croom *et al* (2000) supports its validity.

Table 3.2 Core constituents and key constructs of SCM body of knowledge

No	Key Construct Categories	Key Sub-categories	Sample Key Contributions
1	Logistics Management	• Transport and distribution management • Inventory management and ordering systems • Materials handling & operation management • Warehousing and location studies • Packaging	Bowersox and Closs (1996); Lalonde and Masters (1989)
2	Supply Chain Financial Analysis & Management	• Strategic Cost Management: a supply chain approach to financial management implies a channel-wide evaluation of costs to identify total cost advantages • Financial Value Chain Analysis • Activity Based Costing (whole chain)	• Shank (1989); Shank and Govindarajan (1993); Cavinato (1991) • Dekker (2003) • Gosselin (1997)
3	Relationships Management	• Collaboration and Trust • Power • Risk	• Hines (1994); Merli (1991) • Cox <i>et al</i> (2001) • Sako (1992)
4	Systems Analysis and Improvement (holistic improvement / study of chains and networks)	• Study of feedback flows of information (demand amplification, Forrester and Burbidge effects and other similar systems dynamics approaches, etc.) • Process improvement and Value Stream Mapping	• Forrester (1958); Burbidge (1961); Towill <i>et al</i> (1992) • Hines and Rich (1997); Jones and Womack (2000)
5	Strategic Supply Chains Competitiveness	• The Value Chain/System model as the basis to understand and improve competitiveness. • Supply chains compete not individual firms	• Porter (1985) • Christopher (1992 & 2005); Croom <i>et al</i> (2000)

(Source: Author)

The first construct in Table 3.2 is Logistics Management which is an obvious choice since SCM is rooted in logistics and operations management. Supply Chain Financial Analysis and Management is another principal component body of SCM literature. This construct covers those contributions which adopt a financial approach to SCM. The third proposed construct is Relationships Management. Burgess *et al* (2006) and Giannakis, Croom and Slack (2004) allude to lack of attention to human aspects of relationships in the literature. According to these authors, even those few contributions which investigate relationships fail to address the human side of relational issues. The fourth construct is Systems Analysis and Improvement. As mentioned, this category can be broken up to cover two distinct bodies of literature, i.e. process improvement, and information systems analysis and improvement. The final category is Strategic Supply Chains Competitiveness. More recently, the literature adopts a strategic view on SCM (Gibson, Mentzer and Cook, 2005; Mentzer *et al*, 2001) and regards the whole chain as a key unit of analysis in the strategy debate (Porter, 1985; Christopher, 1992; Womack and Jones, 1996). The review in Table 3.1 shows that strategic connotations of SCM only make an appearance in the literature in the recent years (Mentzer *et al*, 2001; Hewitt, 1994; Gibson, Mentzer and Cook, 2005). Drawing on Burgess *et al*'s (2006) study, the current concentration within the literature is densest respectively around categories 4, 3, 2 and 1 (bearing in mind that category 5 does not appear in their categorisation and that those categories that relate to relationships management in their work cover both business-to-business and human interactions).

Maybe due to its origin in logistics and operations management, SCM is a domain where efficiency improvements are the prime objective, e.g. time-based competition (Stalk and Hout, 1990; Womack and Jones, 1996; La Londe and Masters, 1994; Christopher, 2005), cash-to-cash time (Bowersox and Closs, 1996), quality-based competition (Womack *et al*, 1990) and cost-based competition (Shank and Govindarajan, 1993; Cavinato, 1991). Study of the categories defined in Table 3.2 suggests the same thing. Only two out of five categories potentially go beyond cost reduction to include methods for differentiation and value enhancement, i.e. Strategic Supply Chains Competitiveness and Systems Analysis and Improvement. Nonetheless, the existing body of knowledge – even in these two categories – largely fails to go beyond efficiency to address issues of value enhancement.

Despite the diversity of the ways SCM is defined in the literature, arguably central to all definitions is *customer satisfaction* as a shared objective of the whole supply chain. However, only a few very recent publications emphasise the importance of *enhanced consumer satisfaction* in the context of the supply chain (Zokaei and Hines, 2007; Walters, 2006; Hines *et al*, 1998). Mentzer *et al* (2001) argue that SCM, as an integrative paradigm, is about directing all firms along the chain to focus on developing innovative solutions to create individualized sources of consumer value. In this context, understanding consumers' attributes and jointly striving on augmentation of consumer satisfaction are imperative to successful SCM.

An emerging trend in SCM is the increasing emphasis on the delivery of superior consumer value and leveraging the supply chain as a source of differentiation (Mentzer *et al*, 2001; Hewitt, 1994; Christopher, 2005). SCM is changing focus from supply issues to demand driven value (Juttner, Baker and Christopher, 2007; Godsell and Harrison, 2002). This is to some degree influenced by the work of Porter (1985) who showed that a firm and its supply chain should be disaggregated into groups of value-generating activities (processes) which he referred to as the 'value chain/system' (see Table 3.1). The significance of Porter's value chain model is that it addresses improvement of both efficiency (i.e. cost reduction) and effectiveness (i.e. enhancing value through differentiation) of a value system. For a firm (or a supply chain) to gain competitive advantage over its rivals it must perform those activities more efficiently or perform activities in a unique way that creates differentiation. So in Porter's model a firm's value chain or value system become sources of augmenting consumer value. The Value System model is probably today best recognized as a value stream map.

Another key factor influencing this paradigm shift in SCM is the rise of the Japanese production philosophies and lean thinking (Womack and Jones, 1996). The concept of value chain/system was later adapted as a key element of lean thinking (Womack and Jones, 1996). However, Porter's Value Chain model is criticised by the lean authors for embracing an inherently economic meaning of value and a push-driven approach in the supply chain (Hines, 1993). *"As neither Porter nor the firms being discussed concede that consumer satisfaction and not company profit should be their primary objective, the [value chain/system] model's focus is on each firm's margin and not on consumer's satisfaction. Secondly, although Porter concedes that integration is important, the*

Value Chain/System modelling shows a rather divided network both in-company and between the different organisations in the total supply system” (Hines, 1993, p. 14).

The above review of SCM literature and categorisation of SCM constructs leads to the identification of an emerging area or a gap in the body of literature, i.e. *enhancement of consumer value through better SCM and leveraging the supply chain as a source of differentiation*. The author suggests that consumer value enhancement is an emerging stream in SCM literature which should be added to Table 3.2 either as an independent category or as an emerging sub-construct under Strategic Competitiveness or Systems Analysis and Improvement. The following section elaborates further on this gap whilst referring to it as *supply chain effectiveness* and stipulating the demarcation between chain efficiency and effectiveness.

3.2.2 Supply Chain Effectiveness vs. Efficiency

Chapter 2 explained the demarcation between system's efficiency and effectiveness. Efficiency was defined as the ratio of resources utilized against the results derived and effectiveness as the degree to which system goal is achieved. Simply put, efficiency is about doing things right and effectiveness is about doing the right things. In the same vein, supply chain effectiveness is defined as attainment of consumer satisfaction and supply chain efficiency is defined in terms of the reciprocal of the resources absorbed (Hewitt, 1994). Efficiency indicators measure an output level against an input level, e.g. productivity which is units produced against labour time or delivery performance which is units delivered against an existing transport infrastructure. Supply chain effectiveness indicators, however, measure the level of consumer satisfaction which should be the goal of any supply chain system (Zokaei and Hines, 2007). It was discussed in Chapter 2, Section 2.3, that both effectiveness and efficiency indicators are current measures of performance and not measures of sustainability of a system. Sustainability of a system also depends on levels of satisfactions of different stakeholders both internal and external to an enterprise. Section 3.4 will show that ideally supply chains should go beyond Voice of Customer (VoC) to capture Voice of Society (VoS) in order to become sustainable systems. This section will only address efficiency and effectiveness of supply chains and the future measures of sustainability are left for Section 3.4.

The previous section clearly showed a gap in the body of SCM knowledge in relation to leveraging the chain as a source of enhanced consumer satisfaction. Despite little theoretical discussion around the critical role of the supply chain in developing innovative solutions for enhancement of consumer value (Borgstrom, 2006; Walters, 2006; Christopher, 2005; Mentzer *et al*, 2001; Hewitt, 1994), there is a lack of empirical research explaining *how* this can be realized in practice (Zokaei and Hines, 2007; Hines *et al*, 1998; Baramichi *et al*, 2007). Moreover, consumer value in the context of the chain should not be limited to logistical and quality issues (i.e. zero defect product, right time, right place and right cost), or activities that could be considered to be within the order fulfilment process. Currently, the sources of innovation in the supply chain are largely limited to very few New Product Development functions along the chain. It is certainly ideal to enable all processes along the extended value chain to play a role in creating unique, individualized sources of consumer value. The aim of this thesis is to address this gap through empirical studies. This thesis addresses ways of effectiveness improvement and introduces new tools for enhancing the consumer value, at the supply chain level, in Chapter 6.

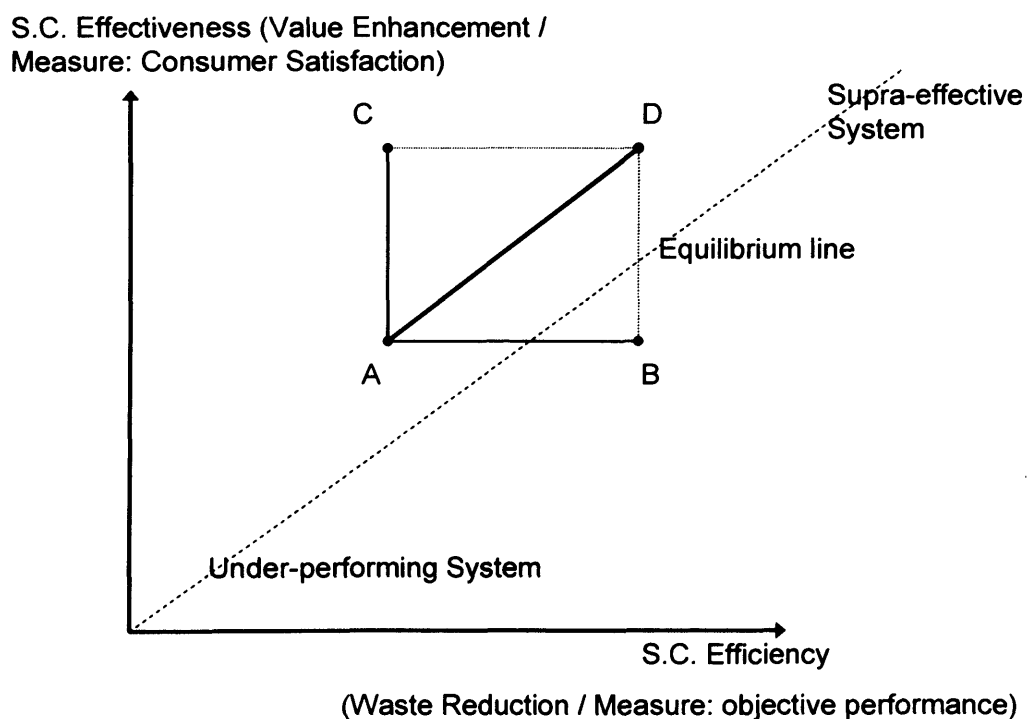


Figure 3.1 Two Dimensional Supply Chain Performance Model – Effectiveness vs. Efficiency
Adapted from Hines *et al* (2004)

Thus supply chain performance is two dimensional consisting of effectiveness and efficiency. As illustrated in Figure 3.1, effectiveness can be improved through enhancement of the value proposition; for instance new features could be added to a product to fulfil an unmet consumer need or a supply chain setup could be altered to deliver the exact requirements of the final-consumer. That is moving from A to C. On the other hand, efficiency is improved through waste elimination, i.e. reducing the input levels while increasing the output levels. That is moving from A to B. It can be argued that efficiency of the supply chains is contingent upon alignment to the overall effectiveness of the value proposition.

The focus of many supply chain improvement efforts has, so far, been solely on efficiency gains, i.e. lowering the supply chain costs, better use of capacity, on-time/in-full deliveries and reducing inventories. It is obvious that such improvements will have – often positive – repercussion in terms of consumer satisfaction and supply effectiveness. For example, Just-in-Time applications can simultaneously reduce inventory costs and improve deliveries. Although there is an ever increasing need for more efficient supply chains, it is not sufficient to focus solely on waste elimination. Christopher (2005 p.52) argues *“damaging has been the focus on cost reduction that has driven many companies’ operational and logistical strategy [...]. Cost reduction is a worthy goal as long as it is not achieved at the expense of value creation. Low-cost strategies may lead to efficient logistics but not effective logistics”*. In fact, it has been argued by several authors that focusing on efficiencies and forgetting the system’s purpose often results in sub-optimisation of the whole (Ackoff, 1999; Seddon, 2003; Evans, Mason and Zokaei, 2007). Hewitt (1994, p.7) maintains that *“whereas the traditional, hierarchical model of management prevalent in most enterprises drives control and efficiency by segregating business activities into standardized sub-tasks, true process management is integrative by nature and drives even greater efficiency and effectiveness through flexibility and responsiveness”*.

Discussions in this section led to identification of the first gap in the body of knowledge. That is lack of focus on consumer value in supply chain management literature and lack of practical solutions and tools for improving supply chain effectiveness.

Since supply chain effectiveness is defined in relation to capturing and addressing the VoC it is linked to the discipline of marketing. In fact a number of authors such as Burgess *et al* (2006) and Croom *et al* (2000) argue that marketing is an underlying discipline holding up supply chain literature. Moreover, there are several contributions addressing the inter-linkages of marketing and SCM. Min and Mentzer (2000) state that although SCM started in logistics literature, its theory is inextricably intertwined with the marketing concepts. They emphasise the new age marketing theories in general and Relationship Marketing (Gummesson, 1996) in particular arguing that “*relationship marketing helps achieve the objectives of SCM such as efficiency (i.e. cost reduction) and effectiveness (i.e. customer service) through increased cooperation in close long-term inter-firm relationships among supply chain partners*” (p. 779). Croom *et al* (2000) count Efficient Consumer Response, Efficient Replenishment and Relationship Marketing as examples of the influence of marketing discipline on SCM. Svensson (2002) takes the argument further by saying that the theoretical origin of SCM is derived from, and underpinned by, the functionalist theory of marketing popularised by Alderson (1965) in 1960’s. He argues that logistics and marketing have common routes and that *SCM* appears to be a concept that may contribute to the re-integration and re-establishment of marketing issues in logistics theory and practice.

A study of the classic marketing texts confirms Svensson’s argument; for example Levitt (1974) extends marketing into product-line planning and operations by discussing detailed provision of services or production of goods as a function of the marketing department. Levitt (1960) criticises the scientific management approach – dominant in production – for lack of vision and for being too narrowly focused on efficiency. He calls on marketing to organise “*work*” to meet the consumer needs contending that “*the entire corporation [including production and logistics] must be viewed as a customer-creating and customer satisfying organism*” (Levitt, 1960 p.12). According to Drucker (1954) customer satisfaction lies at the centre of the marketing concept and, thus, profit is not the objective but the reward for creating a satisfied customer. Even today, Tesco’s core purpose is “*to create value for customers to earn their life-time loyalty*” (Tesco, 2006); for Tesco, which is a lean company, profit is only a lag indicator of success. Nonetheless, it seems that in some respects marketing has been outpaced by new models for value creation originating from outside marketing such as production and NPD (Doyle, 1995).

Demand Chain Management (DCM) is a recent concept developed and popularised at Cranfield School of Management (Christopher, 2005; Godsell and Harrison, 2002) which tries to refocus SCM from supply issues to demand driven value. In this sense the emergence of DCM confirms the gap established in the above in terms of the lack of focus on consumer value in supply chain management literature. However, DCM seems to be more concerned with responsiveness and agility than the broader perspective suggested for supply chain effectiveness in this section. Juttner, Baker and Christopher (2004) suggested DCM as a model for integration of marketing and SCM. According to them, supply chain efficiency by itself will not enhance consumer value and satisfaction; there is a need to draw upon marketing strengths in understanding consumers and value in the supply functions for “*managing customer value through responsive networks*” (p. 10).

According to Svensson (2002) despite logistics and marketing activities being closely linked, there is often an unhealthy distance between them both in literature and in practice. The evolutionary trend discussed in the above shows that there is more tendency amongst the traditional logistics views to ignore the importance of marketing. More recently there are contentions, primarily emerging within the SCM literature, drawing attention to various aspects of consumer value in the context of the supply chain. Despite these arguments and despite the fact that marketing’s strength is in obtaining consumer knowledge, understanding the way in which consumers perceive value and translating that information into product or service features, the existing links between marketing and supply chain functions seem to be tenuous. Burgess *et al* (2006), identify at least 8 key discipline bases for SCM. Using their sample of 100 randomly selected articles, only 5% of supply chain contributions can be associated with marketing out of which only 3 (from a total of 100) articles are purely marketing focused. This shows a clear gap in terms of deployment of marketing knowledge in SCM as also pointed out by authors such as Juttner, Baker and Christopher (2007), Svensson (2002), Min and Mentzer (2000) and Alvarado and Kotzab (2001).

3.3 Lean Thinking

The Japanese production concepts and particularly lean thinking have contributed significantly to the existing body of SCM knowledge. Moreover, given the author's lean background, the thesis draws upon lean tools and techniques, such as value stream mapping, during data collection and analysis. Therefore, it is important to provide a review of this management concept. Lean has especially influenced the recent trend in SCM literature from supply focused mentality to consumer driven value. The first principle of lean thinking is consumer value (Womack and Jones 1996). According to Hines *et al* (2004) lean has two pillars: value creation and waste elimination. The following firstly provides an overview of lean thinking and explains how lean thinking goes beyond efficiency improvements to embrace effectiveness as its primary goal. However, it is notable that many lean implementation projects merely focus on efficiency improvements by adopting a very narrow meaning of consumer value.

3.3.1 Historical Background to Lean Thinking

Nearly a hundred years ago Henry Ford drew upon the Chicago slaughterhouses' carcass disassembly (break down) processes to build the world's first flow assembly line at Highland Park plant, Detroit (Hounshell, 1984). Ford's flow method of production led the global economy into an era of "*production for masses*" (Hounshell, 1984 p. 241), away from crafts production techniques. The key underpinning characteristics of Ford's system were inter-changeability of assembly parts, labour inter-changeability, and high degree of vertical integration and control across the chain. The problem of inter-changeability of assembly parts never existed in the disassembly of an animal carcass. In this sense, Ford was indebted to the pioneers of the American System of Production, especially Colt and Pratt and Whitney (Chandler, 1977). The second most important attribute of *Fordism* was the standardisation and fragmentation of all tasks on the shop-floor (Littler, 1985). Jobs at Ford required limited skills and were as interchangeable as the assembly parts. An army of narrowly trained workforce (some immigrants who barely spoke English and in fact needed not to communicate since tasks were very straightforward) worked in the Ford plants. Ford incentivised this tightly controlled unskilled labour, vigorously to perform simple repetitive jobs, through higher wages (Ford's famous five dollar day). Finally, Henry Ford's dedication for uninterrupted flow of material led him to establish various parts and raw materials

supplier plants adjacent to the assembly line. At the River Rouge plant, Ford literally produced everything required to make a car from oilseed crops to steel mills to power plants. (Hounshell, 1984)

Such an articulate system of production for masses well-suited the manufacture of identical model-T's offering the company the economy of scale which in turn enabled it to constantly lower the prices. Nonetheless, soon the markets were saturated with the monotonous model-T and many customers turned to General Motor's automobiles for a perception of individuality, style and quality. Ironically, the prosperity that production for masses brought to the American society created ever more demanding customers that sought the customised products of the flexible mass production era. Another force which added to Ford's challenge was the emergence of the worker unions during the 1920's demanding better lifestyle in return for their rather tedious jobs. (Hounshell, 1984)

By 1925, GM had a yearly model-change policy. At Chevrolet, Khudson – a former chief production engineer at Ford – had devised a relatively flexible production system which (to some extent) accommodated change. Khudson abandoned Ford's production system by deploying general purpose production machinery as opposed to single purpose machine tools. Although Khudson stuck with Ford's idea of sequenced manufacturing line where possible, he kept large amounts of inventory between the work stations to compensate for the changes. Hence, Chevrolet became the birthplace of what is today known as "*mass production*" (Hounshell, 1984 p. 265) and can be characterised with its batch and queue mode of production and mountains of work-in-progress. Eventually, in 1927, after a significant slump in market shares, Henry Ford had to succumb to the principles of mass production. GM's marketing creed had triumphed over pure operations mentality of Ford. And so, the smooth flow of identical components evolved into mass production of many product variants. (Hounshell, 1984)

Arguably, Ford's highly efficient production model and vertically integrated supply system gave way to GM's slightly less efficient yet more flexible, market oriented and effective system, due to customer perception of individuality and higher value. Eventually, Toyota resolved this contradiction by developing a flow production system for many product variants and became the birthplace of lean thinking (Womack *et al*, 1990). According to Mann (2002), powerful business solutions do not accept trade-offs; the philosophy of lean thinking is to eliminate the non-value adding compromise

between uninterrupted process flow and market oriented flexible production. Lean production contrasts mass production, by emphasising the importance of smooth flow, continuous improvement and employee empowerment (Womack & Jones, 1996).

The term 'lean' was first coined by James Womack, Daniel Jones and Daniel Roos in *"The Machine that Changed the World"* (Womack *et al*, 1990). Lean production is rooted in the Toyota's Production System which turned 'Toyota Motor Corporation' from a small domestic producer in 1950's into one of the world's leading automotive companies in the 1980's and number one in terms of volume in early 2007. The key tenet of lean production is elimination of waste both within the firm and across the supply chain (Womack & Jones, 1996). The notion of waste elimination dates back to the Scientific Management movement (Taylor, 1914; Gilbreth, 1911) in America and has been the cornerstone of all business paradigms which focus on the productive rationality of capital (being human, financial or manufactured capital). Scientific Management rationalises the use of labour-power at the individual worker level – through fragmentation of individual jobs into different tasks and optimisation of each. Fordism adopts the rational principles of Taylorism and *"extends the focus of waste elimination"* to the whole process (Doray, 1988 p. 69). The Fordist flow assembly line – for the first time – made it possible to control the quantity of effort required at the individual workstations through setting an average line speed (the factory clock speed). Similarly, mass production has been defined as *"a ruthless war on waste"* (Filene, 1925 p. 88).

Yet, Lean's definition of waste is quite distinctive from Taylorism, Fordism or that of mass production. Taiichi Ohno (1988), the father of Toyota Production System, defined Muda (Japanese for waste and futility) as any human activity, which absorbs resources but creates no value. Performing a wasteful activity adds no value but incurs cost; by looking at waste in this way Ohno linked efficiency improvement (waste elimination) to value creation which is about effectiveness. He identified seven types of Muda: waste from overproduction, waiting inventories, unnecessary transport, waiting times, unnecessary motion (of people), unnecessary processes and defective products.

Both Taylorism and mass production have been criticised for causing *"alienation of the labour"* (Doray, 1988 p. 116). It is true that there is a degree of work abstraction in lean – due to standardisation of the work methods and sequence, and not allowing for self-

regulation of the work speed. Nonetheless, lean avoids total estrangement of the workers through broadening the scope of jobs, offering task variety, eliminating tight supervision, reducing the need for inspections, and encouraging social interactions in workplace. Contrary to the Sword of Damocles approach of the western auto-manufacturers, Toyota empowered employees and guaranteed jobs for life, which in turn allowed Toyota to benefit from wholehearted participation of its employees.

3.3.2 A Typology of Lean Elements: Philosophies, Policies and Practices

Based on previous research (Macduffie, 1995; Macduffie & Pil, 1996; Hines and Taylor 2001), this section suggests that the success of lean production stems from a combination of practices, policies, and philosophies. Figure 3.2 demonstrates a typology of lean elements. Successful lean implementation involves amalgamation of various elements from different levels in Figure 3.2. For example, Just-in-Time inventory management policy and creation of smooth flow go hand in hand while both depend on the introduction of Takt-time in practice. Furthermore, companies which implement single piece flow need to promote the workers' participation policy and pursue continuous improvement philosophy to sustain the flow production system within the organisation.

The following diagram underlines the fact that lean production is more than just a set of tools and techniques and links into the overall business philosophy of the organization. True lean thinkers restore the organizational focus on real value (from the customers' point of view) and align all the processes to that end. Some argue that the primary aim of the Toyota Production System has been to improve consumer satisfaction and service levels rather than cutting costs (Bicheno, 2000). It is the intention of this thesis to broaden the scope of consumer value in the context of supply chain from just using logistical criteria (e.g. on-time/in-full deliveries) towards more fundamental ways of addressing the Voice of Consumer (VoC). To that end, the author will draw on marketing and NPD techniques, by way of example. The very basic instances of supply chain ineffectiveness are the activities which are unnecessary from the consumer's point of view or duplicated and more subtle effectiveness improvement is when the value chain exceeds consumer expectations (*see* Chapter 6).

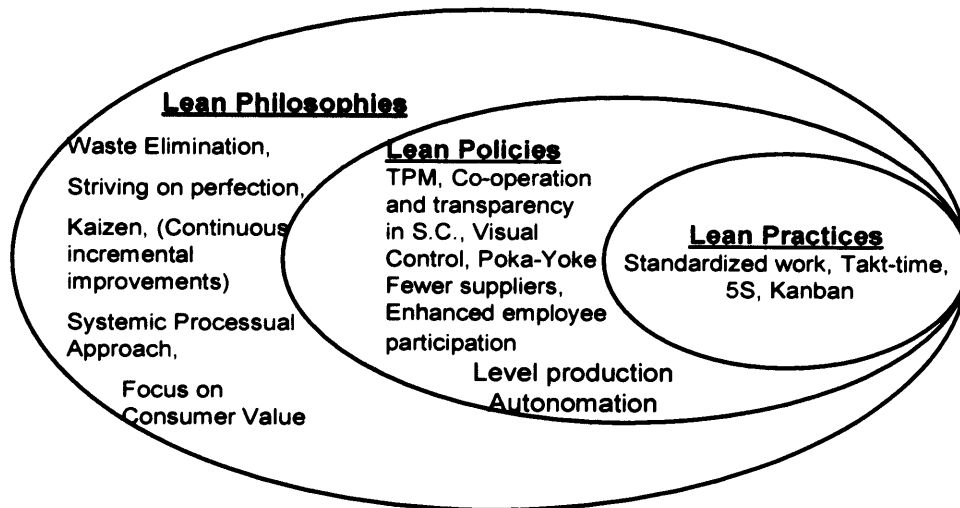


Figure 3.2 A Typology of the Lean Elements: Lean Philosophies, Policies and Practices
Adapted from (Zokaei and Simons, 2006b)

3.4 Sustainable Supply Chain Management

The concept of sustainable development and its linkages with systems theory were introduced in Chapter 2. Visionary literature was discussed and it was suggested that industries ought to fundamentally reinvent themselves in order to become both socially and ecologically sustainable. Sustainable development questions the consumer value as well as every step along the value stream delivering value. Section 2.4.3 introduced several schools of thought each offering various principles or strategies for changing the status quo. Nonetheless, existing management concepts in the field of sustainability are largely speculative and there has been little real progress in implementing the provisos of a sustainable industry. There is a disconnection between the vision and application of SD in the body of management knowledge.

Henceforth, Linton *et al* (2007, p. 1075) contend that “*it is important to move forward to the systemic issues that exist at the intersection of sustainability, environmental management and supply chains*”. This section examines the state of supply chain literature in relation to the environmental pillar of sustainable development showing that sustainability is still peripheral to economic supply chain management despite an increasing attention in recent years. Moreover, those literature that address green supply chain management reside in a narrowly defined silo isolated from core SCM knowledge

critically falling short of addressing the economic side. All in all, there is an immediate need for greater integrity of environmental considerations with mainstream SCM category constructs (e.g. those constructs illustrated in Table 3.2). That is, simultaneous improvement of economic and environmental aspects.

Vachon and Klassen (2006, p. 801) contend that *“while there is growing pressure for environmental criteria to be a major factor in the design and management of supply chains, environmental issues tend to still be viewed as peripheral decisions and ancillary investments. As a result, it is unlikely that environment-related goals and objectives take precedence over primary operational [efficiency] performance criteria such as cost, quality and delivery. This perspective naturally suggests that supply chain characteristics are a central factor that foster or impede the adoption of GSCP [Green Supply Chain Practices], and not vice versa”*. In order for industry to successfully transform to more sustainable modes, green practices need to be engrained in day-to-day supply chain management activities rather than being separated. This can be regarded as a truly systemic approach where environment and voice of society are taken into account along side economic factors. However, the following literature review shows that so far there have been very few contributions aiming to link in sustainability with core SCM practices (Linton *et al*, 2007; Vachon and Klassen, 2006; Klassen and Vachon, 2003; Carter and Dresner, 2001).

As already explained, SCM addresses an array of multifaceted constructs and issues from financial analysis to process improvement to delivery of superior consumer value. Burgess *et al* (2006) conduct a structured literature review exploring various aspects of SCM as it is emerging into an independent field of study. Taking their sample of 100 randomly selected peer reviewed journal articles, which have been collected using ‘supply chain management’ as the search keyword, only 3 contributions address environmental issues, i.e. role of purchasing in environmental management (Carter and Dresner, 2001), management of residual disposition (Young, 2000) and reverse logistics (van Hoek, 1999). It is notable that all three articles have been published in general supply chain journals since 1999. Moreover, it should be borne in mind that Burgess *et al* (2006) do not confine their literature search to supply chain journals potentially covering all ecological and other multidisciplinary publications. In this sample, the number of contributions which address environment is even fewer than the number of

articles that – one way or another – look into voice of customer in the context of supply chain management, i.e. 3 versus 5 articles out of 100⁴ (Table 3.3). Thus, perusing the academic body of knowledge on SCM suggests that environmentally sound practices have received little attention and are regarded as marginal issues.

Table 3.3 Contributions that address Consumer Value and Environmental Issues in the Sample of 100 Randomly Selected Peer Reviewed Journal Articles Produced by Burgess *et al* (2006)

Category	Contributions
Environmental issues in SCM	Carter, C.R. and Dresner, M. (2001) "Purchasing's role in environmental management: cross-functional development of grounded theory" <i>Journal of Supply Chain Management</i> , Vol. 37 No. 3, pp. 12-27
	Young, R.R. (2000) "Managing residual disposition: achieving economy, environmental responsibility, and competitive advantage using the supply chain framework" <i>Journal of Supply Chain Management</i> , Vol. 36 No. 1, pp. 57-66
	van Hoek, R.I. (1999) "From reversed logistics to green supply chains" <i>Supply Chain Management</i> , Vol. 4 No. 3, pp. 129-35
Consumer value and market orientation in supply chains	Klein, K.K., Walburger, A.M., Faminow, M.D., Larue, B., Romain, R., and Foster, K. (1996) "An evaluation of supply chain performance in the Canadian pork sector" <i>Supply Chain Management</i> , Vol. 1 No. 3, pp. 12-24.
	Waller, M.A., Dabholkar, P.A., and Gentry, J.J. (2000) "Postponement, product customization, and market-oriented supply chain management" <i>Journal of Business Logistics</i> , Vol. 21 No. 2, p. 133-59
	Youngdahl, W.E. and Loomba, A.P.S. (2000) "Service-driven global supply chains" <i>International Journal of Service Industry Management</i> , Vol. 11 No. 4, pp. 329-47.
	Czinkota, M.R. and Ronkainen, I.A. (2003) "Global marketing: have lunch or be lunch" <i>Marketing Management</i> , Vol. 12 No. 2, pp. 48-50
	Svensson, G. (2002) "The theoretical foundation of supply chain management: a functionalist theory of marketing" <i>International Journal of Physical Distribution & Logistics Management</i> , Vol. 32 No. 9, pp. 734-54

(Source: Burgess *et al*, 2006)

⁴ Articles that address consumer value/market orientation are numbers 3, 43, 83, 85 and 91 in the list of 100 contributions in Appendix I in Burgess *et al* (2006). Articles which address environment are numbers 8, 17 and 87.

Although rigorously sampled, it was decided not to diagnose a gap in the body of supply chain literature entirely based upon Burgess *et al*'s selection of SCM contributions. For that reason, another literature search was carried out looking at scholarly/peer reviewed journals listed on ABI-Inform Global (ProQuest) database. In the first attempt two keywords were keyed-in: 'supply chain management' AND 'sustainable development'. The search generated a surprisingly low number of contributions that cover both, i.e. 33 articles out of which only 32 were deemed meaningful⁵. In this pool of 32 papers, some looked at both economic and environmental issues in the context of the supply chain and even drew linkages between the two. Others merely deployed techniques from economic SCM to address environmental issues, e.g. better supply chain relationship management for improved environmental performance. Finally 5 contributions were singled out which hardly discussed economic supply chain management at all. In order to identify these, firstly all abstracts were reviewed and then articles were browsed in full text. All remaining 27 articles were published after 1999 except for one which dated back to 1995. A full list of the search result is provided in Appendix C with the 5 aforementioned articles being clearly marked.

In a second attempt 'supply chain management' was searched for alongside 'inventory management' using the same search criteria and database as above. This time the search listed 502 contributions. The search was then repeated, this time using 'supply chain management' AND 'competitive supply' as keywords producing a list of 583 academic contributions. Comparing the search results signifies a gap between the number of contributions addressing mainstream economic problem areas such as inventory control and strategic competitiveness (respectively 502 and 583) compared with the number of contributions simultaneously addressing both environmental and economic problems in the context of the supply chain (27 articles).

The above analysis also shows that those relatively few contributions that deal with sustainability are contemporary. This is confirmed by Linton *et al*'s (2007) diagrammatic representation showing a steep increase in the number of sustainability contributions in the management literature since 1999 indicating that supply chain

⁵ One article was akin to trade advertisements in academic journals rather than a peer reviewed paper

literature is evolving to address environmental issues alongside economic matters. Indeed in a recent special issue of International Journal of Operations and Production Management one article was allocated to green supply chain management (special issue on supply chain management *IJOPM*, 2006) indicating the increasing importance of sustainable supply chain management in academic circles.

This evolution is to some extent driven by external forces. As pressure for environmentally sound products and processes builds up, industries react by adopting various supply chain environmental measures and strategies. For example companies are becoming increasingly conscious about the life cycle impacts of their products and some even go beyond end-of-pipe fixes to adopt pre-emptive holistic strategies such as product stewardship which means that responsibility for the environmental impacts of products do not end with the transfer of ownership to the customer. Environmental pressures are exerted by various stakeholders in the supply chain such as governments, consumers, suppliers, customers, Non Governmental Organisations (NGO's) and employees. As the managerial practice adapts to these pressures so must the theoretical frame of SCM. Nonetheless the *"collaborative paradigm of supply chain management proposed in the recent literature remains focused squarely on core operational issues. For instance, it does not incorporate more peripheral, yet strategic, matters pertaining to the supply chain among them environmental management. As the field of supply chain management evolves to become a discipline of its own right, it must explicitly recognize linkages to related disciplines, and capture concepts and theories that form a broader strategic view"* (Vachon and Klassen, 2006 p.796).

Vachon and Klassen (2006) carried out an empirical analysis on 84 manufacturing plants and established a positive correlation between the core tasks of SCM, such as logistical integration and strategic collaboration for efficiency, and environmental activities within the supply chain such as environmental monitoring and mutual environmental problem solving. This linkage indicates that in practice environmental supply chain management is a natural outgrowth of integrative supply chain activities. They also illustrated that environmental issues are receiving increasing attention at strategic supply chain level. This implies that the boundary constraints of SCM theory need to expand to include environmental concerns (and also later social issues).

Furthermore, there is a significant body of knowledge termed as green supply chain management (GSCM) which focuses specifically on environmental activities in the supply chain. This body of literature tends to be isolated from core economic SCM theory by and large focusing on environmental performance of the system (Seuring, 2004; Vachon and Klassen, 2006). GSCM is defined as *“the practice of monitoring and improving environmental performance in the supply chain”* (Godfrey, 1998 p.244). GSCM literature does not claim to address economic competitiveness. *“Green supply refers to the way in which innovations in supply chain management and industrial purchasing may be considered in the context of the environment”* (Green *et al*, 1996 p.188). Therefore, GSCM literature is a good indication of how SCM and SD literature reside in isolated functional silos. Nonetheless, often GSCM contributions draw upon SCM tools and theories to enhance supply chain environmental performance. Chapter 2 discussed about the gap between visions and realisation of SD in practice. This author believes that the gap can be bridged by more integration of SD and management both in the literature and day-to-day practice.

This section firstly showed that there is only a relatively thin body of literature addressing sustainable development in the context of supply chain management. This was demonstrated by analysing the number of environmental contributions in Burgess *et al*'s (2006) sample of SCM literature as well as comparing the number of literatures that simultaneously address SD and SCM with the number of contributions addressing purely economic issues in ABI-Inform database (i.e. 27 vs. 502 and 583 peer reviewed papers). Secondly, it was explained that SD is gaining increasing momentum in SCM literature and that supply chain body of knowledge is rapidly evolving to embrace sustainability. Finally it was explained that environmental SCM literature and economic SCM literature tend to be in isolated silos and that GSCM literature often fall short of addressing economic considerations. Therefore, the author argues that a second key area missing from Table 3.2 (table of key supply chain constructs) is sustainable supply chain management (in its true systemic meaning, i.e. economic and environmental). Similar to supply chain effectiveness this can be either a stand alone category construct or maybe a sub-category of Systems Analysis and Improvement. This gap translates to a need for further integration of SD and SCM.

Discussions in this section lead to identification of the second gap in the body of knowledge. There is a lack of focus on simultaneous analysis and improvement of environmental and economic aspects in supply chain management literature and a shortage of practical approaches for improving the sustainability of supply chains while being economically competitive.

Chapter 5 will contextualise this gap by highlighting the significant impacts the UK agri-food chains have on the environment and the urgency for implementing more sustainable practices. Chapter 7 of this thesis contributes discussing that implementation of sustainable industry should be integrated into day-to-day management activities rather than being a separate function. Case studies presented in Chapter 7 *explore* how supply chains can become simultaneously efficient, effective and sustainable through a systemic approach.

3.5 Conclusions

The purpose of this chapter was to identify gaps in the body of knowledge in relation to the research problem in order to fashion the focus of the study and inform data collection and analysis in the following chapters. Two key gaps were highlighted in Sections 3.2 and 3.4 which can succinctly be described in the form of the following research questions:

- 1) How can the effectiveness of supply chains be enhanced without compromising their efficiency?
- 2) How can environmental sustainability of supply chains be improved without compromising their economic performance (i.e. both efficiency and effectiveness)? That is, practical solutions for improving the sustainability of the entire system.

A recent seminal contribution by Burgess *et al* (2006, p. 720) asserts that “*the hard core [of SCM] is based in the “operations management – manufacturing – process – positivist” nexus, while numerous other activities are starting to coalesce increasingly within the protection belt. Further, while the hard core is well defined, this is not the case for the protection belt. SCM needs to be more informed about the protection belt if it is to develop a sound body of knowledge. This would require researchers to recognize and engage with themes in the protection belt identified in this research such as the*

psycho-social dimensions of SCM and multi-theoretical perspectives. There is also a need to move beyond positivist methods of research and employ more multi-method research techniques". This thesis identified and discussed two emerging themes within the protection belt, i.e. supply chain effectiveness and supply chain sustainability (simultaneous economic and environmental improvement). The literature review showed critical gaps in our body of knowledge in relation to these themes. Arguably, these two gap areas are increasingly important in the U.K. agri-food sector but the exact extent of the problem in this sector is clarified in Chapter 5 where the literature findings will be contextualised by discussing the problem in practice and by showing the immediate need for action on both grounds.

Chapters 6 and 7 will then respectively address the first and the second research gaps. As explained in Chapter 2 best-fit situations between internal and external contingencies lead to maximum performance and vice versa. The aim of case studies is to explore and explain various aspects of fit-performance associations for maximum chain efficiency, effectiveness and environmental sustainability. While this thesis mainly addresses the first gap through multiple case studies in Chapter 6, Chapter 7 presents *exploratory* research addressing the second research question. This is mainly due to the fact that the second gap is much broader and less mature requiring a great deal of empirical work to address it at an explanatory level which falls outside the remit of this thesis. The next chapter provides detail explanation of research structure, design and methods.

Chapter Four

“The truth is rarely pure and never simple”

Oscar Wilde

4 Research Methodology

4.1 Introduction to Research Methodology

Research Methodology is the domain of choosing, reflecting on, assessing and justifying the philosophies, strategies and techniques used by the researcher to generate knowledge and to reach conclusions from that knowledge (Latham, 2002). In fact the researcher’s methods are out there to be tested, as much as the substantive hypothesis (Walker, 1985).

This chapter addresses the key philosophical approaches underpinning the thesis as well as the structure and individual data gathering techniques deployed at various stages throughout the study. The chapter aims to provide answers to the following questions:

- What are the key paradigmatic inclinations and philosophical assumptions underpinning the study?

- What are the research questions (already defined but discussed further in this chapter)?
- What is the structure and design of the study?
- What data collection and analysis techniques are deployed at each stage of the study? What research protocols are deployed in data gathering?
- What are the boundaries and the potential limitations of the study?

This chapter is laid out following a three layer approach to research methodology. Figure 4.1 illustrates the three overarching levels of research process adapted from Saunders *et al* (2000). Saunders *et al* (2000) argue that the researcher's philosophical approach underpins the research strategies which in turn influence the data gathering techniques and ultimately the research structure. This chapter begins with discussions around research philosophy and the researcher's paradigm inclinations (Section 4.2) and follows with the explanation of the research strategies and factors driving the choice of research strategies (Section 4.3). The chapter continues with delineation of the research structure and the data collection methods in Section 4.4. Finally the rigour and key limitations of the research are discussed in Sections 4.5 and 4.6.

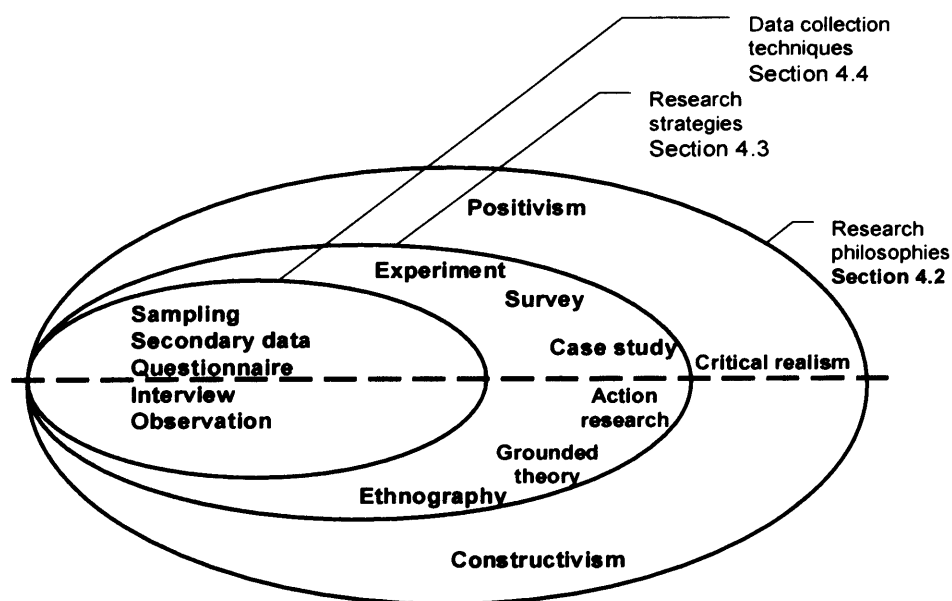


Figure 4.1 Research Philosophy, Research Strategy and Data Collection Methods
Adapted from Saunders *et al* (2000)

4.2 Philosophical Approaches

It is crucial to clarify the researcher's philosophical underpinnings since they largely influence the data collection approaches, the analysis and ultimately the results (Guba, 1990; Saunders, *et al*, 2000). One well-known dichotomy in the philosophy of science is the division between the positivist and the constructivist schools of thought (*see* Figure 4.1). Each one of these two philosophical traditions belongs to a different paradigm and adopts a different set of assumptions about the nature of reality and the relation between the knower and the knowable. These schools of thought, as well as their numerous contenders, are characterised by the answers they provide to the following questions (Guba, 1990):

- Ontological question: What is the nature of the knowable? What is the nature of reality?
- Epistemological question: What is the nature of the relationship between the knower and the knowable?
- Methodological question: How should the knower go about finding out knowledge? What combinations of techniques need to be used to inquire about specific situations?

Each paradigm contains different ontological, epistemological and methodological premises. The positivist paradigm assumes that there is an objective reality out there driven by immutable natural laws also known as the realist ontology. Moreover, the positivist paradigm works on the premise that the researcher can fully apprehend the truth through objective and independent modes of inquiry. The research process can and must be impartial and free of personal opinions also regarded as an objectivist epistemology. The positivist school of thought endorses empirical/experimentalist methodologies as the only ways of grasping the truth. Positivists often deploy sampling techniques (e.g. questionnaires) in management research and apply rigorous measurements to find generalisable and reliable rules which pertain to relatively large populations (*see* Table 4.1). (Guba, 1990; Denzin and Lincoln, 2000; Wass and Wells, 1994; Easterby-Smith *et al*, 2002)

Table 4.1 Taxonomy of Philosophical Approaches in Business and Management Research

Paradigm	Positivism	Critical realism	Constructivism
Ontology (nature of the reality)	Realist ontology: Objective reality out there driven by natural laws. The truth is independent of the subjectivity of the inquirer.	Critical realist ontology: Real world exist but can never be fully apprehended since always seen through researcher's subjective lens.	Relativist ontology: No objective truth. Reality is perceived.
Epistemology (relationship between the knower and the knowable)	Objectivist epistemology: The researcher can fully apprehend the (objective) reality. Researcher to remain objective and free of bias through independent collection of empirical evidence followed by impartial analysis.	Modified objectivist epistemology: Aspires to objectivity but objectivity can only be approximated and subjectivity can only be reduced.	Subjectivist epistemology: Knower and knowable are fused into one. Research finding are constructs of interactions between the two. So the known cannot be free of personal opinion and partiality of the knower.
Methodology (how should knower find out knowledge)	Empirical methodology: hypothesis is stated in advance and subjected to empirical research under controlled conditions to find generalisable and reliable results.	Methodology: Emphasises the importance of the context of the research while recognising the significance of reducing subjectivity through triangulation.	Attempts to interpret the shared subjectivity of researchers to minimise illusion and create as much consensus as possible. Generalisation beyond context is meaningless.
Research modus-operandi (Research techniques)	Often deploys quantitative methods of data collection (e.g. sampling, questionnaire, etc.) and statistical methods of data analysis.	Deploys both qualitative and quantitative data collection techniques. Statistical analysis alongside interpretive methodologies.	Normally draws on qualitative data collection techniques (e.g. interviews, observation, etc.); interprets contextualised findings.
Cycle of inquiry	Research begins with proposition of a hypothesis (usually drawn from earlier research) and subjecting the (operational) hypothesis to empirical tests to verify / falsify (deduction). This may lead to creation of new theories (induction).	Iterative cycles of induction and deduction.	Research can begin by either proposition of hypothesis and observation around the hypothesis (deduction) or by data collection and grounding new theories in empirical evidence (induction). Often a combination of both.

Collated by the author from different sources (Guba 1990; Wass and Wells 1994; Easterby-Smith *et al*, 2002)

On the contrary, the constructivist paradigm assumes that there is no objective truth and that reality exists only in the form of multiple mental constructs in one's mind. The constructivist paradigm proposes a subjectivist epistemology meaning that research findings are constructs of an ongoing interaction between the knower and the knowable. As such, it is impossible for the knower to study the knowable free of bias or to keep personal inclinations out of the research process. Methodologically, constructivists believe in subjecting the known (always a human construct) to ongoing scrutiny in order to generate as much consensus amongst researchers as possible. The aim of research is to minimise illusions and to interpret the subjective opinion of various researchers to create (non-generalisable) results. The constructivist methodologies emphasise richness of observation, the insider view and the importance of contextualised inquiry (*see* Table 4.1). (Guba, 1990; Denzin and Lincoln, 2000; Wass and Wells, 1994; Easterby-Smith *et al*, 2002)

Since its emergence as an academic discipline in the late 1950's, logistics has been dominated by positivist/quantitative research approaches (Bowersox, 1969; Mentzer and Kahn, 1995). In a recent study, Burgess *et al* (2006) cite the presence of very strong positivist paradigmatic stances in the methods employed within the domain of supply chain management. Nevertheless, more recently, an increasing number of authors call for more diversified methodologies emphasising the value of contextualised and qualitative modes of inquiry (Burgess *et al*, 2006; Gammelgaard, 2004; Arlbjorn and Halldorsson, 2002; Näslund, 2002; McCutcheon and Meredith, 1993). As illustrated in Figure 4.1, positivism and constructivism are two extremes in the research philosophy debate. This thesis belongs to a middle-ground paradigm, i.e. critical realism. Critical realism, also referred to as post-positivism or realism, to some extent reconciles the view points of positivist and constructivist camps (Wass and Wells, 1994). Unlike constructivism, the critical realist paradigm assumes that reality exists independent of the subjective consciousness of researchers. However, it argues that the experience of truth is only through subjective consciousness of the researcher; hence reality can never be fully apprehended. Critical realism recognises the importance of the context of research. It questions the notion of determinism and that of general scientific laws; laws are tendencies which only partially explain human actions and are not deterministic. From an epistemological perspective, critical realism aspires to objectivity; however, it admits that objectivity can only be approximated since the truth is always seen through

the subjective lens of the individual inquirer. Methodologically, critical realism is different from both positivism and constructivism since it places greater emphasis on the context of the study while recognising the importance of reducing subjectivity. Critical realism achieves reduced subjectivity through triangulation and use of multiple research techniques. (Wass and Wells, 1994; Denzin and Lincoln, 2000; Guba, 1990)

As illustrated in Table 4.1, critical realism allows for investigation of both universal laws and situational solutions. It encourages context rich analysis while applauding objectivity through triangulation. The thesis is a multi-disciplinary research by its nature requiring attention to context and rigorous measurement at the same time which makes the researcher's paradigmatic stance very suitable. Section 4.3 discusses research strategies deployed (i.e. case study) and explains how they are associated with critical-realism (Figure 4.1). Then, Section 4.4 discusses the research techniques and triangulation approaches, e.g. in a single case study observation and empirical data collection are used alongside interviews and secondary data to reduce subjectivity.

4.3 Research Strategies

Research strategy is a general plan of how the researcher intends to go about data collection, interaction with the research environment and answering the research questions (Saunders *et al*, 2000). A research strategy encompasses one or more data collection techniques, e.g. questionnaire, interview, etc. There is a whole suite of research strategies out there for the management researcher to select from. The choice of research strategy is as much driven by the researcher's philosophical underpinnings as by the research objectives and the type of research questions posed. Table 4.2 gives an overview of some widely accepted strategies in the domain of business and management.

Table 4.2. Taxonomy of Research Strategies in Business and Management

Strategy	Outline and Key characteristics
Survey	The survey method is usually associated with positivism and the purely deductive cycle of inquiry (<i>see</i> Table 4.1 and Figure 4.1). The notion behind carrying out survey is that certain characteristics of a carefully selected sample can be analysed to find general rules pertaining to the entire population. Survey is one of the most common strategies in logistics and operations management. Data is normally collected through questionnaires. Unlike qualitative methods which look at a wide range of issues, evidence collected by a survey is limited to the intended measures which are often NOT context specific. (Saunders <i>et al</i> , 2000; Easterby-Smith <i>et al</i> , 2001)
Action research	<i>see</i> Section 4.3.2
Case study	<i>see</i> Section 4.3.1
Grounded theory	Grounded Theory (Glaser and Struass, 1967) has widely been used in the management literature in the recent decades. Grounded theory is a set of systematic inductive guidelines for comparing and analysing data to generate middle-range theoretical frameworks that can best explain the collected evidence (Charmaz, 2000). In grounded theory, data collection and analysis proceed simultaneously. Moreover, the starting point of research is raw data rather than preconceived logically deduced theories (Easterby-Smith <i>et al</i> , 2001). Since Glaser and Strauss conceived of grounded theory in 1967, their view points have significantly diverged causing many arguments about the validity of each standpoint. Glaser remains closer to the positivist school of thought by arguing that the aim of grounded theory is to generate theory through analytical comparison of data with data and not to verify theories. His point is consistent with the positivist canons that verification depends on random sampling (Charmaz, 2000). On the other hand, Strauss and his co-author Corbin (Strauss and Corbin, 1998) offer the significance of conceptual ordering and elaborate description for theory development. Moreover, they allow for familiarisation of the researcher with prior research to assist with the process of theory generation and conceptual ordering, whereas Glaser (1978) calls for abandonment of pre-suppositions and strict use of comparative methods.
Delphi	Delphi research strategy involves series of iterative surveys (by means of questionnaire, interview, anonymous focus groups, etc.) for obtaining the consensus opinion of a group of experts (Powell, 2003). Delphi exercise is particularly useful where there is lack of consensus over an issue or as an intermediary strategy for refinement of the research ideas (Saunders <i>et al</i> , 2000). Delphi can be deployed within both positivism and constructivism.
Ethnography	Ethnography is firmly rooted in the constructivist paradigm (Saunders <i>et al</i> , 2000). Ethnographers immerse in the context of the research object to obtain rich insider observations and often use anecdotal methods of reporting. Unlike the action researcher, the ethnographer does not aim to bring about change or improvement. (Denzin & Lincoln, 2000)

(Source: Author)

Figure 4.1 illustrated the overall alignment of these strategies to positivism and constructivism. It must be noted that such affinities are not prescriptive and vary under different circumstances. Those strategies mentioned in Figure 4.1 are outlined in Table 4.2 except for experimental research which is deemed not relevant. Moreover, case study and action research are singled out to be discussed at length in Sections 4.3.1 and 4.3.2. That is because case study research strategy has been adopted for the thesis and that the research design shares many characteristics with action research. Section 4.3.3 then develops the linkages between the two strategies further by broaching the concept of *Mode 2* knowledge creation.

4.3.1 Case Study Research Strategy

Case study can be defined as an empirical mode of inquiry for development of rich, detailed and contextual knowledge about a single case. Different schools of thought have different takes on case study research. Whilst offering a somewhat different interpretation of generalisation in the form of analytical generalisability, Robert Yin (2003) is in favour of the positivist criteria for assessing case study research rigour, i.e. validity, reliability and generalisability. On the contrary, Stake (2000) rejects generalisability of case study findings on the grounds of the constructivist paradigm. Stake (2000) criticizes the scientific community for lack of interest in “*intrinsic case study*”. Furthermore, the positivist case study researchers (Yin, 2003 & 2000; and Eisenhardt, 1989) advocate a degree of researcher independence from the case to ensure objectivity, while for the constructivist proponents of case method (Stake, 2000; Näslund, 2002) case study is more about the object being studied than a methodological approach. The constructivist approach to case study represents a somewhat higher level of attention to and involvement with the knowable (i.e. the case itself). Unlike, the critical realist and constructivist proponents of case study method, Yin (2003) contends that a hypothesis – in the form of a presumed causal relationship – should be stated in advance and be subjected to empirical research to find analytically generalisable results. As illustrated in Figure 4.1, Saunders *et al* (2000) take case study to be aligned with critical realism. It is the belief of this author that case study can be generally presented against a spectrum of research philosophies as illustrated later in this chapter but best identified with critical realism in this thesis.

According to Yin (2003), case study does not address universal forces; case study understandings come from immersion in and holistic regard for the phenomena. As opposed to survey research strategy which is suitable for answering ‘what’, ‘who’ and ‘where’ research questions, case study research is particularly suitable for answering ‘why’ and ‘how’ questions when researching contemporary phenomena in their real life contexts (Yin, 2003). Both research questions in the thesis are how questions. Yin (2003) contends that when producing, extending or verifying universal and situational laws is the aim of research (or any form of knowledge creation) case study method is often disadvantaged. However, when the aim of research is to understand and extend experience about a contingent, contextual and complex *process*, then case study with practical objectives is the method of choice.

Notably, case study approach is akin to processual research. As discussed in Chapter 2, processual research explains how and why processes unfold over time. Section 2.3.3 stipulated a set of features for processual inquiry, i.e. contextual mode of analysis, unravelling the temporal interconnectedness of phenomena, addressing the role of human agency in the system and holistic understanding of the situation. Case study strategy possesses all these characteristics; hence demonstrating a true systems approach as a method of inquiry. Moreover, it is suitable for understanding situational fit-performance contingencies, i.e. finding the most appropriate managerial actions for specific situations. To summarise the following factors have influenced the author’s choice of research strategy:

- Alignment with the researcher’s paradigmatic stance (i.e. critical realism).
- Attention to the context of the research and contextual conditions being highly important to supply chains in study.
- Attention to the process of change and case study’s ability to address the temporal interconnectedness of phenomena as well as the role of human agency.
- Suitability to the research questions, i.e. how questions.
- Case study’s ability to emphasise the practical implications of the findings. This is a key feature of case method which is further discussed in the following.
- Finally, the research access was very suitable for carrying out case studies, i.e. the very nature of the projects that the author was involved in lent themselves to case study strategy.

Adopting a critical realist approach to case study means that the thesis does not reduce the method to a – positivist – experiment for testing the validity of a presumed causal linkage (i.e. a hypothesis). Nonetheless, similar to Yin (2003) the author believes that a *theoretical framework* helps in design and conduct of case study research though it need not be a causal hypothesis as suggested by Yin (2003). The hypothesis for this research is discussed in the next section. Case study is an inherently flexible mode of inquiry where the scope can be broadened and the focus shifted, during research, if necessary. However, it clearly cannot be thought of as a casual exercise. Far from it, case study requires clearly stated academic goals, robust theoretical base, well grounded data collection and analysis protocols, and carefully selected research objectives (McCutcheon and Meredith, 1993). The goals of this research are presented through research questions and the data collection protocols set out below (Section 4.5).

It was mentioned that case study approach is researching phenomena in their real life contexts and interested in practical implications of the findings. Some believe that in case studies the researcher *normally* has little control over phenomena (Yin, 2003; Stake, 2000). Nonetheless, although the researcher does not necessarily require control, having influence over phenomena does not preclude case study choice of research strategy. In this thesis the researcher could have to some extent influenced the process of change by playing the role of an active facilitator (or teacher) in each case study. However, it is worth mentioning that the degree of influence has not been such that it could be said agents' behaviours were manipulated. The issue of active participation in the process of change requires further delineation from a methodological point of view as follows.

4.3.2 Action Research Strategy

Action research is a rather broad term used to describe academic research with practical orientation (Easterby-Smith *et al*, 2002). It is the process of identifying, analysing, tackling and redefining problems in a practical context. The action researcher is intent on contributing both to advance the academic boundaries of knowledge and to the practical concerns of organisations; the former is the product of studying the latter. Action research was initially introduced by Kurt Lewin as a strategy for research leading to industrial and social action. In Lewin's theory the researcher participates in

the process of change as a *facilitator, catalyst or agent* (Lewin, 1946). During study of the change process the researchers examine various intervention techniques and refine their learning in a continuous plan-do-check-act cycle. What differentiates action research from other types of problem solving and pure consultancy is the attention to theory guided intervention, continuous refinement of methodologies and techniques, transparent communication and documentation of the research protocols (consultants tend to hide this as their core competency) as well as epistemological considerations. (Kemmis and McTaggart, 2000; O'Brien, 1998; Checkland, 1999)

Normally, the role of the investigator is to facilitate the process of change, to understand the problem and the solutions, and to translate their understanding into academic knowledge. Although contribution to knowledge is through observation and facilitation of the change process, academic reporting of the findings and academic contribution remain the prime objective. There is a continuum of action research from positivist (Easterby-Smith *et al*, 2002; McCutcheon and Jurg, 1990) to constructivist (Kemmis and McTaggart, 2000; Näslund, 2002). In terms of cycle of inquiry, action research is akin to critical realism, i.e. inductive/deductive iterations (Table 4.1). In this thesis action research is presented as a research strategy which falls between positivism and constructivism aligned to critical-realism similar to McCutcheon and Jurg (1990) and Checkland's (1999) take on action research. Checkland (1999) contends that criteria for judging the quality of action research falls in between positivism (repeatability and generalisability) and constructivism (generally plausible social science) and that "*action research should be conducted in such a way that the whole process is subsequently recoverable by any one interested in critically scrutinizing the research. This means declaring explicitly, at the start of the research, the intellectual frameworks and the process of using them which will be used to define what counts as knowledge in this piece of research*" (p. A39).

As evident in the above, there are implicit linkages between case study and action research. Both methods are aligned with critical realism and produce rich, contextual knowledge about single cases. Where action research and case study greatly overlap is in attention to the context of research and more precisely in the soft systems approach to systems analysis. As discussed in Chapter 2, soft systems approach is suitable for social systems where the researcher should be seen as an active participant in the system being

studied or changed. Checkland (1981, p.153) contends that “*when the phenomena under study are social interactions the researcher will find it almost impossible to stay outside them [... the researcher] has to be prepared to react to whatever happens in the research situation*”. In Soft Systems Methodology, action research and case study the phenomena under study (could be change itself) are not separated from the context in which they occur.

However, the key difference between action research and case study is that in action research the actual process of change becomes the main subject of research while case study’s clear objective is the conduct of research and not – necessarily – effecting the change process (Benbasat *et al*, 1987). In this thesis each case study represents a change process. While the focus of research is on the research questions the process of change and the practicalities of the end results are inevitably reflected in the reports (Chapters 6 and 7). Moreover, the conduct of research is of a participatory nature. Therefore, it was necessary to pay particular attention to the characteristics of action and participatory research. The following sheds more light on research of practical nature discussed under the general title of *Mode 2* knowledge creation. It explains the way case study method can be interpreted as a subset of *Mode 2* knowledge generation.

4.3.3 Mode 2 Knowledge Generation and Practical Research

According to Denzin and Lincoln (2000, p.17) “*more action, participatory and activist oriented research is on the horizon*”. The quest for grand theories is being “*replaced by more local, small scale theories fitted to specific problems and particular situations*” (p.17). The role of the researcher is rapidly changing from a detached observer to a much more involved player, especially in the domains of science, technology and management. This represents an epistemological shift rather than a paradigm change, i.e. calling for closer interaction between the knower and the knowable. In fact, some argue that participatory research strategies may belong to either sides of the research paradigm debate (Easterby-Smith *et al*, 2002; McCutcheon and Jurg, 1990).

The author believes that a whole different dimension needs to be introduced into the research methodology debate taking account of those strategies which engage in addressing the practical problems of the industry. Notably, “*a great deal of the*

knowledge creation, currently underway, is of this kind" (Garnsey, 2003 p.5) including most supply chain management research. A number of authors have pointed out that such understanding has not been explicit in the management literature in general and operations and supply management in particular (Näslund, 2002; McCutcheon and Meredith, 1993; Tranfield and Starkey, 1998). The following introduces and elaborates on *Mode 2* knowledge creation (Gibbons *et al*, 1994) as a generic concept for knowledge generation associated with case based, action and participatory research. Mode 2 is a term coined by Gibbons *et al* (1994) who proposed that the significant shift, in the recent years, away from fundamental principles and universal theories towards more local, practical and contextualised types of research warrants a new identity: *Mode 2* knowledge generation as opposed to mode 1 for conventional knowledge creation. In their landmark contribution, Gibbons *et al* (1994) suggested that *"the production of knowledge has advanced into a new phase"* (p.19). Gibbons *et al* (1994) define Mode 2 knowledge production as an integrated process of discovery, application and problem redefinition. Presently, the most sought after knowledge producers are characterised by their influence in transforming academic knowledge into applications for resolving practitioners' problems and the ability to translate practitioners' recurring problems, as well as their respective solutions, into academic theories (Adler *et al*, 2000). Although Gibbons *et al* (1994) attach no value to either modes of knowledge, they do assert that Mode 2 *"occur most frequently in those areas which currently define the frontier and among those who are regarded as leaders in their various fields"* (p.1).

Gibbons *et al* (1994) stipulate a set of attributes which characterise Mode 2 as a separate entity from the conventional methods of knowledge creation (or Mode 1). To summarise, *"Mode 1 [research] problems are set and solved in a context governed by the, largely academic, interests of specific community. By contrast, Mode 2 knowledge is carried out in a context of application. Mode 1 is disciplinary while Mode 2 is trans-disciplinary. Mode 1 is characterised by homogeneity, Mode 2 by heterogeneity. Organisationally, Mode 1 is hierarchical and tends to preserve its form, while Mode 2 is more heterarchical and transient. Each employs a different type of quality control. In comparison with Mode 1, Mode 2 is more socially accountable and reflexive. It includes a wider, more temporary and heterogeneous set of practitioners, collaborating on a problem defined in a specific and localised context"* (Gibbons *et al*, 1994 p.3). Heterogeneity here means that the research entities are loosely institutionalised and

researchers come together in temporary networks which may dissolve as soon as the research problem is solved or redefined.

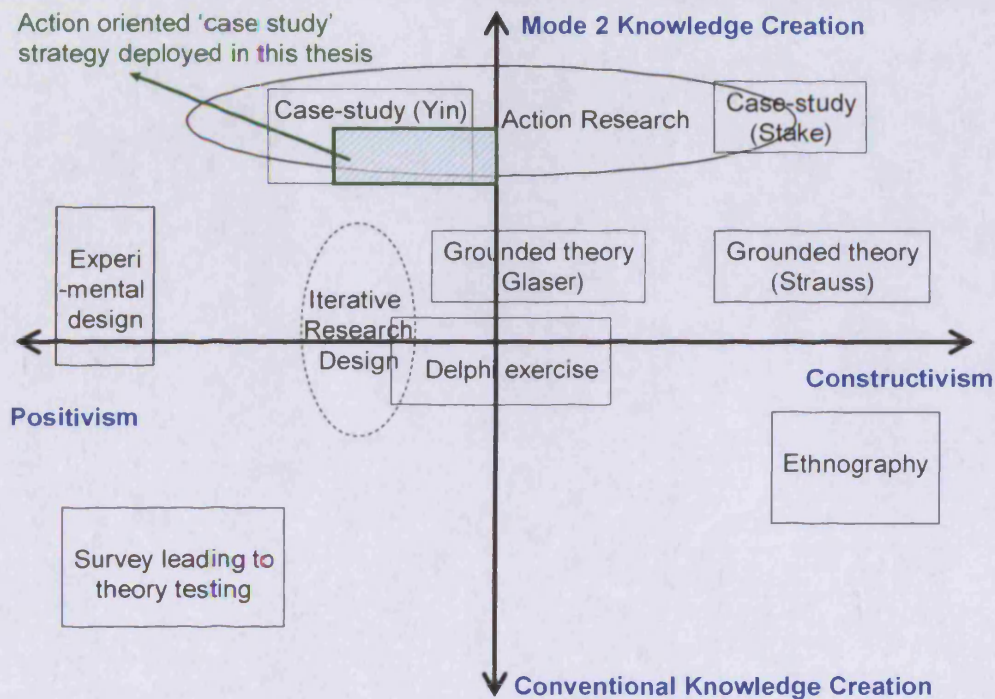


Figure 4.2 Key Dimensions of Research Methodology in Management

(Source: Author; also see Easterby-Smith *et al*, 2001)

Figure 4.2 captures the proposed added dimension of research methodology (i.e. level of practice orientation of research) into a new framework. Figure 4.2 represents a mapping exercise drawing on the works of Easterby-Smith *et al* (2001) and Gibbons *et al* (1994). Research strategies in this model are mapped against two proposed key dimensions of research methodology. The first dimension is the well-known positivist vs. constructivist dichotomy. The second proposed category however adds a whole new dimension allowing for much deeper attention to participatory and action oriented research. The research strategies adopted in this thesis are pinpointed on the model, i.e. towards the practical end of the vertical dimension and in the middle across the horizontal vector. Burgess *et al* (2006) carried out a survey of SCM literature showing that 97% of contributions adopt a functionalist paradigmatic stance (which is aligned

with positivism). It also demonstrates that 31% adopt case study method while 23% employ empirical statistical strategies (i.e. surveys), 0% experimental design and 46% conceptual literature (no data collection strategy).

As discussed there is a continuum of action research and case study strategies from positivist (Easterby-Smith *et al*, 2001) to constructivist (Kemmis and McTaggart, 2000; Näslund, 2002). However, action research invariably falls under Mode 2 while it is less so for case study. Clearly case researcher could be less interested in practical implications of the study. Altogether, one could rightly argue that action research and case study method are the key strategies for Mode 2 knowledge generation. As mentioned in Section 4.3.1 this thesis adopts a critical realist approach to case study strategy with many characteristics of Yin's (2003) approach. Figure 4.2 clearly marks this strategy adopted in this thesis using the term 'action oriented case study strategy' to emphasise the linkages with action research. Since action research is a broad term, the research is illustrated as a subset of action research. Moreover, the strategy is a subset of action research since it reports on the findings from improvement exercises aiming to resolve real-world supply chain issues in the UK agri-food sector. As illustrated the research strategy is aligned with critical-realism but slightly gravitated towards positivism. This is due to using a theoretical framework in the design and conduct of case studies as proposed by Yin (2003). The key focus of case studies is on the study of *processes* in their contingent and specific contexts as opposed to situational analysis. As discussed in the above action research is intimately connected to process theory and systems thinking (Checkland, 1999; Näslund, 2002; van de Van, 1992). Appendix D provides further explanations about various research strategies mapped in Figure 4.2.

One of the key characteristics of Mode 2 knowledge generation is that the researcher adopts a processual analysis approach as opposed to variance analysis (Garnsey, 2003). Processual analysis, as mentioned in Chapter 2, looks at the causes and effects of events which form a process within the context of a system. Process theory is in stark contrast with the conventional logic of neo-classical economics which measures and studies the outcomes of the process – often by using variance analysis⁶ – to compare states of the

⁶ The author uses variance analysis in a broader sense than just statistical variance analysis. It refers to situations where the outcome of a process is compared against a previous state regardless of what went on in the interval.

system before and after a given process has taken place. *“A theory of process consists of statements that explain how and why a process unfolds over time”* (van de Van, 1992 p.174). The lower-left quadrant of Figure 4.2 embodies variance analysis strategies. For example many management researchers carry out survey of relatively large populations and do statistical analysis on the results to test given hypotheses about a presumed causal link. *“Variance analysis is an approach well suited to mature fields where it can be used for theory testing. It is less useful for building theory in new areas. Variance analysis tends to draw inferences from observations of large numbers of units, while process analysis tends to generalise from detailed study at the micro-level”* (Garnsey, 2003 p.12). According to Denzin and Lincoln (2000) process analysis should precede point analysis of variables in terms of importance.

4.4 Research Structure and Data Collection Approaches

Research design is the logic that links data to be collected and conclusions to be drawn with the research problem and research questions. An overview of the structure of this study has already been provided in the first chapter (Figure 1.1). This section further explains the methodological aspects of the research design, reiterates the research questions in the light of case study approach and discusses the data collection techniques deployed at each stage of the thesis. The wider research environment and the context of the UK agri-food industry are discussed in Chapter 5.

The scope of the study, the research problem and the literature gaps were discussed in Chapters 1, 2 and 3. As illustrated in Figure 4.3 (which is an expanded version of Figure 1.1), the overall structure and process of learning in this thesis represents a cyclic learning model consistent with the plan-do-check-act cycles of continuous learning (Imai, 1997) consistent with soft systems methodology and process theory (it was discussed in Chapter 2 that systems thinking will inform both methodology and data collection). Moreover, the following explains that there are iterative learning loops in data collection and analysis, for example the four case studies presented in Chapter 6 build on the findings of each other. The iterative learning between case studies in Chapter 6 is highlighted in Figure 4.3 with dashed lines.

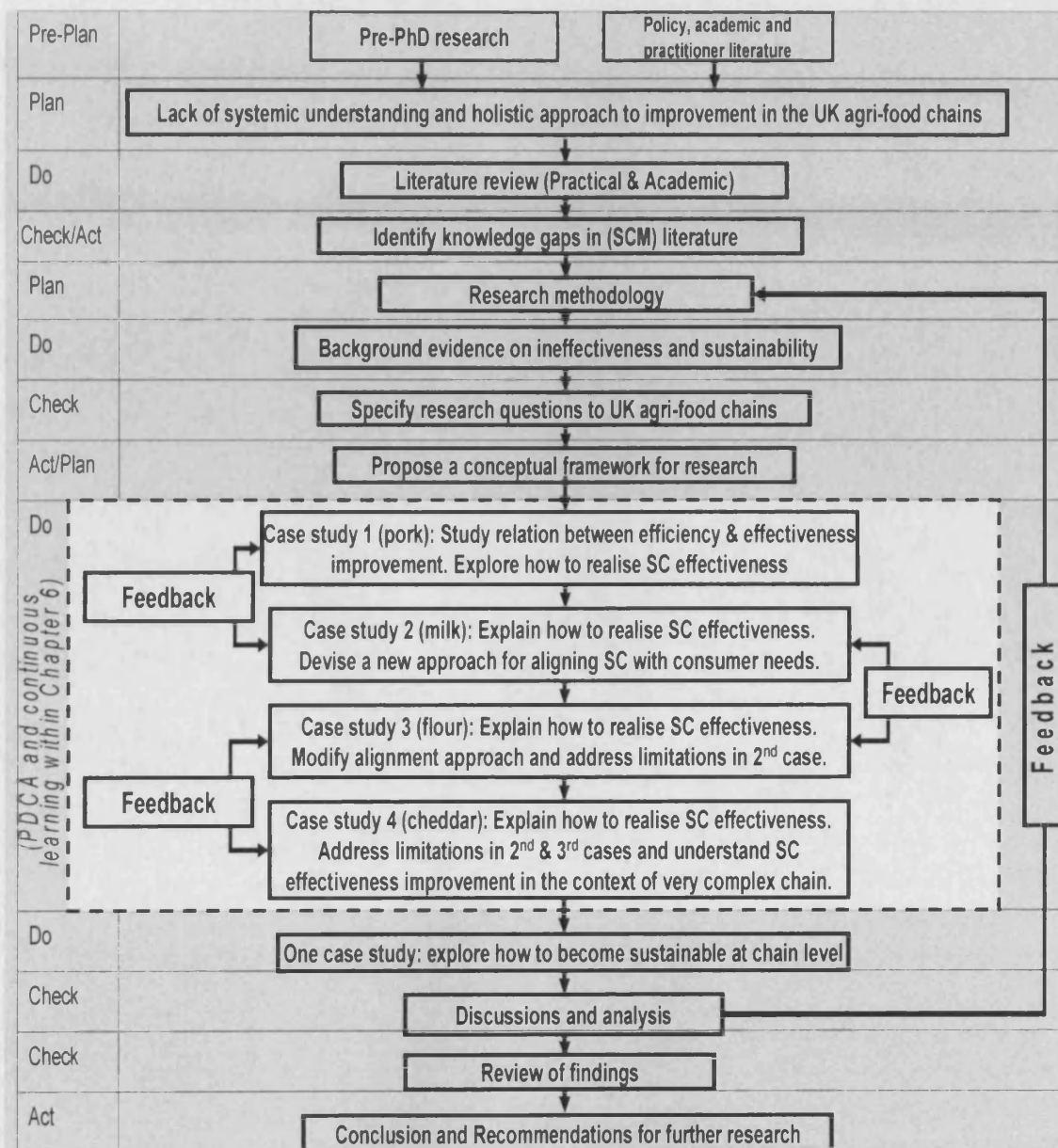


Figure 4.3 Research Structure

(Source: Author)

Broadly speaking, the thesis consists of two iterations. Figure 4.4 illustrates the first iteration of research beginning with the research problem which informs the literature review and the literature review which leads to the identification of two gaps in the body of knowledge. These gaps are then contextualised in Chapter 5 which verifies the gaps' relevance and focuses the study to the UK agri-food sector. This is a deductive cycle or theory testing. The first iteration ends with the proposition of a conceptual model and laying down a theoretical framework with refined research questions for the

second iteration representing an inductive cycle or theory building. Figure 4.5 shows the second iteration which again begins with a deductive cycle, i.e. empirical case study research into the theoretical framework laid down in literature and contextual research. Then the case study findings are discussed and analysed concluding in conceptualisation of the findings and recommendations for further research in Chapter 8.

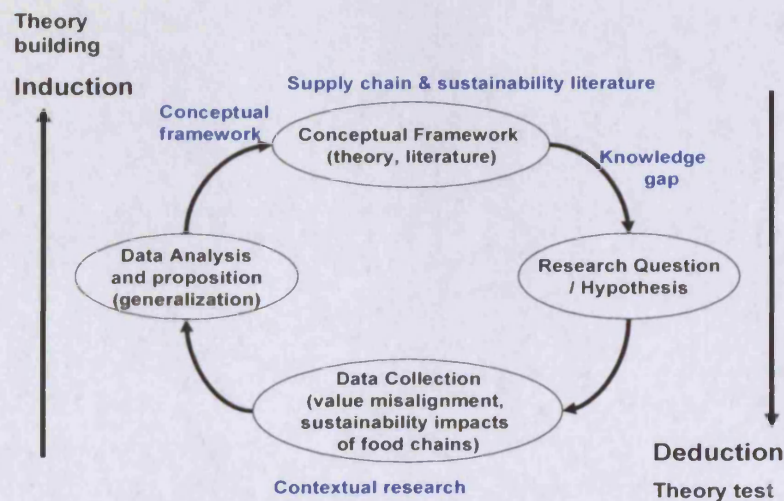


Figure 4.4 The First Iteration of the Thesis: Induction - Deduction Process
(Source: Author)

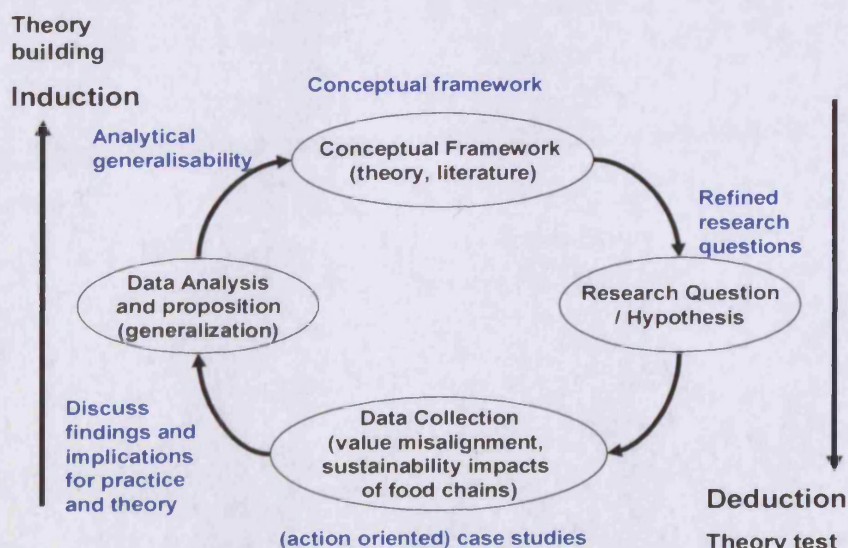


Figure 4.5 The Second Iteration of the Thesis: Induction - Deduction Process
(Source: Author)

Having defined the research structure and its iterations, the following discusses the case study design and data collection techniques. The thesis adopts a multiple case study research approach. The four main components of case study design are discussed below (*adapted from Yin, 2003*):

1. Research questions: the literature review identified two gaps in the body of knowledge which in turn inform the areas of contribution of the thesis. A research question was set against each gap. The contextual research in Chapter 5 makes the connection between the gaps in the general body of SCM knowledge and the UK agri-food sector. Both questions are how questions therefore a case study strategy is suitable. Moreover, the research questions by their very nature require observation of and even engagement in the process of change which makes them apt for Mode 2 knowledge generation approach.

Research question 1) How can the effectiveness of the UK agri-food supply chains be enhanced, without compromising their efficiency? This question can be rephrased as: how can the effectiveness of the UK agri-food chains be improved at the same time as retaining and maximising efficiency?

Research question 2) How can the environmental sustainability of the UK agri-food supply chains can be improved without compromising their economic efficiency and effectiveness? This question can be rephrased as: how can the environmental and economic (both efficiency and effectiveness) aspects of UK agri-food supply chains be analysed and improved simultaneously? That is, finding practical approaches for improving sustainability of chains while being economically competitive.

2. Research propositions: the theory framework for this thesis follows from the literature review summarised below:

- i. True systemic improvement of supply chains requires going beyond efficiency to address issues of consumer value. Moreover, it requires improving environmental sustainability of chains without compromising the chain's economic performance.
- ii. Consideration of supply chain effectiveness and sustainability alongside conventional supply chain management (efficiency) issues leads to systemic improvement of chains.

- iii. It is also implicit in the research questions and preceding discussions that the author is suggesting that the existing supply chain theories, concepts and techniques, which are by and large efficiency focused, can be used or extended to improve effectiveness and environmental sustainability of supply chains, tested through case studies.

The theoretical propositions of the thesis are summed up and operationalised in research questions. According to Yin (2003) laying down a theoretical framework helps in design and conduct of case study research; however, the theoretical propositions need not to necessarily be in the form of a cause and effect hypothesis as suggested by positivist methodologists such as Yin. The theory framework guides as to what type of evidence the researcher should look out for, where to look for the relevant evidence and helps with clearer understanding of the results. It also explains the relationship between the gathered information and serves as a vehicle for generalisation of the findings. This is what Miles and Huberman (1984) regard as the role of pre-existing theoretical frameworks in bounding and focusing the research. It must be noted that while causal hypotheses can lead to better analytical generalisability, overemphasizing analytical generalisability detracts from the richness of data and attention to the case itself. *The aim of the ensuing case studies is not simply to test hypotheses as in positivist experiments but more to develop knowledge around the proposed theoretical framework and explain how and why supply chain effectiveness and sustainability can be improved alongside efficiencies in a truly systemic approach.* Therefore, the findings are analytically generalisable though statistically non-generalisable.

3. Units of Analysis: the unit of analysis is the supply chain (each case study discusses a supply chain) and sub-units of analysis are efficiency, effectiveness and global warming potential of the products analysed in each case study (that is because sustainability is looked at from an environmental perspective and environmental sustainability is examined from the point of view of global warming only).

4. Linking the data to the propositions and interpreting the findings: this component foreshadows analysis of the case study evidence. Where a causal proposition is laid down – such as in positivist experiments – pattern matching is clearly the best way of linking case evidence to the propositions for confirming correctness or concluding incorrectness of the propositions. A good example of pattern matching

multiple case study design is presented in Simons and Zokaei (2005). Cause and effect propositions represent a very high degree of specificity. However, in this thesis the research proposition falls midway between exploratory and confirmatory frameworks requiring *explanatory* research about ways of systemic improvement of UK agri-food chains. A study which establishes cause and effect between variables within a case can be regarded as explanatory (Saunders *et al*, 2000). In positivism explanation should demonstrate causality (often on a grand scale) whereas in critical realism – and therefore in this thesis – the aim is to explain the linkages between variables within the context of the case and to explain the contingent fit-performance relationships (Easterby-Smith *et al*, 2001). For example, the four case studies in Chapter 6 *explain* how effectiveness of the UK agri-food chains can be improved. Therefore, the thesis is *explanatory* for the main part (four case studies). Comparing and contrasting the results of the four cases makes it possible significantly to develop knowledge about the propositions and to test them where testing is needed. On the other hand there is one case study in Chapter 7 based on empirical evidence. The aim of this case study is to *explore* how sustainability of the UK agri-food chains can be improved at the same time as retaining and maximising their economic performance. Therefore, the thesis is *exploratory* when it comes to the second research question. The reason being that the second research question is much broader and less mature requiring a great deal of empirical work which falls outside the remit of this study. As explained in Chapters 2 and 3, the body of knowledge around the second research question is in its infancy.

There are certain advantages with multiple case study design as opposed to single case study design. Firstly, findings from multiple cases are often considered more compelling. Moreover, there is an opportunity to replicate the results in different settings, e.g. cases 2, 3 and 4 in Chapter 6 are replicas to test the validity of the findings and to shed light on their analytical generalisability. Thirdly, theories could be tested / developed under different conditions and the role of case specific contingencies could be investigated. Five cases have been carefully selected for this thesis together representing a *purposive sample*. The choice of case studies has been derived on the basis of the features or processes that the researcher needs to study according to the research questions, i.e. explaining how chain effectiveness and environmental sustainability can be improved in the context of agri-food chains. Denzin and Lincoln

(2000) note that a purposive (qualitative) sample involves seeking out the groups, settings and individuals where the processes to be studied are most likely to occur. Similarly, Saunders *et al* (2000) argue that a purposive sample enables the researcher to select cases that will best enable the answering of the research questions and to meet the research objectives. Yin (2003) cautions that in a purposive sample the case selection logic is fundamentally different from statistical sampling where a representative sample of the total population is sought.

Each case study reported in the thesis draws upon the theoretical frameworks as well as the findings from the earlier cases. Figure 4.3 shows the feedback loops between cases and describes the fact that each case study addresses the limitations of the previous ones. The iterative and evolutionary nature of the data collection and analysis is further discussed and explained in Chapters 6, 7 and 8. In each case study a number of different data collection techniques are deployed. Both quantitative and qualitative data have been collected; however, most evidence were quantitative obtained through direct observation such as mapping of technical operations and operators by walking the end-to-end processes. Yin's approach names three sources of evidence which can be deployed in collection of first hand evidence, i.e. direct observation, participant observation and physical artefacts. In this thesis observations of both physical processes and operators have been used. Moreover, in all five case studies secondary data have been obtained for example by collecting archival measures about certain operations' performance. In order to reduce subjectivity, the mapping exercises deploy a variety of data collection techniques in each case study (triangulation of methods).

Case study strategy by default requires the researcher to document their data collection protocol and techniques. According to Yin (2003) case study protocol contains the purpose of case studies, schedule for doing case studies and field work procedures. In this thesis the researcher deployed a standard protocol referred to as the '10 Days Value Chain Analysis' method (Francis, 2004; Taylor, 2005) which is discussed in length in the following chapter. It is notable that the researcher was flexible in implementing the protocol and in adapting data collection techniques; it was discussed in Section 4.3.1 that case study is an inherently flexible mode of inquiry where the scope can be broadened and the focus shifted, if necessary, during the research. Prior to this study

whenever researchers have employed value chain analysis and improvement protocols they have remained squarely focused on efficiency aspects of chain improvement. One of the contributions of this research is to demonstrate that the existing body of knowledge, containing various supply chain improvement approaches, can be extended to include supply chain effectiveness (this will be discussed in Chapters 6 and 8). The thesis also explores ways of extending the boundaries of knowledge to address environmental sustainability in the context of supply chain analysis and improvement.

Another data collection technique deployed in this thesis is *qualitative interview* (Bryman, 1989). Interviews are often used as part of other research strategies such as case study or sometimes as a standalone research approach (Saunders *et al*, 2000). Interview technique can be structured, semi-structured or unstructured; they can be face-to-face or telephone/internet based (Fontana and Frey, 2000). Bryman refers to unstructured and semi-structured interviews collectively as qualitative interviews. Interview is *not* the main data collection instrument in this thesis; the case studies are largely based on observational data and mapping of the participating firms. However, as an exception, a single semi-structured interview is presented in Chapter 6 as part of the fourth case study where the author used a guide, as an aide memoir, to prompt discussions with the interviewee as will be further discussed in Section 6.5.

4.5 Research Rigour

Research rigour or goodness of research can be looked at from two different perspectives, i.e. methodological and epistemological rigour. Methodological rigour is about the right fit between the research strategy, the data collection techniques, the research questions and the operative paradigm or researcher's inadvertent presumptions. Table 4.3 compiles the key criteria often considered for methodological rigour of both positivist and critical realist inquiries (Easterby-Smith *et al*, 2001; Lincoln and Guba, 2000; Yin, 2003). While positivist and critical realist paradigms deploy totally different interpretation of these criteria, constructivist studies generally opt for different set of criteria (Lincoln and Guba, 2000). Table 4.3 discusses the (methodological) rigour of the case studies presented in Chapters 6 and 7 using a critical realist interpretation. According to Yin (2003) objectivity (also referred to as construct validity) is the most

critical criterion of all for case study research. Objectivity is concerned that subjective judgments do influence data collection and that selective data will not bias the results. In this thesis the researcher uses various tactics to build-in objectivity. First and foremost is triangulation of multiple sources of evidence such as different process mapping techniques, data analysis and interviewing (both qualitative and quantitative data collection techniques are deployed). Critical realism emphasises the importance of the context of the research whilst recognising the significance of reducing subjectivity through triangulation. Secondly, the project participants had the chance to review at least two draft reports for each case study and to express their opinion on the content. Moreover, other key industry informants such as industry body representatives and academic experts reviewed the case study reports (in confidence) in all five case studies. Thirdly, the preceding chapters clarified the types of operational measures and evidence needed to be collected, i.e. supply chain effectiveness in Chapter 6 and global warming potential in Chapter 7.

Internal validity is concerned with whether the findings are really what they appear to be. In other words, internal validity is concerned with ensuring that cause and effects are correctly identified and that there are no other plausible alternatives. It was explained that case studies in Chapter 6 aim to explain how supply chain effectiveness can be improved while paying specific attention to the context of the study and the specificity of each setting. In Chapter 6, for example, one internal validity concern is whether effectiveness has been improved due to the fit-performance relationships explained by the case study or due to other reasons or even by accident. In order to guarantee internal validity each case study deployed a team of expert participants to obtain different viewpoints (Yin 2003; Eisenhardt, 1989).

External validity is concerned about the extent to which the research findings are generalisable beyond the immediate case. In fact, case study strategy has been challenged by proponents of positivism on the ground of lack of generalisability. On the other hand, the constructivist approach to case study altogether rejects generalisability beyond context (Stake, 2000). However, the critical realist approach to case study research suggests that while case study research is not interested in the implications of the findings for the entire population or quantitative generalisation of the results, the findings of a single case (or multiple cases) can be *analytically generalised* to induce

broader theories. Analytical generalisation means that the investigator is generalising specific and contextual findings by linking them to the theoretical propositions summarised in Section 4.4 (i.e. linking to some broader theory) and by developing new insight about ways of improving effectiveness and sustainability of agri-food chains. Moreover, in Chapter 6, the findings are replicated across four case studies to shed more light on analytical generalisability of the findings in different settings. All in all, internal validity is more critical in case study research than external validity. In the words of Bryman (1989) “*case studies should be evaluated in terms of the adequacy of the theoretical inferences that can be generated. The aim is not to infer findings from a sample to a population, but to engender patterns and linkages of theoretical importance*” (p. 173).

Reliability is concerned with reproducibility of the findings. The objective is to be sure that if a later researcher followed the same procedures described in case studies in the *same setting* and under the *same conditions* they will arrive at the same conclusions. This is different from replicating the procedures in a different case and concluding differently, e.g. a different supply chain might be more apt in adopting recommendations for consumer value enhancement. The thesis achieves reliability by standardisation and documentation of the data collection protocols and adhering to the procedures. All mapping exercises and calculations during the data collection phase were conducted in such way that they are capable of being audited by other members of the research group or external investigators. Moreover, several reports and scores of various documents were produced and recorded rigorously. The research protocol and procedures are explained in Chapter 5.

It was discussed that research rigour can be looked at from methodological and epistemological stand points. Epistemological rigour concerns the rigour of the relationship between the researcher and the research object. For example criteria for judgment of the quality of participatory or Mode 2 type research include *extreme relevance* (Näslund, 2002) as Mode 2 inquiries by default aim to satisfy the needs of the practitioner world as well as creating academic knowledge. According to Kemmis and McTaggart (2000) participatory research is a form of insider research in which participants move between an outsider position looking at the events in a detached and objective manner and an insider position becoming much more attached to the research

settings (even influencing and being influenced by the research object). They argue that researchers' insider position is so valuable in terms of gaining contextual, practical and highly relevant knowledge that it warrants the term '*epistemological rigour*'. Therefore, epistemological rigour can be defined as the level of involvement of the knower with the knowable and the ability of the researcher to generate practically relevant research as well as academically relevant which needs to be taken into consideration for those research strategies that are akin to Mode 2 knowledge generation such as the case study method. Clearly, this is not to say methodological rigour is no more important. Nonetheless, according to Kemmis and McTaggart (2000) there could potentially be trade-offs between methodological sophistication and practical influence, relevance and timeliness of the findings of the study. The author believes that attention to both methodological correctness (i.e. fit between research questions, hypotheses, research strategies, data collection techniques, paradigm inclinations, etc.) and epistemological rigour are necessary. Historically, good research has been determined on the basis of methodological rigour rather than epistemological suitability; nonetheless the author has included both in the following table.

Chapter 5 will demonstrate the relevance of the research questions (academic gaps) for the UK agri-food industry. Therefore, the findings address concerns of both industry and academia (this not just the companies involved but the whole industry considering analytical generalisability of the results). Moreover, from an epistemological perspective, the researcher immersed in the research setting and deployed a hands-on (participatory) approach to obtain knowledge about the knowable by going to the work place (Gemba⁷).

This chapter explained the researcher's paradigmatic inclinations, research structure, rigour, data collection techniques and the key methodological and epistemological decisions underpinning the research. Clearly, these decisions were made to achieve maximum coherence and rigour. The methodological limitations of this research are discussed in the final chapter.

⁷ Gemba, often used in lean terminology, is Japanese for where value is being added to products, i.e. the work place.

Table 4.3 Assessment of the Rigour of Case Study Research in this Thesis

Key criteria for research rigour		How achieved within case study research? (Yin, 2003; Eisenhardt, 1989)	How achieved within the thesis?
Methodological rigour Adapted from (Yin, 2003; Lincoln, 2000; Easterby-Smith <i>et al</i> , 2001)	Objectivity – <i>are the results free from bias?</i>	Triangulation of data sources. Key informants review draft case study report. Establishing the right operational measures for the concept being studied.	• Triangulation of multiple sources of evidence, e.g. process activity mapping, value stream mapping and interviews (both qualitative and quantitative data collection). • Participants and industry informants saw reports for each case study and had the chance to express their opinion. • Established the operational measures and evidence for case studies, i.e. consumer value and GWP
	Internal validity – <i>how accurately are cause/effect relationships identified?</i>	Use of a team of experts and obtaining different viewpoints.	• Each case study deployed a team of participants and experts obtaining different viewpoints within each case. • Also a second facilitator sometimes supported field activities.
	External validity – <i>can the findings be translated to other settings?</i>	Analytically generalise by reflecting on pre-set theoretical propositions. Use replication logic in multiple case design.	Deploying analytical generalisability and use a theoretical framework for further comparisons and generalisations.
	Reliability – <i>can the findings be reproduced by others?</i>	Use standard case study protocol and document research procedures. Develop case study database.	• Documenting the research protocol and continuous communication and refinement of methods. • Creating a portfolio of various documents and collected evidence for each case study.
Epistemological Rigour Kemmis & McTaggart (2000)	Relevance of research <i>what is the relationship between the knower and the knowable? Are the findings relevant to real-life settings and practitioners?</i>	Attention to timeliness and relevance of the findings to the context of the case under study and to the industry on the whole (Kemmis & McTaggart, 2000)	• Findings addressed concerns of both industry and academia. • The researcher immersed in the research setting and deploys a participatory approach to obtain knowledge about the knowable.

(Source: Author)

Chapter Five

5 Contextual Research: An Overview of the UK Agri-food Chains

5.1 Introduction

The literature review identified two critical gaps in the general body of SCM knowledge, i.e. lack of focus on value enhancement and lack of systemic approaches for the understanding and simultaneous improvement of environmental and economic aspects of supply chains. Whereas the research problem was specific to the UK agri-food chains, the gaps were established by reviewing the general supply chain (academic) literature. This chapter aims to contextualise the literature gaps by specifically looking at the agri-food sector and carrying out *contextual studies*. The theoretical framework established in Chapter 3 needs to be attuned to the UK agri-food sector and the extent to which the gaps apply to the UK agri-food industry need to be clarified. It might be necessary to modify the research questions and the theoretical frameworks in accordance with the realities of the sector prior to carrying out case

studies in Chapters 6 and 7. So this chapter investigates the implications of the literature gaps and the theoretical propositions for the UK agri-food industry and proposes modified conceptual frameworks for the case study stage of the research. This is achieved by looking at both first hand evidence and secondary sources such as agri-food academic literature and practitioner reports.

Most of the evidence presented in this chapter has been collected as part of an extensive research programme commissioned by the Department for Environment, Food and Rural Affairs (DEFRA) known as the Value Chain Analysis (VCA) project. Section 5.2 provides a general overview of the UK agri-food sector drawing on the findings of the VCA programme in which the author was involved as lead researcher. Section 5.2 defines the scope and the boundaries of this thesis and provides an up-to-date picture of the sector as well as its significance to the UK economy. It also outlines the generic findings of the VCA programme such as lack of collaboration in chains, transport inefficiencies, poor availability at retail end, lack of consistent measurement along the chain, poor alignment to consumer value. Sections 5.3 and 5.4 then respectively examine the extent of the effectiveness and environmental sustainability problems within the UK agri-food sector. The presented evidence substantiates and verifies the gaps found in the general body of SCM literature leading to the development of a conceptual framework in Section 5.5.

5.2 Background to the Research

Following a recommendation by the Policy Commission on the Future of Farming and Food (also known as the Curry Commission), the Food Chain Centre (FCC) was established in 2002 to “... *bring together people from each part of the food chain*” (Curry *et al*, 2002). FCC then linked up with several industry and levy bodies in the UK Fast Moving Consumer Goods (FMCG) and agri-food sectors such as the Institute for Grocery Distribution (IGD), Efficient Consumer Response (ECR), the National Farmers Union (NFU), Home Grown Cereals Authority (HGCA), Dairy Industry Forum (DIF) and Red Meat Industry Forum (RMIF) to launch an extensive research initiative widely known as the VCA programme. FCC received several million pounds joint funding from DEFRA and DTI for improving supply chain performance and vertical collaboration in the UK agri-business sector and, subsequently, commissioned the Lean

Enterprise Research Centre (LERC) at Cardiff Business School to analyse 33 value chains in four key agribusiness sectors, i.e. Dairy, Cereals, Red Meat and Horticulture. The author was part of the core team developing methods and delivering extended value chain analysis work from farm to fork. The author assumed a leading role in several VCA's in various sectors and carried out the bulk of the study into the cereals sector (Zokaei *et al*, 2008). The empirical evidence and the data collection reported in this thesis have been exclusively developed for the purpose of the thesis.

5.2.1 The Context of the UK Agri-food Sector

Agriculture in Europe, until recently, has been heavily supported by government intervention and protected by trade barriers. In Europe, the Common Agricultural Policy (CAP) producer support payments represent a large proportion of the EU expenditure. However, following the 'Agenda 2000 Agreement'⁸ reforms in the European Common Agricultural Policy (also known as CAP-reform) and the admission of former eastern bloc states the CAP budget is undergoing major reform. At the same time, trade liberalisation and globalization trends, penetration of cheap suppliers of agricultural produce, and consumer behavioural changes in favour of convenience, organic and green products, challenge the industry (Baxter, 2003). Moreover, as discussed in Chapter 1, the UK agri-food chains have faced several crises such as the BSE and Foot and Mouth outbreaks, and concentration of market power in the hands of few multiples (Hingley, 2005).

It was also discussed in the first chapter that, against this backdrop, a parliamentary policy commission was assigned in 2001 to advise the UK government on ways to achieve profitable farming and a sustainable rural economy in the light of the government's objectives for CAP-reform, world trade liberalisation, poverty alleviation and expansions of the EU. The Curry commission published its report in January 2002 triggering a series of change initiatives in the UK. The report urged the government to establish "*a clear timetable for reform and encouraging and supporting the farming and food industry to adapt to change.*" (Curry *et al*, 2002, p. 23). It also, rather plainly,

⁸ The Agenda 2000 agreement was agreed in Berlin in March 1999. It aims to help European agriculture meet the challenges of future trade liberalisation.

added that *“taxpayers are handing over huge subsidies every year for a policy which is destroying economic value. Consumers are paying more for their food than world prices. The environment is being degraded. Farming incomes are on the floor”* (p. 109). The report offered in excess of 100 suggestions; the *operational* recommendations broadly fall into three key categories:

1. Reducing waste and improving efficiencies along the food chain. For example the commission recommended measures to strengthen the food supply chain and promote collaboration among farmers to reduce inefficiencies, improve competitiveness and secure a fairer return for the primary producer. It, also, urged multiple retailers to adopt more transparent and collaborative policies towards their suppliers.
2. De-commoditisation of goods and adding more value to the consumers: For example the commission suggested that the farmers should reconnect with their markets and the rest of the food chain (reconnecting the food chain and the consumers with the countryside) to create superior value.
3. Preservation of natural environment: For example retargeting public funds towards environmental and rural development instead of direct subsidisation of production, i.e. rewarding farmers who deliver a sustainable and attractive countryside, and making the environment a selling point not a sore point for the industry.

It is notable that the Curry report also included a series of key policy recommendations. The commission called for radical reform of the CAP arguing that a subsidy system which is linked to production levels serves no-one and divides farmers from their market, suppresses innovation, and destroys economic and environmental value. From January 2005, the UK payments ceased on productivity basis (e.g. headage or acreage); instead producers receive single-farm payments based on historic claims and/or land area. Pre-2005, in order to secure an acreage/headage support payment, producers could make a rational decision to produce at a loss against global prices. The new support regime, however, increases producers' need both to minimise costs and to more closely match market demand potentially leading to rapid change within the industry. Policies introduced following the publication of the Curry Commission report have led to a degree of rationalisation in the food industry. This rationalisation coupled with a series of regulations to improve traceability and hygiene (e.g. Hygiene Assurance at Critical

Control Points and Beef Labelling Scheme) has begun to create a more efficient food production chain.

To respond to post-Curry policies, rapid changes in the macro-environment and the aforesaid market pressures in agri-business industry, a number of researchers have proposed different solutions (Hingley, 2005; Fearne, 2000; Zokaei and Simons, 2006b):

- i) Effectively capturing consumer requirements and focusing on adding value to consumers across the whole chain (Zokaei and Simons, 2006a; McEachern and Warnaby, 2005; Fearne and Hughes, 1999; Pickernell and Hermyt, 1999)
- ii) Developing strategic collaboration with customers and/or suppliers (Hingley, 2005; Simons *et al*, 2003)
- iii) Striving on continuous improvement by means of various techniques and pursuit of best available practices to improve efficiency and reduce costs of meeting consumer expectations (Pickernell and Hermyt, 1999; Zokaei and Simons, 2006b; Simons and Zokaei, 2005).

In order to achieve these factors, collaborative supply chain improvement is a dominant theme in the literature (Womack *et al* 1990, Lamming 1993, Womack and Jones 1996). However, practicality and validity of the collaborative supply chain management models have been widely questioned (Cox, 2001a, Cox *et al*, 2001), especially with regards to the existing asymmetry of power in the UK food sector in favour of the multiple retailers. Cox (2001a; 2001b) argues that collaboration is possible in situations of buyer dominance or where power is equally distributed between buyer and seller to create interdependence.

Nonetheless, Hingley (2005) contends that it is possible for the weaker links in the food chain to engage in fruitful collaboration with powerful supermarkets given that they accept the inherent power imbalance in the chain and strive to make themselves invaluable to their key customers. Rewards are in staying ahead of the game by anticipating future retailer service requirements and conceding to the control of the retailers in the chain (Hingley, 2005). The author agrees with Hingley (2005) that “*power is not necessarily inhibitive to relationship forming and management*” (p. 64) in

food chains. In fact, approaches adopted in the VCA programme were conducive towards formation of supply chain relationships under power imbalance conditions. The VCA programme adopted a Lean perspective whilst emphasising a positive attitude in relationship management as suggested by Hingley. The following section explains the approaches used in conducting the VCA project and how they are anchored in lean thinking.

5.2.2 Value Chain Analysis Method

The VCA programme looked at four key sectors within the UK agri-business industry, i.e. Dairy, Cereals, Red Meat and Fresh Produce. Thirty three supply chains were studied in total covering different routes to market as well as different raw materials (e.g. pork, beef and lamb in the case of red meat). Each one of these supply chains was studied independently as a separate project facilitated by a lead researcher and a supporting facilitator. VCA Projects, on average, each took three to five months to complete. The author was directly involved in 9 projects covering all four sectors. Table 5.1 provides an overview of the supply chains contained in the programme.

A standard data collection protocol was put in place and communicated at the outset of the VCA programme referred to as the 10 days value chain analysis technique in this thesis (Francis, 2004; Taylor 2005; Zokaei and Simons, 2006a). A cross-company team of various stake holders (e.g. primary producer, processors, retailer, food service, etc.) were pulled together in each project where approximately 8 to 12 contact days were spent with team members in the field. All data was treated as confidential unless cleared by companies and a confidential report was published per chain containing a detailed analysis of the chain for the eyes of the team members only. Moreover, as agreed with the Food Chain Centre, and for the purpose of public dissemination, a number of practitioner case studies containing non-sensitive information were also published as well as four sector specific final reports.

Table 5.1 Overview of Value Chain Analysis Programme Activities

No.	Sector	Chains Analysed	Reports (non-academic publications)	Time- frame
1	Red Meat	• 8 chains through RMIF • 1 in Wales	• Sector specific final report • Individual chain confidential reports and case studies	2003 – 2006
2	Dairy	• 8 chains through DIF	• Sector specific final report • Individual chain confidential reports and case studies	2004 – 2007
3	Cereals	• 8 chains through HGCA (3 sub-contracted to Cranfield University)	• Sector specific final report • Individual chain confidential reports and case studies	2004 – 2007
4	Fresh Produce	• 7 Defra funded chains (including 2 organic chains) with HDC • 1 joint private and public funding	• Sector specific final report • Individual chain confidential reports and case studies	2004 – 2007

(Source: Author)

The notion that key processes along the supply chain form a value chain and the method of analysing the value chain for competitive advantage were introduced by Porter (1985). Subsequently, Value Chain Analysis (VCA) was developed in the management accounting literature (Shank, 1989; Shank and Govindarajan, 1993) and more recently in the operations management literature (Rainbird, 2004, Zokaei and Simons, 2006a) following on from previous claims that supply chain management should go beyond a narrow focus on efficiency management to deliver superior value to the end consumer (Christopher, 2005). Value chain analysis refers to a structured method of analyzing the effects of all core activities on cost and/or differentiation of the value chain. According to Dekker (2003) VCA analyses where in the supply chain the “*costs can be reduced or differentiation can be enhanced*” (p. 5).

Therefore, in an operational sense VCA is a subset of supply chain management. Obviously this thesis comes at VCA from an operational angle rather than management accounting. Moreover, financial VCA has been subject to criticism, especially in relation to its practical relevance. Lord (1996) argues that the lack of empirical evidence on application of VCA – in the accounting management stream – implies that it may be just “*a figment of academic imagination*” (p. 364). When performing accounting VCA,

a company's first concern is about their future bargaining position and leakages of sensitive financial information to their competitors (Dekker, 2003). Despite emphasizing the impracticalities of value chain analysis in its management accounting sense, Lord (1996) and Hergert and Morris (1989) acknowledge that the process itself provides valuable insight by screening various chain activities against value to the user.

The essence of the Value Chain Analysis methodology and data collection protocol developed at Cardiff Business School is producing a systemic map of the value chain and a systematic method of analyzing each strategic activity in relation to consumer value. In this sense, the proposed VCA method draws extensively upon the lean paradigm (Womack and Jones 1996), value stream mapping (Hines and Rich, 1997; Rother and Shook, 1999; Jones and Womack, 2000) and Porter's value chain analysis. A key attribute of the proposed method is that analyses and metrics are based on determinant attributes such as quality and time, not on output financial attributes (Fitzgerald *et al*, 1991). The advantages proposed for deployment of determinant or operational measures are that they are leading indicators of financial attributes and that, from a change management perspective, operational measures are more readily shared across companies than sensitive financial data.

As opposed to conventional supply chain analysis approaches where the focus is on efficiency of individual firms or functions along the chain, lean focuses on the horizontal flow of products. The lean approach begins with the selection of a single product family for mapping and then a supply chain team is established to follow the flows of the product across firms and functions. As such the supply chain becomes the value stream; and the technique used in analysing the flow of product families is regarded as value stream mapping (VSM). A product family is defined as products or stock keeping units (SKU) that flow through similar processes in their value streams.

The Lean mapping technique was first documented by Rother and Shook (1999) for a single firm and later extended to the whole supply chain by Jones and Womack (2000) both heavily borrowing from Toyota's approach to supply chain management and analysis. The data collection approaches deployed during the VCA programme were based on the VSM technique, i.e. choosing a product family and mapping the end-to-end supply chain for a single value stream in each chain project. Broadly speaking the

data collection protocol consisted of the following four stages that the researchers broadly adhered to for the sake of consistency:

1. **Team building and introduction:** At this stage, the teams familiarized with the data collection procedures and protocols, mapping and analysis techniques deployed during the project and the basic principles of SCM. At least one representative from each participating firm committed to walk the entire value chain from farm to end point of purchase. A benefit sharing agreement was put in place to ensure that the potential benefits are fairly shared. The early team building meetings were of great importance to the overall success of the projects.
2. **Inter-firm and intra-firm data collection:** During this stage a current state map of the physical and information flows along the whole supply chain was constructed with specific attention to time data (Rother and Shook, 1999). The team walked the whole supply chain and collected the necessary information over a period of on average three to four months. Some common units of analysis were time, delivery and quality at each stage in the chain. Also, the teams looked at operations and logistics efficiency measures such as demand amplification, on-time/in-full delivery performance, lead-times and defective parts. Financial data were not collected to ensure maximum buy in from all participant companies. Mapping of the end-to-end supply chain and collection of the current state data often required four to five days in the field. (Hines and Rich, 1997)
3. **Evaluation of the current state and suggestions for the future state of the supply chain:** Having gained a clear understanding of the current state, the teams analysed the crude data and identified potential improvement opportunities both at the whole chain and individual firm levels. Also, there was an opportunity to compare and contrast the current states against teams' understanding of consumer value. Each VCA was an opportunity for the team members to connect their role in the chain with the ultimate satisfaction of consumers. Normally several improvement opportunities were identified as a result of detailed mappings ranging from low hanging fruits to very difficult to implement.
4. **Action Planning:** In the final stage of each VCA project an action plan was developed to take the supply chain from the current state to the future state based on the immediacy of the actions, the size of the prize, availability of change resources and the relevance of the identified improvement opportunities to consumer needs.

The data collection protocol (the 10 days activity plan) is further explained in Table 5.2. The role and importance of a data collection protocol, in the context of case study research strategy, has already been discussed in Chapter 4.

Table 5.2 Data Collection and Analysis Protocol: the 10 Days Value Chain Analysis Activity Plan

Session	Event	Activities
1	Initial Team Building Workshop	• Explanation of key chain management concepts such as flow, pull, agility, demand amplification, etc. • Explaining value stream mapping techniques and tools deployed during VCA, e.g. process activity mapping, product variety funnel, etc. • Explaining principles of collaboration along the chain • Discussing a benefit sharing agreement • Identifying the core team members and establishing a value chain continuous improvement office.
2	Workshop Current State	• Selecting a suitable product group for mapping. For example choosing the largest mutual flow or a product with biggest potential for improvement. • Creating a generic big picture (current state) map of the value chain.
3,4,5 & 6	On-site mapping	• Creating detailed current state maps for individual firms along the chain, e.g. farm, food processor, distribution centres and retail store. The current state maps cover both the physical and information flows. Also, the current state maps bear all the relevant operational (determinant) performance indicators. • Identifying internal operational improvement opportunities at each facility
7	Workshop: Whole Chain Ideal State Map	• Discussing and creating an ideal state map so that the whole team can aspire towards a single shared vision, e.g. an ideal lean value chain • Identifying, discussing and categorizing consumer value • Identifying Key Performance Indicators (KPI's) for the whole chain
8 & 9	Workshop: Future State Map	• Discussing and creating a future state for the whole chain. The ideal state is a vision whereas the future state is an achievable target. At this workshop the ideal state map is rationalized to the future state map. • Identifying key projects towards the future state • Linking key projects (opportunities for improvement) with the measures of consumer value to identify the vital few projects for improvement • Creating a clear action where all key stake holders and people responsible for implementation are identified.
10	Presentation of Final Results	• Team presentation of recommendation for improvement and findings to top tier management of all companies involved • Confirm proposal with all stake holders and various project owners • Discussions around benefit allocations and milestones • Final decisions taken as to which improvement projects to progress

(Source: Zokaiei, in press)

5.2.3 Value Chain Analysis Programme: Generic Findings

There were a number of generic findings across the four sectors. Whilst this thesis ultimately contributes in supply chain consumer effectiveness and sustainability areas, discussing the generic findings of the VCA programme gives a current picture of the UK agri-food sector and provides a useful background. As already discussed, understanding the context of the UK agri-food sector helps to tune the theoretical frameworks and even modify them prior to the case study data collection stage. Most importantly, the following discussions illustrate that the VCA programme was driven by and focused on economic efficiency, whereas this thesis takes the challenge forward by adopting a systemic view of the sector through efficiency, effectiveness and sustainability lenses. That is the *original contribution* of the thesis. The following compiles the findings in the sector specific final reports in four separate tables followed by comparisons and discussions. Each table illustrates findings in the same order in which they have been presented in the final reports.

Table 5.3. VCA Summary Findings – Red Meat Industry

No.	Issue	Remarks
1	Demand Management	Demand distortion/amplification effect was noted throughout the sector, e.g. forecast efficacy, poor information availability, lack of demand visibility, etc. The situation was exacerbated further due to carcase imbalance which is unique to the industry.
2	Quality Performance	One of the major findings of the red meat VCA was occurrence of high levels of loss and/or non-perfect quality products evident across all echelons of the supply chain (namely 77% cumulative loss), e.g. breeding loss, mortality, trimming process waste, packaging defects, and damage during distribution and retail.
3	In-house Process Inefficiency	In-house operational performance was compared in this sector with world class manufacturing performance levels and it was observed that considerable improvement can be achieved in certain areas such as retail on-shelf-availability, on farm best practice standardisation, and packaging in the meat packers where Overall Equipment Effectiveness (OEE) was generally very poor. Notably, Zokaei and Simons (2006b) report a potential 9% saving against the final retail value through adoption of best practices and improving to the highest available efficiency levels along the chain.

4	Inventory Management	In the studied chains, only a fraction of the total lead-time was spent adding value for the consumer by converting, maturing to specification, packaging or transporting the meat. The remaining non-value adding time was product that had reached weight on farm awaiting delivery to the processing system and extra maturation above specification storage.
5	Excessive Transport	Researchers observed unnecessary transport miles which not only put transaction costs up but also can result in weight loss due to avoidable stress level of animals.
6	Trust, Risk Share and Contracts	Evidence from red meat VCA show that none of the retail chains studied had long-term written commitment at retailer/processor or processor/producer level, though some foodservice and public sector chains did have written contracts. Lack of contracts was cited in many chains as a barrier to collaboration and improvement due to the imbalance in risk. There was a lack of trust in chains due to a perception that participants could switch at short notice. The study called for written contracts as essential to risk sharing and long-term collaboration along the chain.
7	Opportunistic Trading	A striking feature of nearly all the chains studied in this sector was the predominance of a market trading approach to commercial relationships. Farmers were continually reviewing prices, and were prepared to push forward or hold back animals in response to short term market prices. In this model, profits are gained at the expense of supply chain partners. This in turn has created an environment where there is little willingness to collaborate towards bigger savings and more sustainable benefits.
8	Supply Chain Structure	The report highlighted threats emanating from the dominance of supermarkets in the chain namely little opportunity for processors to build sustained consumer links which could lead to brand loyalty since retailers are ready to switch and the risk of one major retailer defecting to source from overseas and the rest following.
9	Customer Value	The report is very brief in explaining the extent of this problem. However, it touches on the absence of joint up market research in the sector, misalignments with end consumer requirements and taste vs. appearance dilemma (i.e. mature meat may look not fresh).

(Source: Simons, Taylor, Francis, Zokaei *et al*, 2007)

Table 5.4. VCA Summary Findings – Dairy Industry

No.	Issue	Remarks
1	In-house Process Inefficiency (referred to as operational management in the Dairy VCA final report)	The project reported that significant variations in production efficiencies between farms have been observed with little evidence of farmers critically examining their working practices. Differences in output levels and efficiency are well known and widely studied. Moreover, considerable variation in milk characteristics such as fat and protein exist even across small milk fields. Furthermore, operational opportunities are reported in dairies, e.g. improved equipment utilization, improved layout, reduced handling, reduced stock levels and better understanding of Takt-time in bottling lines.
2	Transport Inefficiency	One key finding in the dairy VCA was occurrence of transport inefficiencies at different echelons within the chain, e.g. milk collection at farms, milk distribution and reloading to dairies, multiple transports between dairies and final consumer.
3	Reducing Information Complexity	Highly complex and convoluted information flows were observed in all 8 chains. Problems included lack of visibility in information handling, duplication of information handling between computer and manual systems, unconnected IT systems and multiple points of data entry, errors in data entry and lack of coordination between dairies, depots and the retail customer.
4	Demand Management	Whereas mapping showed that demand profile for milk was quite stable, demand distortion/amplification effect was noted throughout the sector due to various reasons such as batching orders, minimum delivery sizes, quantity discounts, forecast efficacy, poor information availability and lack of demand visibility.
5	Lack of Overall Supply Chain Key Performance Measures	In order to know how efficient a chain is, a set of supply chain performance measures is necessary. Researchers observed that none of the chains had an integrated method of measuring whole chain performance. A set of key measures were suggested and targets were set against these measures for the future state, e.g. future state total lead-time, demand amplification index, total product travel distance, cumulative delivery errors and cumulative quality defects.
6	Developing a better understanding of Customer Value	<i>"In most of the chains studied there was a need to gain a much clearer and more consistent understanding of value from the point of view of the end consumer. This was particularly the case in relation to fresh milk, which is often regarded as a simple commodity for which price is the only important factor"</i> (p. 17). In few chains in this sector where

		market research was carried out previously and information regarding consumer requirements was available, this helped to consider how possible improvements in supply chain performance could deliver better consumer value. Again the report only briefly touches on the issue which comes at relatively low importance.
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(Taylor, Simons, Bailey, Zokaei *et al*, 2007)

Table 5.5. VCA Summary Findings – Fresh Produce Industry

No.	Issue	Remarks
1	Understanding Consumer Value	The project reported that across all chain projects there were opportunities to gain clearer and more consistent understanding of what value is from the end customer's point of view. <i>"Typically each organisation in the chain develops its own view of customer value and these often do not align"</i> (p. 7). The Report suggests that systematic approaches to market research need to be adopted in order to achieve deeper understanding of value especially to help upstream partners connect with consumers.
2	Tracking and Reducing Product Loss through the Chain	The VCA project identified that waste levels are alarmingly high within the Fresh Produce sector, when aggregated they were anything between 30% and 50% of product being scrapped, downgraded or being subjected to rework.
3	Demand Management	Chain investigations showed that for many fresh products the consumer demand is taken to be quite variable on a week by week basis at the retail end. However analyses showed that although there is a degree of seasonal variability, the underlying demand was fairly constant and that much of the variability was caused by promotional activities, etc. This variability was exaggerated throughout the chain due to demand amplification/distortion effect.
4	In-house Process Inefficiency	Similar to Dairy and Red Meat sectors in-house operational inefficiencies were unearthed at the grower end as well as the processing level. The VCA reported great need for standardisation of on-farm best practices and measurement and improvement of harvest efficiencies.
5	Transport Inefficiency	Similar to Dairy and Red Meat sectors, transport inefficiencies were reported in this project especially between field and pack house.
6	Lack of Overall Supply Chain KPI's	The project reported that not enough attention was given to operational measures along those chains mapped in this sector, while financial performance was being measured. <i>"In each whole chain project a set of</i>

		<i>between six and ten whole chain Key Performance Indicators was developed by the team members. These measures were specific to each chain but would typically include parameters such as pack-out rates, lead time from harvest to consumer, inventory levels, transport time, food miles and on-shelf availability at the store” (p. 13).</i>
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(Simons, Taylor, Bailey, Zokaei *et al*, 2007)

Table 5.6 VCA Summary Findings – Cereals Industry

No.	Issue	Remarks
1	Transport Performances	The study reported poor delivery adherence (especially into flour mills) in several chains. The cereals final report delves into root causes of poor delivery performances.
2	Storage / Inventory	The study showed excess stock and great need for rationalising the stock holding points along the cereals chain.
3	Quality / Inspection	Researchers observed the need for reducing the number of inspections and testing points along the chain and operating vendor assured deliveries wherever possible.
4	Trust, Risk Share and Relationships	The report highlights the need for long term collaboration and trust along the chain away from wasteful trading mentality. The report shows that sometimes internal relationships between departments within the same company are not very good either.
5	Information flows and Communication	A significant opportunity in all studied chains was in information flows and communication, e.g. forecast errors, demand visibility, communication of real market needs and trends, etc.
6	In-house Process Inefficiency	For example standardisation of farm practices and shop-floor improvements in a bakery.
7	Differentiation and Value Enhancement	For example the report discusses the need to identify how upstream parties (farmers and millers) can contribute to differentiation and value enhancement of the end product.

(Zokaei *et al*, 2008)

Tables 5.3 to 5.6 show that VCA in different sectors has identified remarkably similar results. Also, it is evident that the emphasis of the VCA work has predominantly been on efficiency factors such as transport, quality, demand management and inventory levels. What's more, the VCA reports, in all four sectors, call for greater supply chain integration and collaboration. Clearly supply chain collaboration is required for improvement of both efficiency and effectiveness of supply chains. The following table demonstrates common themes across different sectors (where findings have been similar they have been bundled under one single theme).

Six key concerns can broadly be identified as common themes *amongst all thirty three chains in the four sectors analysed* during the VCA programme (see Table 5.7). The other three issues each appear in at least two sectors. Five out of the six common concerns are directly related to supply chain efficiency, whilst the sixth one is the *lack of understanding of consumer value* which is related to supply chain effectiveness. Identification of consumer value is the first principle of lean and the VCA project created a rare opportunity for the team members to connect supply chain activities with the actual requirements of the end consumers. Although all the aforementioned reports (even if only briefly) touch on a lack of understanding of consumer needs, none puts forward a practical solution for improving consumer alignment along the chain, let alone enhancing consumer experience (FCC, 2007).

The red meat report only briefly alludes to lack of understanding of the end consumer needs with little explanation about the nature of the problem or even any examples of its occurrence. The Dairy and Fresh Produce reports are slightly more structured in describing the issue, especially highlighting that the upstream partners are more likely to benefit from better appreciation of consumer requirements. However, they lack real solutions (and even clear expansive examples). The cereals final report is to some extent more assertive in discussing the issue. Furthermore, recently the Food Chain Centre published its completion report reiterating the same problem: *"It is rare to find an understanding of consumer needs shared through a product chain but when achieved, it helps greatly to promote trust and innovation"* (FCC, 2007 p. 19). Yet again, the report fails to fully explain the issue or to show how re-alignment can be achieved and why it boosts chain performance and competitiveness.

Table 5.7 Cross Sector VCA Findings

No.	Concern	Red Meat	Dairy	Fresh Produce	Cereals
1	Quality issues and product loss	√	√ (in the text)	√	√
2	Demand management and waste in information flows	√	√	√	√
3	In-house operational inefficiency at different levels in the chain	√	√	√	√
4	Transportation inefficiencies	√	√	√	√
5	Lack of understanding of consumer requirements	√	√	√	√
6	lack of trust and collaboration / lack of contracts and risk share agreements / opportunistic trading relationships	√	√ (in the text but little attention)	√ (in the text but little attention)	√
7	Lack of consistent measurement of operational performances at the whole chain level	-	√	√	-
8	Inventory management issues	√	-	-	√
9	Supply chain structural issues	√	-	-	-

(Source: Author)

What the VCA projects claim to report is a ‘lack of understanding of consumer needs along the chain’. In effect what researchers involved in these projects have observed is the issue of misalignment of supply chain activities (and arrangements) with consumer value as well as supply chain members’ inability to demonstrate clear cut appreciation of consumer requirements both of which indicate lack of focus on consumer needs at supply chain level. This is what was referred to as supply chain ineffectiveness in Chapter 3. Considering that the VCA final reports and FCC completion report all fail to give lucid examples of supply chain ineffectiveness, the following examines the issue of chain ineffectiveness within the UK agri-food sector through case illustrations from across four sectors.

5.3 Evidence of Ineffectiveness in the UK Agri-food Supply Chains

Table 5.8 provides evidence of value misalignment and lack of consumer focus in 19 agri-food supply chains in the UK compiling 31 cases of supply chain ineffectiveness in total (more than one instance in several chains). These are clear examples of disconnection between supply chain activities and/or product specifications with consumer requirements. Table 5.8 contains information both from chains mapped by the author (8 chains) and secondary evidence obtained through interviewing other researchers who facilitated various VCA chains (11 chains); where secondary evidence is illustrated it has been clearly marked. *In total 23 chains were investigated (interviews covered 14 chains and the author carried out 9 VCA's in total) – out of which examples of supply chain ineffectiveness were found in 19 chains.* It is notable that not reporting evidence of ineffectiveness in 4 chains is *not indicative* of an effective chain. For example in one chain facilitated by the author where no evidence of ineffectiveness has been reported, the scope of project was restricted to the operational and efficiency issues and the focus was on two upstream organisations limiting the possibility of relating the findings to end-consumers. Table 5.8 is formatted to reflect the concerns, causes and possible countermeasures for each chain.

Supply chain effectiveness can be improved through enhancement of the value proposition, for instance new features could be added to a product to fulfil an unmet consumer need or a supply chain setup could be altered to deliver the exact requirements of the final consumer. On the other hand, efficiency is improved through waste elimination, i.e. reducing the input levels while increasing the output levels. What is demonstrated in Table 5.8, are rather straight forward cases of misalignment of supply chain activities (or supply chain arrangements) with the consumer requirements. There could be more to value enhancement than just simple realignment to the end customer and straightforward readjustment of product specifications along the chain. Capturing consumer needs, categorising those requirements and linking to supply chain activities, demands rigorous approaches and elaborate systemic effort. Chapter 6 will explain *how* supply chain effectiveness can be improved through several case studies.

Table 5.8 Supply Chain Ineffectiveness in the UK Agri-business Sector

Chain	Concern	Cause	Counter Measure
Chain 1 Red Meat Secondary data	Shelf-life of the product was based on a technical assessment that was several years old. Improved processes had reduced bacterial counts, but this had not been reflected in the shelf-life. Adding this extra time to shelf-life would result in higher shelf stocks leading to increased availability and therefore better consumer value. Paradoxically, the retailer specified an extended shelf-life for the Christmas holiday.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None
	The carcass assessment systems in the UK are based on production quantities of useable meat. This does not always connect directly with taste, succulence and tenderness of meat. For example, in this high quality beef chain, meat was accepted out of specification, because qualitative assessment showed that it tastes good! Chain participants frequently raised the Australian system of grading as being more consumer focused.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None
Chain 2 Red Meat Secondary data	This chain followed Pork product from farm through abattoir and processing to a multiple supermarket. Specification of different consumer products (e.g. pork chops; bacon, ham) that originated from the same species (i.e. pigs) was made independently by autonomous category buyers at the retailer. This resulted in specifications that either could not be obtained from the same animal or required excessive trimming during the butchery process. This result was increased complexity in the management of the supply chain and unnecessary waste of premium product.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None
	Different category buyers at the retailer made independent forecasts and promotional decisions. Moreover, multiple forecasts made independently by the retailer, processor and the farmer many of which were contradictory or not used leading to demand distortion and demand amplification.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the consumer.	Raising awareness and recommending coordinated demand management

	The supermarket carried out consumer market research to ascertain consumer value requirements in terms of meat products. The VCA analysis showed that this value proposition was passed through a number of parties along the chain with a real danger of blurring. Furthermore, lack of a direct link between the supermarket and the farmer meant that opportunities were lost for the farmer to respond quickly and innovatively in meeting changing consumer needs.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None
Chain 3 Red Meat Secondary data	This chain followed both conventional and organic lamb from farm to a multiple retailer. The chain had a tightly specified animal in terms of weight, meat conformation and fat. However, the analysis showed that this specification did not provide the optimum meat content for retail consumers and processed meat customers. In other words, there was a mismatch between the reward system that was used to pay farmers and the specification required by the retailer.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of end-consumer.	None
Chain 4 Red Meat	This chain followed pork chops and loin from farm through abattoir and processing and a food service company to a public sector organisation. Although focus groups continuously revised characteristics of the final products and satisfaction of the end consumers the product specs (communicated with the suppliers) were not reviewed since established in 1963. For example the Bone-in Loin product mapped during the study, needed to be trimmed at the canteen. Not only did the bone have no added value to the end-consumer but created unnecessary economic and environmental waste, too. Moreover, there was a small value to the bone at the processor.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Boneless loin was listed
	Pork chops were reassembled into the shape of a loin at the processor. Historically, there were reasons for reforming, including preserving meat for longer periods of storage. This was no more necessary from the consumer point of view. There was a 0.5% saving on consumer price by eliminating the reassembly process.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of end-consumer.	No reforming at the supplier

Chain 5 Red Meat Secondary data	This chain followed beef prime cuts from Argentina to a meat cutting and packing plant in the UK to a restaurant chain. The meat processor had previously carried out an independent customer survey showing that around 24% of the meat product ending up on consumer plate in the restaurant chain was not cooked to consumer satisfaction. The restaurant chain was not aware of this issue despite relatively extensive consumer questionnaires and surveys being carried out frequently. Supply chain design was focused on delivering the product from farm to foodservice outlet to specification on-time/in-full. The chain achieved 99% to specification and 99% on-time/in-full. However, once delivered there was a disconnection between supply chain and consumer value in that only 76% of product was cooked to the consumer's preference; and this variable was not part of supply chain performance measurement system.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Raising awareness along the chain regarding this concern and also suggesting a new measure. i.e. perfect steak encounter (PSE) which was a multiple measure. i.e. steak availability x raw material quality x cooking performance. The PSE measure was recommended as a method for tracking value throughout the restaurant chain and to link supply chain performance with consumer needs.
	This food service supply chain was fairly efficient; nonetheless efficient logistics does not guarantee high consumer satisfaction on its own. Customers of the restaurant chain require high quality ingredients, good ambience and service. as well as available food. For example customer courtesy is a key element of consumer value. The supply chain does not end with delivery of meat to the restaurant chain; there needs to be ways of looking at moments of truth for the duration of consumer experience in the restaurant including taste, succulence, tenderness, ease of transaction and staff courtesy.	No measurement of the moments of truth. Lack of joint focus and understanding of different aspects of consumer value.	The VCA project raised awareness.
	There was opportunity for Argentinean farmers to improve value proposition by moving to organic fairly easily since there is no steroids, and animals are fed on grass. Argentinean beef can be taken to organic with little cost implications and huge potential. But this potential was generally unexploited. It is notable that Argentinean beef industry largely operates on beef reared animals (Hereford & Angus breeds) rather	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None

	than by-product of dairy industry which is largely the case in the UK. And therefore a more suitable match to consumer needs anyways.		
Chain 6 Red Meat Secondary data	This chain mapped Aberdeen Angus prime beef cuts (Sirloin steak, rump steak, etc.) from farm to a catering company serving several canteens in a major UK university. The final link in the chain (i.e. university eateries) benefited from a very efficient scheduling method of rolling menus between canteens and a central deep freeze facility. The farmer, the abattoir and the butchery were delivering a premium product. Whereas the product would normally be marketed as Aberdeen Angus beef due to its unique quality and image, there was no indication of the product source at the university restaurants. This was perceived as missed opportunity during the analysis.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	It was recommended to canteens to communicate the source of the product (e.g. mention source on menu).
Chain 7 Red Meat Secondary data	This chain followed fresh lamb chops from a farm in Wales through a major processing plant to a multiple supermarket. There was quality based pricing system in place where farmers were being paid a premium for hitting the supermarket's set specification quality grades, i.e. market price plus bonus. The traditional measure of quality considers only grading (conformation and fatness) performance against the supermarket specification, against which the processor's suppliers achieved 90%+ compared with a national average of 50%. However, the findings from the VCA exercise revealed that this is only a narrow definition of quality. It was concluded that the grading system does not induce 'proper production'. Therefore, a new multiple measure was devised which combined %grading, %weight and %cleanness. %weight illustrates what % of lambs hit the right weight, i.e. between 15 and 21 Kg. Lambs are paid up to 21Kg and anything above is deemed to be "too fat" and the premium is only paid within this bracket. %cleanness shows what % of lambs require cleaning prior to lairage which causes significant disturbance to abattoir operation. Although significantly performing better than the national average only 64% of suppliers hit the "perfect lamb" criteria.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Raising awareness and understanding / linking real consumer needs to production. Suggesting a new measure which tests the true level of quality supplied by farmers, and is intended to better connect the suppliers with their marketplace.

	The “perfect lamb” criteria are different between winter and summer due to seasonal changes in consumer preferences. Consumption in winter is largely geared around casserole and roasting cuts whereas in summer lamb chops are popular each requiring different carcase grading approach and payment criteria. Therefore quality based pricing – even when using “perfect lamb” criteria – is a partial solution. The existing quality pricing was only an average and disconnected from true consumer requirements which vary seasonally.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Raising awareness and understanding / linking real consumer needs to production. Selective breeding was being considered as a potential solution where the right breeds is available for the right season.
Chain 8 Fresh Produce Secondary data	This chain followed potatoes from primary production through a processor to one of the UK largest retailers. Potatoes were being marketed as value added (i.e. ready to cook) products. However, there was no joined-up evaluation of consumer needs. The retailer assumed that consumer value is ready peeled potatoes and communicated this to the processor. There was no rigorous attempt to capture real consumer requirements and to include other factors such as range, size and variety. This lack of attention to consumer needs inevitably translates into commoditisation of the product leading to a lose-lose situation.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None
Chain 9 Fresh Produce Secondary data	This chain followed raspberries from a farmers cooperative establishment in Spain through a Spanish processor to one of the UK largest retailers. Product quality specifications were “mixed up” and not linked into rigorous valuation of consumer value. This meant that those farmers who produced good or excellent quality products were not being rewarded and likewise poor quality farmers were receiving equal payment as the harvest was pooled and there was no linkage between reward and recognition and consumer value.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Recommended that the UK importer sets up a deal with the Spanish co-op to receive from specified growers only and growers to put a grower ID on the punnet so quality can be tracked back to individual units.

Chain 10 Organic Fresh produce Secondary data	40% of carrots produced on farms were rejected due to not meeting the specification. Reasons for rejection could vary, e.g. being damaged, too large, too small, bent, corkscrew shape and general misshape issues. Farmers only got paid for what was being packed and changes in product specifications had disproportionate impact on farm incomes, for example if the amount of product that ended up on the supermarket shelf – the ‘pack-out’ rate – was increased by 5 percentage points (i.e. from 60% to 65%), the budgeted farm profit would increase by 60%. Although the specifications were clear and transparent, it was not clear on what grounds those specifications were based. They were not set in accordance with the Voice of Customer (VoC). Whereas, few millimetre changes in the pack size could potentially have a huge impact on farmers’ income, it was not allowed due to rigidity of the specifications. However, it was not clear whether the specifications met consumer value due to disconnection with VoC.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Raising participants’ awareness by alluding to the problem.
	Processors and retailers held the key to vital information regarding what percentage of produce hit the target and rejection root causes. However, this vital information was not passed down the chain, i.e. zero feedback to farmers on quality and quality root causes. Although in the case of carrots that was about to change as a result of optical grader information being made available on-line in real time to growers.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Raising participants’ awareness by alluding to the problem.
	Organic producers understood that their product had an image of being superior in terms of health, taste/quality and environment. Whilst there was some evidence suggesting these points were correct, such image did not always match the reality. Producers were concerned with the sustainability of such image. In particular the producers felt they did not have the evidence to justify superior taste or health claims.	Little communication and transparency in the supply chain regarding needs of the end-consumer and product imaging.	Raising participants’ awareness by alluding to the problem.

Chain 11 Organic Fresh produce Secondary data	Similar to the previous chain, rather arbitrary standards were set in terms of packed potatoes sizes, i.e. 45 mm. Again it was not clear why the standard has been set at 45 mm? Certainly it was not based on consumer research and did not necessarily reflect VoC. Although it was generally accepted that very small potatoes were not acceptable. Another constraint was size of meshes at processing stage.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Raising participants awareness by alluding to the problem.
Chain 12 Fresh Produce	In this fruits supply chain, the consumers were not the arbiter of value. Value was determined and communicated to the supply chain by a public organisation that sponsors delivery of fruits; consumer value is seen as long-term public health through improved dietary. The public organisation has NOT gathered focus group information to determine what the actual consumers like in their daily portion of fruit. On the surface this might sound OK. However, since only 74% of the fruits delivered were consumed (while the supply chain aims to deliver 99.9% On-time In-full into the public organisation canteens spread across England) the preference of the consumers is very relevant to the overall success of the supply chain.	Confusion in identifying the consumer and the consumer value. The two customers of this supply chain are the general public (improving the long-term public health) and the final consumers in the catering locations.	Further investigation to be carried out by the public organisation.
Chain 13 Dairy	The final product was fresh milk from a Cornish farm to an outlet in Cornwall. However, the fact that the chain was delivering 100% local produce was not communicated to end consumers and was not commercially exploited. Consumers valued local products and the retailer was aware of the importance of a regional brand image. On the other hand, the processor/bottler was aware of the local production base. Nonetheless, neither sides of the chain were aware of the other side of the equation!	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Kano Model and Supply Chain QFD techniques were applied. A supply chain Kaizen team was established to market and emphasise local supply base.
Chain 14 Dairy	This was a Y-shaped chain. The researcher followed two products, i.e. Irish sourced cheese from a UK processor and sour cream sourced from a medium size UK dairy, through distribution to a chain restaurant. Several points of disconnection with the end customer	Lack of joint focus on consumer value. Little communication and transparency in the supply chain	Larger shred size

	were revealed on the cheese side. Through joint mapping and analysis, it was identified that less cheese will be used when the shred size is increased since larger cheese melts better and chefs need to use less cheese. It also potentially makes the line run faster at the processor. Consumers prefer the appearance of larger shred sizes presenting a win-win-win opportunity.	regarding needs of the end-consumer.	
	In the cheese chain, it was also discovered that the existing 1 Kg bags were of no value to chefs and in fact they always opened two bags together. Therefore, one suggestion for the future state was to replace 2 Kg bags.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of end-consumer.	Replace 1 Kg bags with 2 Kg bags.
	In the cheese chain again, it was cheaper to use medium cheddar as opposed to mature cheddar due to much shorter stay in maturation warehouse. Moreover, shorter supply chain lead-time allowed for better stock control and even lower stock overall. Consumers either don't notice the difference between the two products or in certain products even prefer medium cheddar.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Use medium cheddar only (de-list mature) cheddar.
	Similarly several points of disconnection with the end customer were revealed on the sour cream side. For example, during the mapping exercise it was noticed that the handles on cream tubs were not used in the factory, the distribution centre or the restaurant. The handles were in fact not adding any value to customer(s). Also, the mapping showed that while the food service chain ordered both 1 Kg and 2.5 Kg units, chefs in restaurants often needed to open two 1 Kg units at once. By de-listing 1 Kg units and replacing with 2.5 Kg tubs supply chain complexity was reduced for the foodservice company and production complexity was reduced for the dairy. Moreover, this meant more convenience for chefs and obviously no difference whatsoever from the end-consumers' point of view.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Remove handles and change 1 kg sour cream tubs for 2.5 kg (range standardisation)

	Two different production methods were deployed for producing each. Set sour cream required additional 24 hours stay in the oven to set and then 24 hours in blast-chiller to cool down while stirred product didn't. Therefore, by replacing stirred product the lead-time could be reduced by about 48 hours. Moreover, in the stirred product chives were added and mixed with the product during production. This meant that chefs did not have to stir products in the kitchen as in the set product guaranteeing that consumers will always get the chives in their sour cream. The author observed that there was a perception in buying department in the foodservice company that set sour cream was preferred by consumers. When examined there was no evidence of this; in fact there was information suggesting the opposite. This way 5 touches were eliminated from the production process and the customers got pre-mixed product which was more convenient.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Replacing set sour-cream with stirred product and pre-mix chives during production at the dairy.
Chain 15 Cereals Secondary data	This chain looked at supply of feed wheat from a UK farm through central grain storage and distribution to a major poultry company. The poultry company owned both the feed milling and the meat processing operations. It operated a highly integrated supply chain supplying 100% of its poultry from own farms. They were entirely driven by efficiency and cost reduction in the supply chain. This cost focus had led them to taking the decision to move a big part of their operations to a lower cost economic area. The poultry company owned the outsourced operation (both farms and processing plants); processed meat was imported to the UK and distributed to various retail outlets. The vertically integrated supply chain based in a low cost economy was perceived to deliver the lowest cost to the company. However, by outsourcing the company had exposed itself to various health and safety risks. Health and safety are core constituents of consumer value. Whereas a vertically integrated chain presents even more opportunities (in terms of control) for	Lack of focus on consumer value. Poor communication in the supply chain regarding consumer value. Focusing overtly on efficiency and cost reduction.	The poultry company stopped importing from its farms abroad.

	enhanced value creation, by putting cost first the company exposed itself to risks that eventually culminated in an outbreak costing them great amounts both in monetary terms and customer goodwill. Moreover, moving abroad involved longer lead-times and higher safety stocks. Hence sacrificing both time (agility to react to changes in demand) and effectiveness in meeting core consumer requirements.		
Chain 16 Cereals	This chain looked at supply of bread making flour from breeding all the way through to a convenient retail store. The grain breeder has to wait up to five years to get national recommendation accreditation status from the authorities. Farmers treat the national recommended list as a bible for choosing varieties. However, the same list is only an aid de memoir for the millers buying different varieties.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumers.	Raised awareness.
Chain 17 Cereals	This chain followed biscuit making wheat from farm to milling to a biscuit manufacturer. The farmers' choice of wheat (variety) and husbandry largely influence the final product quality (e.g. bread). The farmer, however, does not have a clear understanding of the requirements of the end-users. The specifications used by the farmer are driven by wheat merchants and ultimately by the millers; but hardly relate to the end-users needs or even bakers' requirements. Grain merchants, millers and bakers have no means of communicating the right variety of wheat for future drill.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	Improve communication. Improve farmers' awareness of the market needs.
Chain 18 Cereals	This Bio-fuels supply chain consisted of an agri-business upstream chain (oilseed rape) and an oil and gas downstream chain. Consumer value in this chain was greener energy compared with fossil fuels. The mapping showed that there were not any specific oilseed rape (OSR) varieties for bio-fuels production. Nonetheless, requirements of a fuel chain are different from, for example, an animal feed chain where high protein OSR is desired. In bio-fuel chains, high yield and high oil content have a big impact on profitability	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None

	of the whole supply chain. Breeding new oilseed varieties can sustain the industry and reduce its dependency on tax break incentives.		
Chain 19 Cereals	This chain followed bread making wheat from farm through milling to a large bakery in South West of the UK. The farmers' choice of wheat (variety) and husbandry largely influence bread's quality. The farmer, however, does not have a clear understanding of the requirements of the end-users. The specifications used by the farmer are driven by wheat merchants and ultimately by the millers; but hardly relate to the end-users needs or even bakers' requirements. Grain merchants, millers and bakers have no means of communicating the right variety of wheat for future drill.	Lack of joint focus on consumer value. Little communication and transparency in the supply chain regarding needs of the end-consumer.	None

(Source: Author)

Evidence presented in Table 5.8 show that although occurrences of ineffectiveness vary greatly in terms of scope, site, type and potential impacts, they have very *common causes*, i.e. lack of shared understanding of consumer value, lack of joint focus on consumer value and poor communication and transparency in the supply chain regarding consumer needs. Moreover, despite most concerns being fairly straight forward to tackle, the table shows that only in 4 chains the VCA project has yielded clear cut countermeasures beyond awareness rising. Table 5.8 shows that in 7 cases there has not even been awareness rising. This means the facilitators (the author or the interviewees) were aware of the concern but the rest of the VCA team were not.

Furthermore, in 11 instances, although the agri-food processor took great care to adhere to the specifications required by the customer(s), the specification did not necessarily reflect consumer value (*see* chains 1, 2, 3, 4, 7, 9, 10, 11, 12, 14 and 15). A common type of supply chain ineffectiveness is when product specifications are out of sync with the actual consumer needs (in other words the Voice of Customer). This can happen because consumer needs change over time (e.g. chain 4) and/or when consumer needs are not appropriately captured in the first place. Even when consumer requirements are

captured through sophisticated market research, they are often not communicated across the entire chain and do not get reflected in the design of processes further upstream. Sources of innovation and value enhancement in the supply chain remain limited to one company or even one department (e.g. the new product development or marketing department at the retail end).

The aim of this section was to examine the extent of the effectiveness issue within the UK agri-food sector and to contextualise the first research gap put forward in Section 3.2. Evidence presented in Table 5.8 bears out the immediate importance of the first gap within the context of the UK agri-food sector and therefore the research question is modified as follows: How can the effectiveness of *the UK agri-food supply chains* be improved at the same time as efficiency is retained.

5.4 Impacts of the UK Agri-food Sector on Environment

It was discussed in Chapter 2 that climate change is an unequivocal human induced fact and that management theory is evolving to embrace the issue. It was also shown that economic supply chain literature and sustainable supply chain literature reside in isolated silos despite the great need for simultaneous consideration of both issues in the context of chain management. The question at hand is the bearing of the second research gap in the context of the UK agri-food chains, i.e. what is the extent of the impact of the UK agri-food chains on the environment. The aim is to contextualise the second research gap/question consistent with the realities of the sector. Chapter 7 then contributes exploring and explaining *how* supply chain environmental sustainability can be improved alongside economic factors.

A report published by the European Science and Technology Observatory entitled the Environmental Impact of Products (also known as the EIPRO report) looks at the life cycle environmental impacts of products within the EU-25 countries from the final consumption point of view covering both private and public sector consumers. Environmental impacts can be analysed either from a consumption perspective or from a production angle. Analysing environmental impacts from the consumption standpoint means that production within the EU-25 for exports is not included (Tukker *et al*, 2005).

The report shows that direct food related GHG emissions contribute 31.0% of the total EU global warming potential (Tukker *et al*, 2005). This figure neither includes home cooking and refrigeration nor emissions rising from the catering industry (i.e. eating and drinking places) which respectively contribute 2.8% and 8.1%. The EIPRO report is so far the most thorough study of the EU environmental impacts based on both literature review and extensive data generation. The report begins by reviewing seven seminal studies seeking to assess the environmental impacts of consumer goods and services. The study then continues by conducting extensive input-output analysis for consumer products across the whole EU-25 countries. The EIPRO report looks into a very wide range of different products consumed within EU including associated services and sets the system boundaries to cover the entire cradle-to-grave life cycle looking at environmental impacts from Global Warming Potential (GWP) to eutrophication to land and water use.

Table 5.9 Detailed Analysis of the Impact of Food Related Products on GWP

EIPRO Study: Consumption in EU-25	% of total	Nijdam and Wilting (2003)	% of total
Meat packing plants	5.5	Meat and meat ware	4.24
Poultry slaughtering & processing	3.9	Milk, cheese, butter	3.87
Sausages & other prepared meat products	2.5	Potatoes – groceries - fruits	3.12
Fluid milk	2.4	Cereals	3.84
Natural, processed & imitation cheese	2.1	Feeding – Other	1.55
Edible fats & oils	1.3	Jams, sweets	1.44
Bottled & canned soft drinks	0.9	Non-alcoholic beverages	1.08
Bread, cake & related products	0.9	Alcoholic beverages	0.73
Others	7.1	Others	2.25
Total for food, beverages, tobacco and similar	31.0	Total for food, beverages, tobacco and similar	22.1
Household refrigerators & freezers	1.8	Household refrigerators & freezers	2.38
Household cooking equipment	1.0	Kitchen appliances etc	1.53
Eating & drinking places	8.1	Restaurants and pubs	2.77
Total for food and food related	41.9		28.80

(Source: Tukker *et al*, 2005)

Table 5.9 gives a breakdown of the contribution to GWP by different food products and food related categories. The first column shows the results reported in the EIPRO study, while the second column reports the findings of another seminal publication by Nijdam and Wilting (2003). It must be noted that the second study, altogether, adopts different methods of categorisation and analysis only covering household consumption in Netherlands. However, it is often regarded as a key environmental report in the literature and provides a useful comparison. The table shows that a staggering 41.9% of the EU total global warming contribution comes from food, beverages and other food related activities such as cooking and eating out. Transportation to and from food outlets is NOT included in the total. Although, the EIPRO study “*scores food on average one third higher than other studies*” (Tukker *et al*, 2005 p.96) such as Nijdam and Wilting (2003), it can be considered reliable due to the rigour of methods deployed and the level of scrutiny. The EIPRO study, also, allows for identification of products within the food category with highest overall environmental impact. Animal foods such as meat, poultry and dairy products can be singled out since they account for more than 50% of food related GHG’s (i.e. 17.5% out of 31.0%).

There are various estimates of the UK agri-food sector’s impact on the environment not much different from the EIPRO study results. The Carbon Trust published a study in 2006 looking into the GHG emissions related to various categories of consumption within the UK (Carbon Trust, 2006a). The underlying premise of the study, similar to the EIPRO report, is that the driver of carbon emissions ultimately lies with the satisfaction of consumer requirements and therefore global warming potential should be analysed from a top-down or consumption point of view. According to Carbon Trust (2006a), the combined carbon footprint of the UK consumers is 176.4 Million tonnes of Carbon (MtC) out of which 22.4 MtC is attributed to the food and catering sector (~ 12.7 % of total UK GHG’s). This figure is lower than the EIPRO report for several possible reasons. Firstly, almost all GHG’s rising from ‘eating and drinking places’ are attributed to the ‘recreation and leisure’ category and excluded from ‘food and catering’. Secondly, Carbon Trust (2006a) only accounts for household emissions; public sector consumption is likely to have noticeably higher food component (Nijdam and Wilting, 2003). Thirdly, the EIPRO analysis includes the less affluent countries of EU-25, where food represents a much higher portion of the household basket than in the

UK. Most importantly, the Carbon Trust report only looks at carbon emissions excluding other GHG emissions such as NO_x or CH₄.

Figure 5.1 shows the UK emissions allocation by high-level consumer needs in MtC as reported in Carbon Trust (2006a). In this chart, direct emissions are the emissions associated with the direct use of fossil fuels and electricity in the household except for transport. Indirect emissions include the missions embodied in goods and services, including energy required to produce the goods and services and the emissions from space heating and lighting by the service and government sectors. Travel related emissions include emissions from transport fuels and the indirect emissions embodied in transport goods and services (Carbon Trust, 2006a).

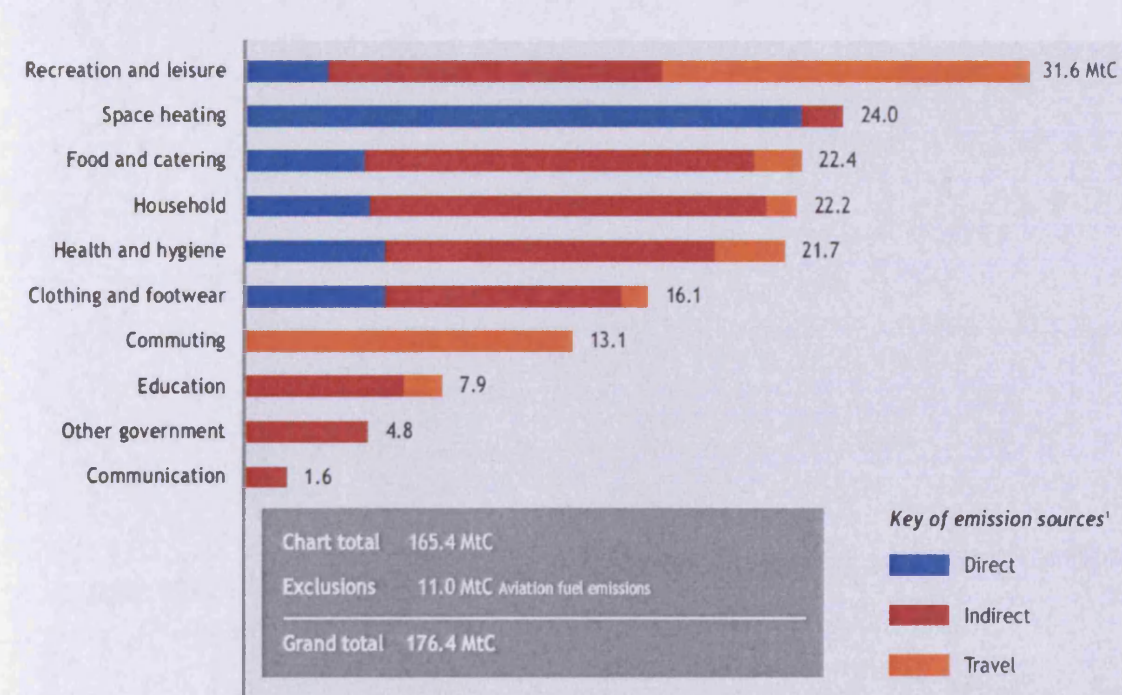


Figure 5.1 Carbon Emissions Allocation by High-level Consumer Needs
 (Source: Carbon Trust, 2006a)

More recently, the Food Climate Research Network (FCRN) published an up-to-date and modified estimate based on the Carbon Trust's sum of the UK private consumption, which shows that at least 19% of the total UK global warming potential can be attributed to agri-food related GHG emissions (Garnett, 2007), while the UK food and

catering sector only accounts for about 8% of the total UK GDP (DEFRA, 2006). Although, FCRN's figure to some extent closes the gap between the EIPRO and the Carbon Trust findings, it is still an estimate which is nowhere near as rigorous as the EIPRO study. In fact, Garnett (2007) believes that 19% is "*probably an underestimate*" due to various omissions (e.g. mobile refrigeration), too many approximations and lack of reliable data. The following diagram illustrates a breakdown of the UK agri-food chains GWP contribution as calculated by Garnett (2007) indicating the significant impact of the agricultural part of the chain (i.e. 8.4% of the total when including fertilizer manufacture).

The above discussions and analyses confirm the relevance of the second research question by demonstrating the immense global warming impact of the agri-food chains across the EU and the UK. Accordingly the research question is modified as: How can the environmental sustainability of *the UK agri-food supply chains* be improved without compromising the economic performances?

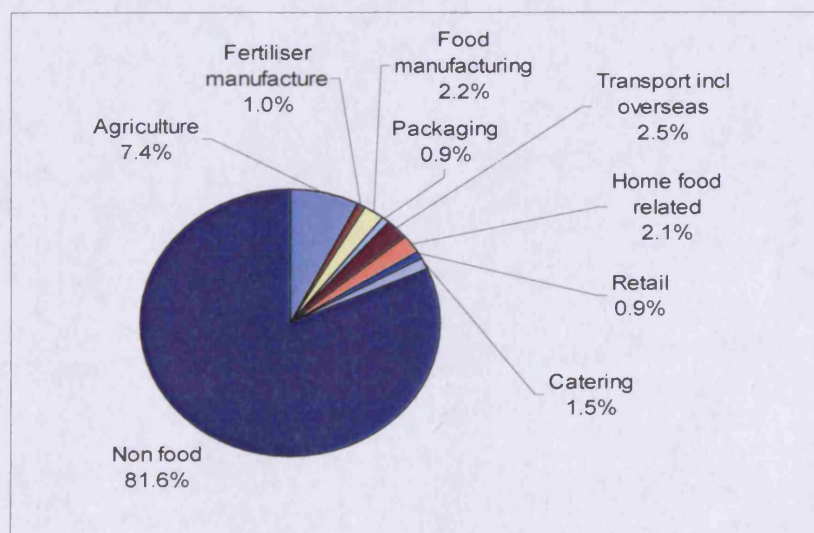


Figure 5.2 The UK Food Consumption GHG's as Percentage of the UK Total Consumption GHG's
(Source: Garnett, 2007)

Moreover, there are several issues and challenges to be considered when addressing the second research question:

- The environmental sustainability body of knowledge is in its infancy. This is evident from vagaries in using different environmental metrics, impact matrices and data-bases in various studies. There seems to be little standards in deployment of basic assumptions regarding environmental impacts of various components, products and sectors. Even worse, the databases show great inconsistency and keep being altered every now and then. For example IPCC data references have been significantly altered several times in certain categories in the past few years (IPCC, 2007).
- It is often not easy to specify the right unit(s) of analysis. For example must emissions (GWP or CO₂) be studied per unit of weight or per calorie? The answer could vary depending on researcher's perspective and/or research needs.
- There are two fundamentally distinct approaches to studying the environmental impacts of products: bottom-up and top-down. The bottom-up approach begins with an individual product and conducts a Life-Cycle Assessment (LCA) of it. The results for this particular product are then assumed to be representative for a wider range of products and are extrapolated to a larger family of products. Combined with other LCA's for representative products it is possible to put together a picture of the whole economy. A key weak point of the bottom-up approach, apart from the issue with extrapolation and generalisability, is that the LCA approach inevitably cuts across processes and therefore the researcher needs to make assumptions in terms of the coverage of environmental impacts. (Tukker *et al*, 2005)

On the contrary, the top-down approach begins with input-output tables at macro-level often produced by statistical agencies. These tables, in the form of matrices, describe production activities in terms of the purchases of each sector from all other sectors (i.e. input-output models). Available models have different degrees of aggregation (between several and several hundred sectors). When matrices also contain data about the emissions and resource use in each sector this information can be used to calculate the environmental impacts of products covering the entire supply chains. (Tukker *et al*, 2005)

The main weak point of the top-down approach is that the availability of suitable input-output tables including the required environmental information is rather limited and that the products in available input-output tables are typically rather highly aggregated. The EIPRO study and the Carbon Trust report adopt a top-

down input-output approach, while few other reports such as the ‘Shopping Trolley’ report (Foster *et al*, 2006) take a bottom-up LCA route. It is the belief of this author that top-down analysis is more appropriate when creating overview reports in terms of total impact of products or industry sectors. Nonetheless, the top-down approach is permissive in details, disconnected from the ground and non-interventionist. Therefore, the bottom-up approach is preferred in terms of intervention and when it comes to bringing change about.

- In terms of the system boundaries, it is often difficult to establish the appropriate boundary which depends on the situation and research objectives. For example where does food end and everything else begin in the system?
- Foster *et al* (2006) in the DEFRA funded ‘Shopping Trolley’ report attempt to develop a bottom-up picture of the UK food system. Nonetheless, their attempt is only a partial success due to “*few studies taking account of the specific food system within the UK*” (p. 14). There seems to be an immediate need to verify findings in the FCRN, Carbon Trust and EIPRO reports through extensive bottom-up research.
- Several reports highlight the significance of the food sector giving special attention to dietary impacts and skewness of results across different food categories (Garnett, 2007; Foster *et al*, 2006; Tukker *et al*, 2005)
- Reviewing the information provided in Foster *et al* (2006), Garnett (2007) and Tukker *et al* (2005) identifies a number of potential hotspots along the food chain. Any attempt to improve the environmental impact of chains should be mindful of these hotspots:
 - Agricultural and fertilizer manufacturing accounting for nearly 45% of total food related emission as reported by Garnett (2007). Also see case study in Chapter 8.
 - Significance of transportation especially air freight in the food chain as reported by Foster *et al* (2006). Foster *et al* (2006) argue that – when viewed from a single product standpoint – the impacts of post retail transport (i.e. car-based shopping) are greater than that of distribution to the retail point.
 - Eating and drinking out have huge impacts within the overall system, i.e. estimated up to 20% of the total impact of food related categories (Tukker *et al*, 2005).

5.5 A Conceptual Framework of the Evolution of Agri-food SCM

It was discussed that the aim of this chapter is to contextualise the theoretical propositions posed in Chapters 2, 3 and 4, (potentially) leading to conception of new frameworks consistent with the realities of the agri-food sector which in turn form the foundation for conducting case studies. Yin (2003) suggests where researchers make use of existing theories to formulate research questions and objectives, they should also draw upon those theoretical propositions as a means to devise a framework to organise and direct data analysis. Miles and Huberman (1994, p.27) argue that *“any researcher, no matter how unstructured or inductive, comes to fieldwork with some orienting ideas, foci, and tools”*; therefore, they recommend *consciously building a conceptual framework* (such as the one posed in this section) for bounding and focusing the data collection. Accordingly, a new conceptual model is put forward in Figure 5.3 illustrating the evolution of supply chain management knowledge in the agri-food sector. There are many advantages in commencing research from a theoretical framework, for example by doing so the research is more clearly linked with the existing body of knowledge in the field of supply chain management and to the UK agri-food industry (the model is subsequently referred to in case studies in Chapters 6 and 7). Moreover, this initial analytical framework provides a sound basis for subsequent refinement of theories and clarifies contribution to knowledge.

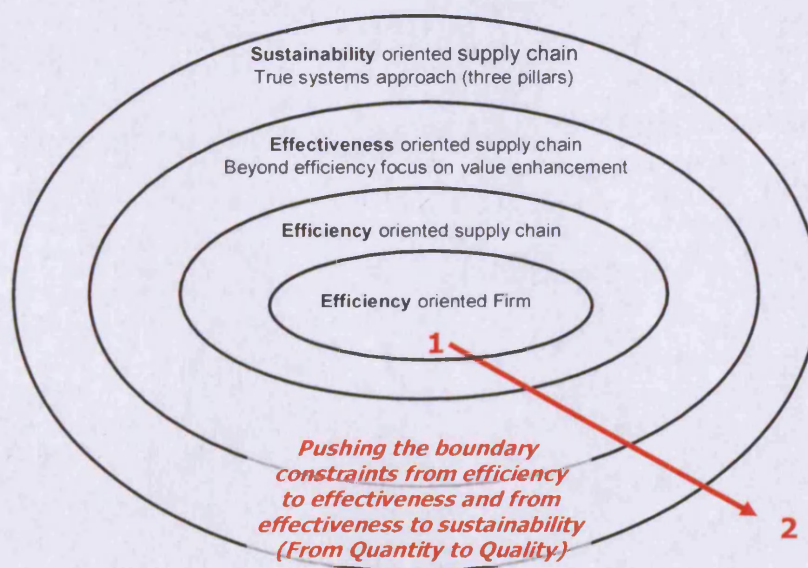


Figure 5.3 The Four Ring Model of Evolution of Agri-food Chain Management Body of Knowledge
(Source: Author)

In Figure 5.3 the first (inner) layer represents a situation when agri-food chain management body of knowledge (then operations and logistics management) was squarely focused on efficiency improvements within the four walls of the firm. The second ring shows a more advanced situation where the body of knowledge has evolved to address/emphasise efficiency opportunities beyond the boundaries of the single firm. More recently agri-food literature promotes collaboration and offer synergistic solutions amongst chain members as reflected in the Curry report and discussed in Section 5.2. The third ring refers to a further advancement in agri-food chain management whereupon supply chain effectiveness becomes an established theme in the body of knowledge. That is the whole chain aiming to understand the needs of end-consumers and realigning inter / intra firm processes to deliver superior value.

The fourth ring represents the final stage in the evolution of agri-food supply chain management literature where economic, environmental and social sustainability are simultaneously taken into account. The overarching rings embrace the favourable conditions of the previous layers. The two inner rings relate to the present time while the outer rings represent *should be* situations and give guidelines for future advancement of the boundaries of knowledge based upon the two critical gap areas discussed in Sections 5.3 and 5.4. On the other hand, the second ring represents a shift occurring or already occurred within the industry; it shows that SCM related to the UK agri-food sector has evolved beyond operational focus from single firm efficiency to efficient whole chain management. Not surprisingly this is consistent with the evolution of general SCM body of knowledge as discussed in Chapter 3. *The model aims to illustrate that the focus should continue to evolve from supply chain efficiency to supply chain effectiveness and whole system sustainability. As such the issues of effectiveness and sustainability are linked together and characterized into a single framework.* The rest of the thesis will explain how the boundary constraints of the system can be pushed from whole chain efficiency to whole chain effectiveness to sustainable development respectively discussed in Chapters 6 and 7. It must be noted that Figure 5.3 represents the evolution of agri-food body of knowledge and *not* necessarily the agri-food sector itself.

5.6 Conclusions

This chapter provided an overview of the UK agri-food industry looking into both economic and environmental factors. The literature gaps and the theoretical frameworks, identified in the previous chapters, were contextualised by showing the prevalence of the supply chain ineffectiveness issues and the disproportionately large global warming impact of the UK agri-food sector. Section 5.3 illustrated evidence of chain ineffectiveness within the UK agri-food industry from the VCA programme. Section 5.4 investigated the extent of the environmental impacts of the sector drawing upon literature and secondary evidence. It was not required to modify the research questions, since the appropriateness and relevance of both were obtained. The contextual research also led to proposition of a conceptual model of the evolution of the UK agri-food chain management body of knowledge which encapsulates the theoretical underpinnings of the thesis into a single framework (Figure 5.3). The research questions operationalise this framework directing data collection and analysis in Chapters 6 and 7.

Chapter Six

6 Achieving Consumer Focus in the UK Agri-food Supply Chains

6.1 Introduction

This chapter addresses the first research question which was initially put forward in Chapter 3 and subsequently discussed further and contextualised in Chapters 4 and 5. The chapter presents four case studies focusing on the issue of supply chain effectiveness and explaining ways for improvement of consumer focus in the UK agri-food supply chain (all data in this chapter are primary evidence). Discussions begin with a red meat chain case study in Section 6.2 exploring and explaining the differences between supply chain efficiency and effectiveness. In this case study efficiency and effectiveness opportunities are compared and contrasted, their relationships are studied and more light is shed on the importance of consumer focus in practice. Section 6.3 then presents an explanatory case study which discusses how effectiveness in a supply chain can be improved while at the same time supply chain efficiency is sustained, i.e. moving

from the second ring to the third ring in the ‘four rings’ conceptual framework presented in Chapter 5 (Figure 5.3). The second case study puts forward a new tool, developed by the author, termed as the *SC Kano-QFD* approach.

Section 6.4 presents another case study where the SC Kano-QFD method is tested again and further developed to overcome some of the limitations in Section 6.3 in terms of capturing the Voice of Customer (VoC) and accessing important market research and consumer survey data. Section 6.5 then builds on the previous discussions especially with regards to which factors of consumer value the supply chain can influence and how? The case study in Section 6.5, too, draws upon valuable market information to address the limitations encountered in the first and second cases. Unlike the first case study which is both exploratory and explanatory the other three cases are explanatory focusing on how consumer value can be enhanced in the context of a supply chain. Each case study begins with an explanation of the project and the participating companies without naming any of the individuals or organisations involved due to confidentiality reasons. Findings from each case are discussed in the light of the theoretical frameworks in previous chapters.

6.2 Case Study 1: A UK Red Meat Supply Chain

6.2.1 Project Background and Introduction to Participating Companies

The fieldwork for this case study was conducted in 2005 as part of the VCA programme. The scope of the case encompassed the entire supply chain from a medium size pig farm through a consolidated abattoir and processing plant to a public sector canteen. The companies involved were a farm, a meatpacker, a foodservice company and the catering department of a public sector company. A team of senior company representatives and two academic facilitators followed pork legs and loins from farm to canteen. The public sector organisation had a central contract with the foodservice company to provide their entire catering requirement at various locations throughout the UK. The following table lists the companies involved and representatives from each.

Table 6.1 Supply Chain Improvement Core Team Members

No.	Company	Representative
1	Farmer	No representation in the core team
2	Abattoir and meatpacker	General Sales Manager
3	Foodservice Company	Director of 'Public Catering' Supply
		Senior Buyer – Fresh Foods
4	Public Organisations Catering Department	Operations Manager
5	Cardiff University	The author

The mapping exercise showed that the canteens have a relatively steady demand due to an almost fixed number of people routinely stationed onsite being catered for with occasional significant changes in demand related to additional numbers being brought in. The budget allocated to caterers was based on the cost of a selection of main

ingredients drawn from a core range of products. The budget at the time of this study was averaged at £1.80 per head to provide 3 meals per day with extra funds being allocated for additional requirements. The supply chain members decided to participate in this project to ensure the highest levels of logistical efficiency were achieved and that the supply chain tightly adheres to the target budget. As explained in Chapter 5, the VCA project primarily aimed at improving whole chain efficiencies. The foodservice company is one of the UK's leading foodservice organisations with a turnover of over £1 billion a year. It supplied a food range of around 1,600 products across three temperature bands (ambient, frozen and chilled), delivered to around 1,000 delivery points, making 150,000 deliveries and assembling 21 million food items a year. The total value of this catering contract in 2005 was just less than £100 million per annum where approximately £15 million was spent on red meat procurement only (including pork) and delivery to flexible locations and formats was required. The case study looks at the supply of frozen pork loins and legs from the meatpacker plant in East Anglia. The farm was an integrated system of cereals, potatoes and pigs located in Lincolnshire with a long term relationship with the meatpacker. The following shows *how* the supply chain team was able to identify the disconnectedness of consumer value with both product attributes and supply chain activities. Also, there are discussions around *how* processes along the supply chain were potentially realigned with consumer requirements and *why* supply chain effectiveness was partially improved followed by a description of the subsequent efficiency gains.

6.2.2 Case Study Findings and Analysis

The researcher followed the 10 days data collection protocol expounded in Chapter 5. As already discussed, the protocol draws upon the Toyota mapping technique (Rother and Shook, 1999) where a detailed current state map of all activities along the chain is created for detailed analysis against the customer imposed requirements. Then a future state map is created and the companies involved work towards implementing it. Those aspects of the data collection which have been specific to this case study are explained in the following. Table 6.2 describes the activities during the fieldwork and the number of sessions (days) spent at each stage; in this case the project was carried out over 8 sessions (i.e. 8 contact days).

Table 6.2 Data Collection Events: Fieldwork Activity Details for Mapping Pork Loin and Legs

Session	Event	Activities
1	Introductory Workshop	- The project began with a team selection / team building workshop during which a principal agreement for benefit sharing was put in place to ensure maximum buy-in throughout the work. Also, all team members committed jointly to walk the entire supply chain from farm to the point of consumption. - The basic principles of SCM and Lean thinking were introduced. The team were familiarized with data collection methods and the relevant lean tools and techniques for value chain mapping and analysis (Hines and Rich, 1997). - Pork loins and legs were selected for mapping since they represented a good size of mutual business between the meatpacker, the foodservice company and the public sector organisation; they were also deemed to cover some of the most critical processes desired for analysis, e.g. the freezer at the distribution centre. - A generic map of the whole chain was created to help with understanding the scope of the work and for the team members to become broadly acquainted with the existing processes along the chain. Finally, the big picture map helped with selection and further refinement of the core team members.
2-5	Current State Mapping	- The whole team walked every stage of the value chain and produced a detailed map of all physical and information flows, from farm to canteen. This provided a unique opportunity systematically to analyse the performance of intra and inter-firm processes, and to evaluate supply chain relationships. During current state mapping both internal operational opportunities at each facility and external between companies were identified. Moreover, the mapping activity made it possible to identify those activities which do not have any role in adding-value (or minimising risk) to the end consumer. - Process Activity Mapping (PAM) technique was deployed which is an industrial engineering tool for analyzing each step of the process and logging the time at each step. PAM technique and findings are discussed below.
6 & 7	Future State Mapping Workshop	- Following the recommendations of Rother and Shook (1999) and Jones and Womack (2000), the team compared and contrasted current state activities against the ultimate consumer value as well as the immediate customer's requirements. Consumer value was captured through a brainstorm session followed by rudimentary discussions around consumer requirements. - The team then analysed the current state based on the efficiency measures collected during current state mapping at different echelon and against the consumer value. Also the current state was analysed against the end customers' needs. This led to identification of several opportunities for improvement. - The next step was to identify the key projects towards the future state: in the following it is explained how the vital few projects for implementation were identified based on cost vs. benefit analysis. - A shared vision of the future state of the whole chain was created based upon identified opportunities; the future state vision depicted how the chain should look like after the implementation period and served as a blue print for change management. - A number of Key Performance Indicators were identified to guide the implementation efforts. Target KPI's were stipulated to the future state.
8	Final Presentation	Joint presentation of recommendation to senior management of companies involved. Taking a decision as to which improvement projects must be progressed. Confirming the change proposal, allocating project owners, setting targets and milestones.

(Source: Author)

The Current State Map:

A variety of mapping tools and techniques were deployed during the project, e.g. quality filter map, delivery adherence map and demand amplification. (Hines and Rich, 1997) and the relevant tools were introduced to the team members at the outset of the project. The most basic tool deployed was Process Activity Mapping (PAM) which is a means of recording every step along the chain and a platform for creating current state maps. It captures details of all the tasks required for completion of each process including time taken to complete each task, distances moved and the number of times operators touch the product during each task. Table 6.3 shows a sample PAM sheet related to the cutting process at the abattoir for pork loin. As illustrated, PAM records all activities in a flow chart and classifies them into five distinct categories, i.e. operations, delay, inventory, inspection and transportation.

Table 6.3 Sample Process Activity Map - Abattoir

No	Activity step	Duration (sec.)	Distance (meter)	Touche	Operation	Legal	Transport	Inspection	Storage	Delay
1	Pig removal from chiller to the cutting line	30	15	1						
2	Queue of carcasses to the processing room	60	10	1						
3	Head removal	15	1	1						
4	pigs from hook to conveyor	30	15	0						
5	Separation into sub-primal	12	15	4						
6	Removal of rind	2	3	1						
7	Movement to the end of line	2	10	0						
8	Check and trim	2	1	1						
9	Check weight (make sure meet the spec)	3	1	1						
10	Product placed on racks	2	1	1						
11	Filling rack to capacity (100 each rack)	360	0	0						
12	Rack weighed on scale	60	3	1						
13	Rack moved to chiller	30	22	1						
14	Holding in chiller	14400	0	0						
15	Chiller to packing line	150	60	1						
16	Bag loins (on rack)	20	0	1						
17	Metal detection	5	0	1						

(Source: Author)

A separate PAM was created for the farm, the abattoir, the processing plants, the distribution centre and the canteen. Activities were then categorised as Value Adding (VA) and Non Value Adding (NVA) along the whole chain. Only a fraction of the operational category in the PAM sheet is considered to be value adding. The aim is to increase value adding operational time where possible. In the lean approach the ultimate arbiter of value is the end-consumer and the yardstick for determining VA and NVA activities is the consumers' willingness to pay for the service. It must be noted that some NVA are necessary given the technical and practical constraints. For example, if a product is waiting in stock it is recorded as NVA in the lean approach; nonetheless certain amount of inventory is inevitable in any supply chain. In the above example only five out of seventeen steps are operational steps where only four are considered to be value adding operations, i.e. step seven which is picking the sub-primal and moving it to the end of line is not considered value adding operation despite the fact that it is necessary in the existing layout. The total time is 15,178 seconds (or ~253 minutes) out of which only 49 second are value adding; in other words 0.3% VA time.

Subsequently, all PAM data were pulled together to create a current state map of the physical flows for the whole chain and then the information flows were added to generate the current state map as illustrated in Figure 6.1 (map of loin). The current state map shows the physical flows, the information flows, total lead-time, value adding time and a number of logistical efficiency KPI's. It shows that the total lead-time for loin is 276 days and 11 hours out of which 233 days are spent at farm (animal breeding and rearing). So lead-time excluding time at farm is 43 days and 11 hours and according to PAM sheets value adding time is just less than 25 hours (i.e. 24 hours cooling at the meat packer, 15 minutes value adding operation in slaughter and cutting, 15 minutes value adding operation in the distribution centre and 20 minutes value adding time during cooking in the canteen's kitchen). That is 2.4% of the total lead-time excluding time spent at farm.

In the diagram, the physical flows are shown in black and information flows are illustrated in red across the top of the map. Dotted red lines represent rework or information processing that should be avoided in the first place, e.g. at the food service depot exceptions and order substitutions are keyed-in separately which are caused by unavailability and considered to be rework or failure demand. The triangles stand for inventory. Finally, the time line is given at the bottom of the diagram where figures in brackets represent value adding times at each stage.

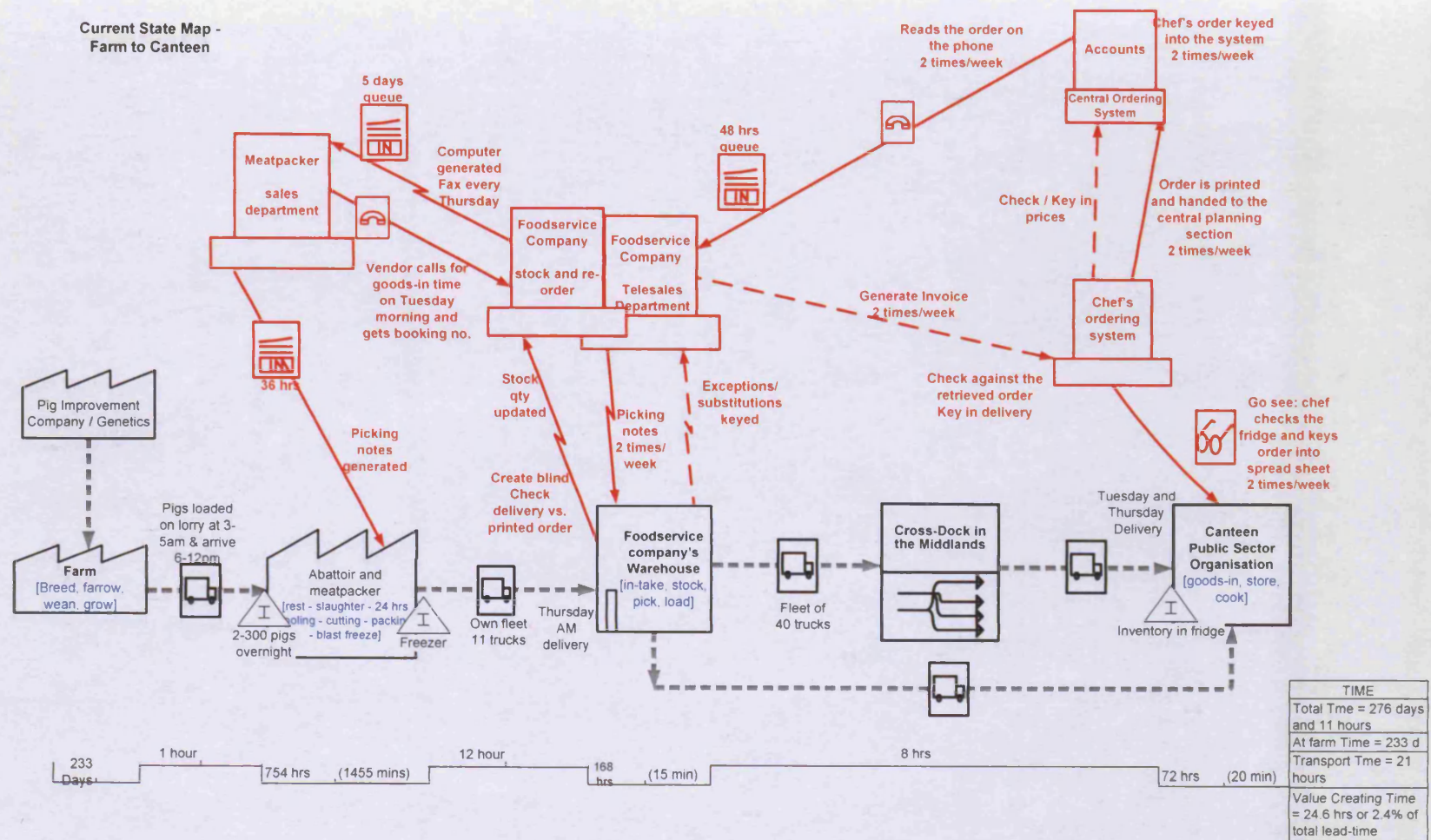


Figure 6.1 Current State Map for Pork Loins from Farm to Canteen

(Source: Author)

Identifying key opportunities for improvement and generating future state maps:

Analysis of the chain threw up many opportunities for improvement ranging from quick fixes to long-term changes. Value stream mapping often leads to exposure of several quick fixes which are in most cases related to supplier's unfamiliarity with the actual needs of the customer. During this project for example, in the course of mapping at the cut and pack process the Director of Public Catering Supply at the foodservice company noticed that labels were being applied to cardboard boxes which were no longer required due to a change of the scanning process at the foodservice company many years ago. This opportunity and many similar opportunities (found in a number of chains) were fixed during the project without needing to be left to the planning stage. Furthermore, in terms of consumer alignment this instance is similar to cases reported in Table 5.8, serving as moments of truth for the researcher and influencing his understanding of the importance of supply chain consumer alignment. An understanding of supply chain effectiveness was developed and applied beyond the quick fixes as will be explained in the following.

Apart from the quick fixes, the VCA identified several critical improvement opportunities. During the future state mapping sessions a full list of all opportunities was generated and they were ranked through discussion and consensus. Discussions centred on the perceived cost/benefit of implementing each improvement opportunity. After much qualitative analysis, the team identified the following five key opportunities to be taken forward into the implementation phase:

1. Review of the product specifications. The product specifications had not been revised since being established in 1963 and were by and large outdated.
2. Setting up Electronic Data Interchange (EDI) between the foodservice company and the public sector organisation. At the time of the study, a telesales system was in operation with 20 staff dedicated to the telesales department at the food service company.
3. Backhaul opportunities between the supplier and the distribution company. Both the processor and the foodservice company operated their own fleet. The team established that, in addition to this value stream, plenty more opportunities existed for backhaul to and from the central warehouse through better planning with various suppliers.

4. In-house improvement opportunities at the processing plant (such as improved lay-out, work balance and packing equipment performance).
5. Work standardization at the farm. For example, reducing the variance in the performance of stockmen. Historic records showed that skilled stockmen achieved piglet mortality rate four times lower than poor stockmen. It was endeavoured to standardize the skilled stockman's operations for training new staff.

Having mapped and analysed the current state, the team worked towards generating a collective vision of a supply chain that operates as an integrated entity focusing on elimination of all non-value adding activities and enhancement of the supply chain *value* proposition. The shared aim amongst team members was the satisfaction of the end consumer. The team members brainstormed the attributes of consumer value, categorised them *and related them to a set of supply chain Key Performance Indicators* illustrated in Table 6.4. Through consensus, five factors were identified as the key constituents of value in this chain reflecting the requirements set by the public sector organisation, the chefs and the actual consumers. The Voice of Customer (VoC) can be seen as a bundle of various explicit or implicit value attributes (Khalifa, 2004). The brainstorm session was a rudimentary way of capturing and discussing VoC. The outcome of the discussion session was largely influenced by and depended on the public organization sharing their knowledge of consumer needs acquired through focus groups and direct contact with chefs. At this stage it was obvious that, *even though the foodservice company and the public sector organisation were separately measuring and analysing consumer satisfaction, they had never coherently linked together the requirements of the consumer, the product features and the supply chain activities*. The future state workshop provided the opportunity to link the three together for the first time. Altogether, lack of consistent understanding about consumer requirements suggests that, from a supply chain effectiveness perspective, the chain was in a state of unconscious incompetence. In contrast, the efficiency levels along the supply chain were good. For example the distribution service achieved 99.7% lines delivered in-full against lines ordered (substitutions permitted). In the abattoir a state of the art slaughter line was observed, which had excellent ergonomics leading to better consistency in quality, and the first Autofom application in the UK that ultrasonically scanned each carcass immediately after slaughter. A three dimensional picture was built up of the muscle and fat allowing accurate payment to the producer for the actual meat delivered.

Table 6.4 Translating Consumer Value into Supply Chain KPI's

Consumer Value	Supply Chain KPI's
Cost efficient distribution	Total cost to serve for the whole job
Quality and consistency	Produce to exact product specifications as required by the final customer
Value for money	Top 40 products' buying effectiveness (examined by independent 3 rd party)
Delivery on-time/in-full	99.7% right quantity delivered (substitution allowed) 97% perfect order (no substitutions measured by comparing credit notes with invoices)
Strategic reserve	21 days to feed

(Source: Author)

In spite of the attempt to address consumer value during the future state workshop, the value categories presented in Table 6.4 are no more than a list of efficiency related issues. *The reason is that the method deployed in capturing value categories – i.e. linking the consumer value to supply chain operational measures – is limited and inhibitive in terms of free thinking around consumer needs.* This method, which first appeared in Hines and Taylor (2001), inadvertently channels the participants' thinking towards operational efficiency measures such as quality, cost and delivery (QCD). Section 6.3 explains that the issues of consumer value and supply chain measures should be addressed separately and that value categories should not be limited within the confines of QCD.

Table 6.4 shows different aspects of value as agreed upon by the team members and ranked by importance through consensus. The team's perception was that the most important feature of consumer value is cost efficient distribution linked into an overall measure for the total cost of delivering the pork product. There was a cost-plus contract in operation between the foodservice company and the public sector organisation. Accordingly, in order to encourage ongoing collaboration, any saving in the cost of distribution was to be shared equally between the two parties. The team's perception was that the aim of the VCA project is to deliver cost savings and an obvious area for cost saving – which could be equitably shared – was distribution costs.

The second most important facet of value was quality and consistency of the product measured through rigorous methods such as customer direct feedback to the suppliers and random quality checks. At the outset of the project both the end customer and the distribution company were adamant that the supply chain consistently met the specifications and the quality criteria. However, this was later proved to be a wrong measure due to the specifications themselves being outdated and a lack of understanding of consumer needs. This aspect of VCA is expanded in more detail in the following (also see case 4 in Table 5.8). The third attribute of the consumer value was cost efficient purchase of the raw material which was being measured through independent third-party monitoring of the procurement of the top 40 products (including the pork products). The fourth aspect of the consumer value was on-time/in-full (OTIF) delivery into the canteen. The food service company achieved 97% OTIF obtained by checking the credit notes against the invoices. The measure was closer to 99.7% when substitutions were taken into account (the contract allowed for substitutions within reason). Last but not least, the end-customer required a strategic reserve of at least 21 days stock to be kept in the distribution pipe-line at anytime (i.e. inventory anywhere between the distribution company's warehouse and the canteen). It was not clear whether this is actually needed or just a legacy of past systems. However, keeping strategic reserve was not an issue since the products were delivered via a frozen chain. Then again, a chilled chain would have meant cheaper and fresher produce.

The key improvement opportunities and the issues related to consumer value have so far been discussed in this case study. Moreover, value attributes were related to a set of supply chain KPI's (Table 6.4). In order to understand the extent to which the key projects deliver against the supply chain objectives, a "*sanity check*" (Taylor, 2005) against the supply chain KPI's was carried out during the future state workshop.

Supply Chain Improvements Opportunities

Consumer Value Attributes	Supply Chain KPI	Review of product specification	Electronic data interchange	Backhaul between abattoir and foodservice	Farm work standards	Meatpacker in-house efficiency gains	
Cost effective distribution	Total cost to serve for job	2	3	2	0	0	7
Quality & Consistency	Product specification	3	1	0	0	0	4
Value for Money	Check top 40 products' price	3	3	1	3	3	13
Delivery On-time/in-full	97% perfect order	0	1	0	0	0	1
Strategic reserve	21 days to feed	0	0	0	0	0	0
		8	8	3	3	3	

Figure 6.2 Key Improvement Projects impacts against Supply Chain KPI's (Scale: 0-3)

(Source: Author)

In the above diagram, each box is scored on a scale of 0-3 where 0 denotes no impact on the relevant KPI and 3 shows very high impact. As illustrated, implementation of EDI and product specification review equally had the highest impacts against the supply chain KPI's. Implementation of the EDI could result in significant efficiency gains estimated at around £400,000 per year. Nevertheless, it required relatively large capital investment and hence the need for a long lasting cost/benefit sharing agreement between the foodservice and the public sector organisation. The two companies could not reach an agreement mainly because the remaining length of the contract did not cover the pay back period for the required investment. On the other hand, review of product specifications required zero investment while potentially improving both effectiveness and efficiency of the chain. The following explains how chain effectiveness was improved and what efficiency gains were obtained as a result.

Future state discussions revealed that the foodservice company and the public sector procurement organisation were both active in understanding consumer needs through focus groups. Moreover, the processor and its suppliers took great care to produce to the correct specification. Even though the product was reasonably priced, had good quality and was delivered 99.7% in right quantity (allowing for substitutions), it did not match the customer attributes. The supply chain analysis connected all aspects of the supply chain together and revealed that the product specifications were outdated and did not reflect true consumer needs. The team identified three specific opportunities for changes to the product attributes and supply chain activities related to the products mapped in this value stream (pork loin and chops) as described below:

Reforming loin chops – Loin chops were manufactured by cutting a loin into about twenty-two pieces. The old specification required the meat processor to reassemble and pack the chops back into the shape of a loin. Historically, there were reasons for reforming, including preserving moisture for longer periods of storage especially for use in old facilities without refrigeration equipment. The team calculated 0.51% saving against consumer price (price delivered to the public organisation) by eliminating the reform process at the processor, and simply packing the chops from the loin into a plastic bag. This efficiency gain was achieved by focusing on the consumer value and realigning supply chain activities to that end. Therefore, focusing on effectiveness, in this instance, yields considerable efficiency gains details of which are not discussed for confidentiality reasons.

Fillet pack size - The team made an observation that the number of pork fillets in one pack should be reduced from 15 to 5. This enabled the chefs to defrost fillets in smaller quantities and no more than required which offered better convenience to the customer. In addition to better convenience, the team anticipated some efficiency gains due to reduced wastage of pork fillet.

Boneless Loin – The current state map showed that the loin was being supplied with bone. In the kitchen the product needed to be boned and the bone to be disposed of which incurred extra cost. The impacts of aligning the supply chain to consumer value in this case were two fold:

1. Effectiveness gains: a questionnaire was sent out by the public sector organisation following the team's suggestion to see whether delivering boneless loin is aligned to customers' preference. In all cases the public sector organisation followed up the results by telephone and in a few cases had even obtained the entire results through telephone interviews. One limitation of the study was in consulting the chefs rather than the actual end consumers about their preferences. Moreover, the telephone interviews did not exactly ask why chefs liked or disliked the boneless product; nor did it follow-up when an answer was not specified increasing the possibility of type II error⁹ in analysing the results. 23 answers were received from chefs responsible for fairly similar size canteens supplied through this chain (from the same source) results of which are illustrated in Table 6.5. Out of 23 respondents 14 preferred boneless loin, 3 were indifferent, and 6 said no. That is 61% in favour, 14% indifferent and 25% against boneless loin. The expected distribution of answers is binomial¹⁰. According to Silver (1997) for small samples (such as this one) the continuous distribution approximations, such as the chi-squared test, break down and there is no alternative to a binomial test. In this case the population size is more than 300 canteens which is more than 10 times bigger than the sample size. The statistical question is whether the proportion of yes answers is significantly higher than would be expected by chance. To find an answer to this question using the binomial test, the researcher uses the binomial distribution to identify the probability of finding 6 or fewer negative answers in a sample of 20 when the random probability of a 'NO' in each trial is 50%. The probability of 6 or fewer respondents disliking the boneless product out of 20 respondents is 0.057, i.e. $B(20, 6, 0.5) = 0.057$. It is notable that 3 respondents did not specify their preference and therefore were regarded as meaningless data. Assuming an alpha level of 0.05, it is marginally concluded that the customers preferred boneless loin (since no boning).

⁹ Type II error occurs when we believe that there is no effect in the population, when, in reality there is.

¹⁰ The binomial distribution applies when an experiment is repeated a number of times (discrete data), there are only two possible outcomes for each experiment (dichotomous outcomes), outcome of experiments are independent from one another and mutually exclusive, the probability of the two outcomes remain the same throughout the experiment and experiments are randomly selected (Silver, 1997). The indifferent answers are not included in the test. The binomial test is an exact test of the statistical significance of deviations from a theoretically expected distribution of observations into two categories. If no specific preference we would expect 10 yes answers and 10 no.

Table 6.5 Customer Preference for Boneless Loin: Results of the Postal Questionnaire

Type of Product Listed on Menu from Loin		Roast	Chops	Roast	Steak	Stir Fry	Escalope	Medallion	Dice	General Preference
Canteen	(Bone in or out)	In	In	Out	Out	Out	Out	Out	Out	Boneless (YES/No)
1			Menu	Menu	Menu	Menu	Menu	Menu	Menu	NO
2				Menu	Menu	Menu	Menu	Menu	Menu	NO
3				Menu		Menu	Menu	Menu	Menu	YES
4				Menu	Menu	Menu				YES
5				Menu						NO
6		Menu	Menu	Menu					Menu	NO
7					Menu	Menu	Menu	Menu	Menu	YES
8			Menu	Menu					Menu	Not specified
9		Menu		Menu	Menu	Menu	Menu		Menu	Not specified
10		Menu		Menu	Menu	Menu	Menu		Menu	Not specified
11				Menu		Menu	Menu			YES
12					Menu	Menu	Menu	Menu	Menu	YES
13		Menu		Menu	Menu	Menu	Menu	Menu	Menu	NO
14				Menu						YES
15		Menu	Menu			Menu			Menu	YES
16			Menu		Menu		Menu	Menu		YES
17					Menu	Menu	Menu		Menu	YES
18					Menu	Menu	Menu		Menu	YES
19			Menu	Menu		Menu	Menu			YES
20			Menu	Menu	Menu	Menu	Menu			YES
21		Menu								NO
22										YES
23				Menu	Menu					YES
	Total Yes	6	7	15	13	15	14	7	13	14
	% Yes	26%	30%	65%	57%	65%	61%	30%	57%	61%
	% In-different									13%

(Source: Anonymous Public Sector Organisation)

2. Efficiency gains: Realignment of the supply chain with consumer value (i.e. boning at the cut and pack stage and delivering boneless loin) leads to a number of efficiency improvements. Firstly, the boning operation was more time consuming and labour intensive when carried out at the canteen as opposed to being done at the processor on an industrial scale. The processor produced boneless loin for other customers and could batch products together. Secondly, there was a small residual value to the bone at the processor. Thirdly, there were logistical savings to be made along the chain. Four bone-in loins were fitted in a box compared with six boneless products after

the modification. Therefore 33% fewer boxes and delivery pallets were needed which amounted to 96 full pallet deliveries saved in a single year. The following diagram shows a map of the perceived logistical savings along the chain *just emanating from fewer boxes and pallets as calculated by the team* (assuming linearity of the purchasing costs of boxes).

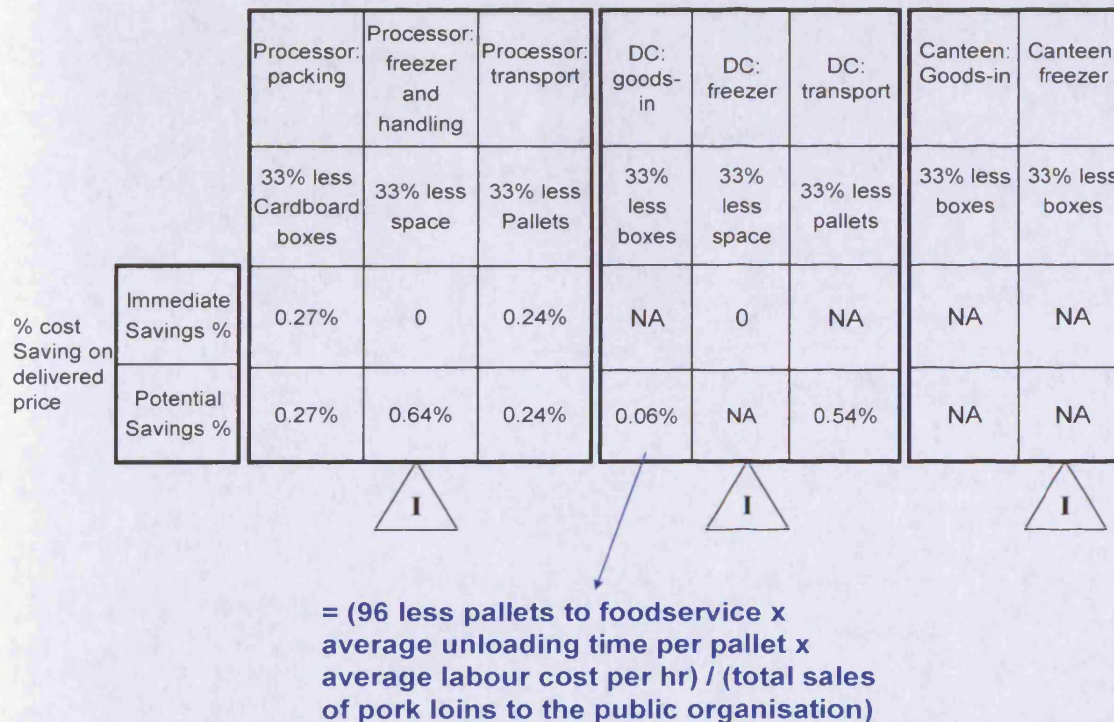


Figure 6.3 The Logistical Efficiency Gains from the Boneless Loin Related to Fewer Boxes
(Source: Author – partially reported in Zokaei and Simons 2006a)

Figure 6.3 quantifies both the immediate and the potential logistical efficiency gains related to introducing boneless loin. The potential savings related to this particular value stream include: 33% packaging material at the processor, less freezer space and handling at the processor, less box handling at goods-in in the distribution centre, less freezer space and handling at the distribution centre, less pallet transportation to the public sector organization and less handling and freezer space at the canteen. Total potential savings are around 1.75% on the final price delivered to the canteen (where data was not available zero saving was assumed). However, only a fraction of the potential savings can be immediately realised since for example saving space on a

single SKU does not translate into less space in the freezer or less goods-in for one product does not reduce the requirement for a goods-in person. Figure 6.3 provides an example of how the potential savings are calculated, i.e. the goods received process at the distribution centre. The actual figures related to cost of labour, and time required to handle a single pallet are censored to protect the total sales figure related to pork loins.

When potential savings thinking is repeated over time and in a range of products then at some point there may be the potential to redeploy resource to other activities. This is the continuous improvement principle of lean thinking (Womack and Jones, 1996). Total immediate savings are at least 0.51%. This amount was equal to about 1% profitability on sales against a backdrop of only 3-5% average chain profitability across the whole red meat sector (Simons, Taylor, Francis, Zokaei, *et al* 2007). Saving related to labour in the canteen is partly offset by extra labour required at the processing end to bone-out loin; however this is not included in calculations due to lack of data.

6.2.3 Discussions, Conclusions and Recommendations

This case study shed light on the great need for addressing consumer value in the context of supply chain management by explaining *how* and *why* the supply chain was disconnected from the consumer needs while being reasonably efficient. For example pork products were being delivered 99.7% OTIF, yet a huge amount of waste existed since product specification had essentially not been revisited since they were established in 1963. The concept of supply chain effectiveness was explained in Chapter 3 as an abstraction for the ability of supply chains to deliver enhanced consumer satisfaction. This case study shed light on the nature and differences between supply chain efficiency and effectiveness showing that efficiency measurement and improvements *per se* fall short of meeting the consumer requirements.

The value chain improvement method deployed in this case study (the 10 days protocol and underlying approaches) is rooted in lean concepts and Toyota supply chain management techniques. Focusing on consumer value is the first principle and the very tenet of lean thinking (Womack and Jones, 1996). Therefore, and regardless of the fact that so far lean supply chain improvement efforts tend solely to address efficiency improvements (e.g. inventory reduction, just-in-time deliveries, zero defects, machine

uptime improvements, etc.), lean presents a suitable platform for greater attention to supply chain effectiveness and delivering enhanced consumer satisfaction through superior SCM. For example PAM and VSM techniques were used which categorise activities into VA and NVA depending on the end customer's willingness to pay. More importantly, the VCA project involved the entire process and brings a team together creating an apt environment where consumer value could become the central focus.

The VCA exercise threw up many improvement opportunities; the team opted for 'review of product specification' which delivered both supply chain effectiveness and efficiency improvements while requiring almost nil investment. On the other hand, opting for efficiency improvements such as 'implementation of EDI' would have required hefty capital investment upfront while not necessarily securing consumer satisfaction since the same out-of-spec product would have been delivered. In Figure 3.1 (Chapter 3), focusing only on efficiency gains (e.g. implementation of EDI ordering system) corresponds with moving from A to B while 'review of product specification' is linked to moving A→C which inadvertently resulted in considerable efficiency gains and turned out to be an ideal A→D move. At the same time that further A→B improvements are encouraged in any chain, it is suggested that an efficiency gain is an illusion unless linked in with consumer value. There are three key learning points in this case study:

1. Every supply chain is there to serve the final customer, but often chain members do not have a clear and consistent understanding of consumer requirements nor the means of capturing value and translating it into supply chain actions. Creating a supply chain improvement team (or office) is one way of tackling the problem while lean mapping, VSM and VCA techniques present great untapped potential for realigning chain with true consumer value and linking efficiency measures to effectiveness.
2. The existing supply chain improvement toolbox (Jones and Womack, 2000; Rother and Shook, 1999; Hines and Rich, 1997; Taylor and Simons, 2004) currently has serious shortcomings in terms of linking efficiency improvements to the actual requirements of consumers (i.e. linking efficiency with effectiveness). Conventional supply chain management focuses on efficiency of firms along the chain. Shortcomings of conventional SCM are well documented in the lean supply chain literature (Womack and Jones, 1996; Hines *et al*, 2000) and call for analysis of the

entire flow of (individual) products along the chain (Jones and Womack, 2000). However, this case study showed that the lean approach does not get grasp of its own first principle, i.e. the consumer value, in the context of the extended chain since it does not put forward a rigorous method of linking measures and improvements to the ultimate value.

Previously this author said that the traditional lean approach – branded as the VCA method and developed by authors such as Francis (2004) and Taylor (2005) – is conducive towards improving supply chain effectiveness and enhancing consumer focus (Zokaei and Simons, 2006a). This is to some extent true as creating a supply chain improvement team is a unique opportunity for linking activities to consumer value. During the project, the team did realise the need for understanding the consumer value and made a degree of progress in addressing supply chain effectiveness. Nonetheless, discussions in this case study partially show that the mechanism deployed to address the consumer value and to link it in with supply chain opportunities was limited. In Figure 6.2, both the vertical and horizontal axes include efficiency issues and measures. As already discussed, the problem arises from the limitations in capturing the Voice of Customer in Table 6.4. Therefore, unlike the QFD method (Akao, 1990) which links the VoC to product attributes, there is not a proper *sanity check* put forward in this model which arguably compares efficiency against efficiency [see Appendix E]. In the next three case studies a more advanced technique is developed to explain *how* supply chain effectiveness can be enhanced.

3. This case study explains the relationship between efficiency and effectiveness through quantification of some of the inadvertent efficiency gains resulting from ‘review of product specification’. It must be noted that the key aim of this improvement initiative for the team was to deliver better customer satisfaction and all efficiency gains were regarded as icing on the cake. Also, as already mentioned, what has been quantified in Figure 6.3 is just a fraction of the potential savings only related to one aspect of product specification review.

A key limitation of the study was that the real requirements of consumers were not captured. A post event questionnaire was sent to chefs and the actual consumers were not surveyed. The next three case studies address this limitation by developing new approaches and drawing upon extensive consumer data.

6.3 Case Study 2: A UK Fresh Milk Supply Chain

6.3.1 Project Background and Introduction to Participating Companies

Fresh milk is considered to be a basic commodity and, as for many other agri-food commodities, there is intense price competition in this sector in the UK. The average milk farm gate prices decreased from 25 pence per litre in 1997 to about 18.5 pence per litre in 2005 (MDC, 2006). In recent years supermarkets and brand owners have attempted to formulate ways to differentiate in the fresh milk category (e.g. organic and local brands). Differentiation and de-commoditization are of massive importance to the UK agri-food sector in general and the dairy sector in particular (see Section 5.2.3). With so many dairy farmers struggling to cover their production costs at the basic farm gate prices, the need for more premium products is urgent.

Table 6.6 Supply Chain Improvement Core Team Members

No.	Company	Representative
1	Dairy farm	Farm manager
2	Milk Collections and Distribution	Operation Supervisor
3	Dairy company	Operations Director
4	Dairy Coop	Operations Manager
5	Retailer	Store Manager
6	Cardiff University	The author

This case study reports on the findings from a project involving a dairy farmer, a milk collection and distribution company, an SME milk processing and bottling firm, and a convenience retail store. The farmer was part of a dairy cooperative, one of the largest in the UK, which also owned the milk distribution company and the dairy plant. The distribution company and the dairy firm were however largely autonomously managed. The supermarket was part of a franchise retail chain, one the largest convenience brands

in the UK. The project facilitation and data collection protocols were the same as explained in the previous case study and Chapter 5. The above table lists the companies involved and representatives from each company.

6.3.2 Case Study Findings and Analysis

This value chain analysis and improvement project was twofold. On one hand, the team analysed the efficiency of the supply chain, using conventional mapping approaches (as fleshed out by authors such as Simons *et al*, 2003) to identify efficiency improvement opportunities such as time reduction and logistical improvements. On the other hand, the author urged the team to focus on understanding consumer requirements to find out how better supply chain management can contribute to the delivery of superior consumer value, i.e. creating a more effective supply chain. The previous case study reported efforts to reconnect with consumer value and duly to realign processes to deliver basic consumer requirements. This case study shows ways to enhance consumer value even beyond the basic needs and illustrates an example where consumer expectations are exceeded. It reports on a new method for enhancing the supply chain consumer focus, i.e. the *Supply Chain Kano-QFD* technique.

Table 6.7 illustrates the key opportunities identified after mapping the supply chain (these are the key findings selected and ranked through consensus from a longer list). Opportunities 2 to 5 were identified through mapping and analysis around efficiency measures. The first opportunity, however, was identified and added to the list by comparing the supply chain activities against implicit and explicit consumer needs. This section does not intend to delve into how the efficiency opportunities were identified since this aspect of the method was explained in the previous section. Having discussed the key improvement opportunities in Table 6.7, the following addresses supply chain effectiveness by linking the potential improvement projects to consumer satisfaction through a novel approach.

Table 6.7 Supply Chain Improvement Opportunities

No	Improvement Opportunity	Description
1	Promotion of local fresh milk and local branding strategy	The consumers were concerned whether the products were locally supplied. However, the chain was not communicating the fact that the product is 100% locally sourced and processed.
2	Improve ordering system between the convenience store and the dairy company to increase efficiency and reduce time to replenish.	It was possible to reduce the lead-time from order to delivery by up to 24 hours. The analysis also showed that the dairy firm needed to improve the overall alignment of its order taking system to the end customer demand to reduce distortion and amplification of actual end consumer demand. The team targeted development of a simple integrated cross-company ordering process between the retail franchise and the dairy. Also, development of a standardised simple, logical process to ensure that orders generated are linked to actual end consumer demand with minimal distortion. In the long term, this project should investigate the implementation of an IT/web based system to allow the retail stores automatically communicate daily their actual sales and orders with dairy company.
3	Introduce on-farm Key Performance Indicators (KPI's)	Price of the milk was based on its quality (quality based pricing). The farmers needed to introduce a standard set of on-farm measures linked to quality, e.g. composite measure of protein, fat and cleanliness content of milk delivered milk by each farm. KPI's need to be monitored regularly in order to be able to track long-term farm performances and to highlight where improvement opportunities lie. This allows the farmers' cooperative to provide pro-active feedback about farm performances and to give support through improvement forums.
4	Improve production efficiency at the processing plant	Issues of high wastage, low equipment utilization, lack of work standardization, lack of visual management, change-over times and Takt-time problems (Simons and Zokaei, 2005) were observed at the dairy firm. The team also recommended standardized design for labels to reduce product complexity.
5	Implementing clearer transport efficiency measures for milk collection	Better quantification of delivery performance to the processor and vehicle turn-around time at the farm to reduce transport losses at the distribution company.

(Source: Author)

Capturing and Understanding the Consumer Value:

Ideally everyone within a supply chain should have the same view of what consumers' needs are, based on good market research and communication along the chain. However, different parts of the chain, often, have differing opinions about consumers' value leading to conflicting behaviour and poor overall consumer satisfaction. The understanding of consumer value should come from the consumers themselves and businesses cannot assume what the end buyers need (Hauser and Clausing, 1988). Many methods for capturing consumer needs have been developed and used within the marketing literature such as the use of focus groups (Floyd *et al*, 1993). However, these tools are hardly ever used at the supply chain level.

Sometimes direct consumer data might seem irrelevant to some parts of the chain, especially those upstream. Moreover, the resources and sophistication required for capturing and analyzing consumer value can be too onerous for smaller firms in the chain. In this case study all the participating businesses were small to medium size firms and had limited resources on their own to commit to sophisticated market research. However, when the supply chain joined forces, it became possible to establish a supply chain continuous improvement office to look at the consumer needs. In the first step the team looked at market information provided by a third-party market research company to gain the basic understanding of the shopping patterns and preferences of the consumers. This was across the whole fresh milk market explaining demographics of various buying groups. Then the team applied the Kano model of consumer value to capture and categorize the consumers' requirements (Kano, 1984). The Kano Model (Figure 6.4) illustrates the relationship between consumer satisfaction and performance of products/services. The Kano model provides an effective categorizing of the consumer value into three distinct dimensions: attractive value elements, one-dimensional attributes and must-be attributes (Matzler and Hinterhuber, 1998).

Must-be attributes: These are the basic criteria for consumer satisfaction. They are hygiene factors taken for granted by the consumer. When these value elements are not fulfilled the consumers are extremely dissatisfied; however, excelling in their fulfillment can only result in a state of *not dissatisfied* and nothing more. For example, in this case study, it was deemed that milk should have the right colour and taste, a minimum of 2-3 days shelf-life, no leakage and be safe to consume. Any defect in any of these aspects meant extremely dissatisfied consumers.

One-dimensional attributes: The one-dimensional requirements are generally explicitly expressed by the customers. They result in consumers' satisfaction when fulfilled and dissatisfaction when missing with higher levels of fulfilment corresponding to higher consumers' satisfaction. For example, in the studied chain, availability in the right size and the right fat content, speed of the transaction in store, ease of identification from other fat content products and other brands, and more than 3 days shelf life were recognized as the one-dimensional value elements.

Attractive value elements: the value attributes under this dimension of the Kano model, are neither explicitly demanded nor expected by the customer but are latent. Their absence does not cause dissatisfaction since the consumers are not aware of them; however, strong fulfilment in this dimension delights the consumers resulting in more than proportional satisfaction as illustrated in Figure 6.4. The team highlighted two possible delight factors: the local brand and low food miles as an environmental factor. The product was locally sourced and, naturally, travelled relatively fewer miles compared to the competitors' products. The consumers, also, highly valued the fact that the product was sourced from a local farm.

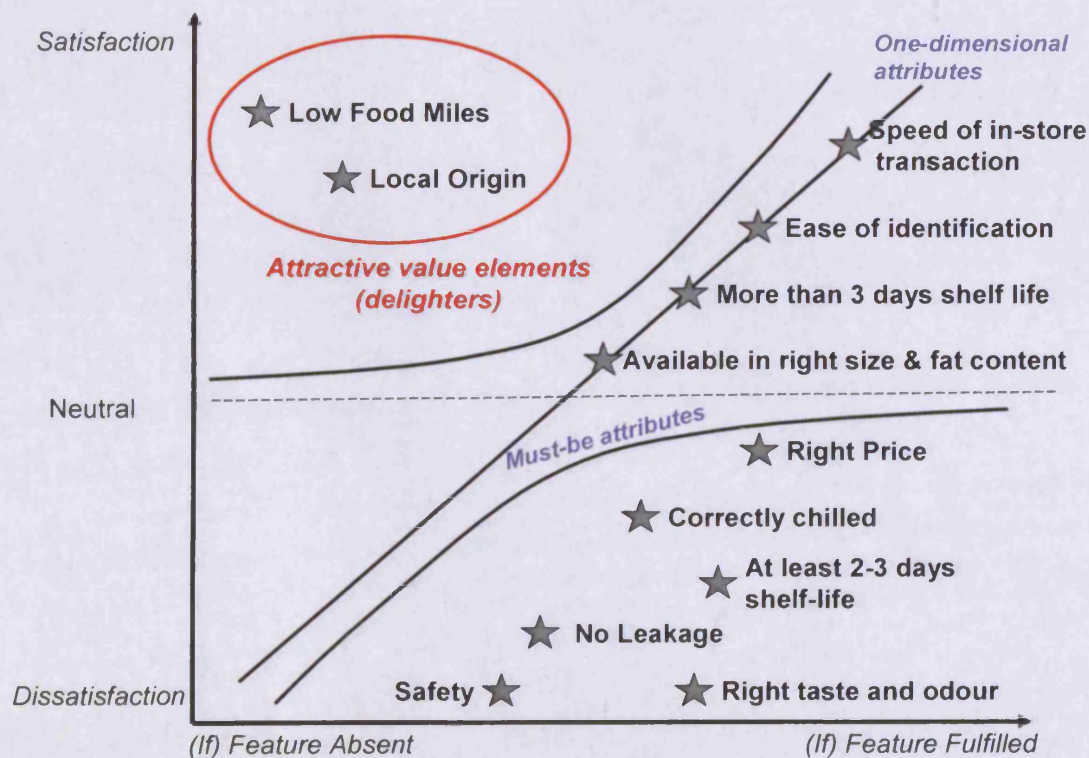


Figure 6.4 The Kano Model of Consumer Value

(Source: Author)

Figure 6.4 shows the team's view of value attributes against the Kano model obtained through discussions and by consensus. It must be mentioned that the limitation of this stage of the study was that the team had no direct contact with the end consumers; the categorization was entirely based on the experience of the retail and marketing teams in each firm and the market research information.

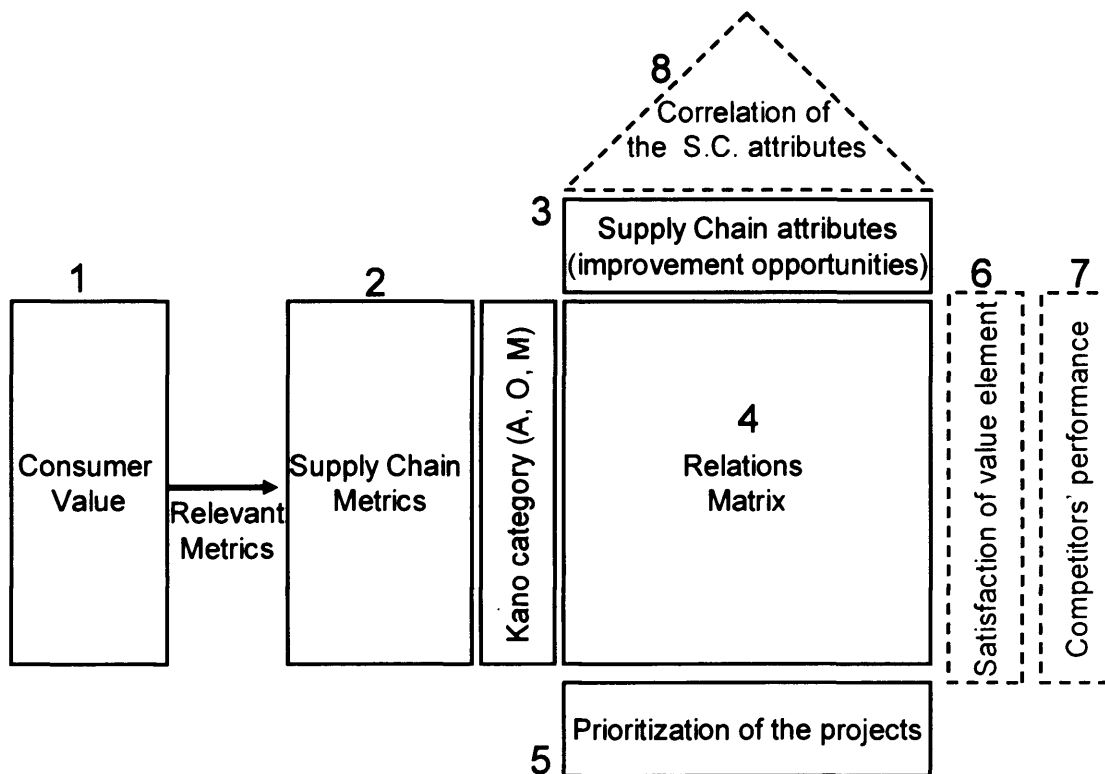
Linking Improvement Projects to Consumer Value:

The role of the supply chain in fulfilment of the identified consumer requirements is not always straight forward. The Voice of Customer (VoC) is often abstract and not meaningful to the supply chain managers. In this chain, it was necessary to translate the identified value elements into a supply chain language meaningful for the team members. Quality Function Deployment (QFD) is a technique, often deployed in New Product Development (NPD), to arrive at specific product (and production) attributes from the consumer requirements (Akao, 1990; Hauser and Clausing, 1998). “*It is equally valid to think of QFD as a way of identifying the true voice of the customer*” (Knowles, 2002, p. 58) as it pertains to product and process engineers. QFD is a mechanism through which companies ascertain that the product being designed is the product that consumers require [see Appendix E].

The value chain team adapted the QFD method to the supply chain to convert the Voice of Consumer (classified under Kano categories) into supply chain improvement projects. In other words, the *supply chain QFD* helps to establish the impacts of the identified supply chain improvement opportunities (Table 6.7) in terms of consumer satisfaction. It also helps to find out if there are any value elements which are not addressed by the supply chain improvement projects. If so the team needs to look into potential changes in the way the supply chain operates to make sure that the supply chain is, to its full capacity, contributing to the delivery of various consumer needs.

Figure 6.5, illustrates the proposed *Supply Chain Kano-QFD* technique for improving and creating effective value chains. To the left of the model, (Section 1 in Figure 6.5) are the value attributes; and at the upper-end of the model (Section 3) are the supply chain improvement opportunities. In the middle (Section 4) is a relationship matrix which shows the impact of each improvement opportunity on consumer satisfaction. At

the bottom (Section 5) is the cumulative importance of each improvement opportunity indicating priorities for implementation. The action plan should take into account the relative prioritization as well as availability of change resources (stage 4 of the method). The following explains how the method was deployed in the fresh milk chain.



Kano Categories: A = Attractive, O = One-dimensional, M = Must-be.

Boxes not addressed in the case-study are distinguished with dashed lines.

Figure 6.5 Supply Chain Kano-QFD Technique

(Source: Author)

The first step in this approach is to capture the VoC and categorise consumer value under the Kano dimensions as described in Figure 6.4. In some areas such as the speed of in-store transaction, the supply chain might have no impact or very little influence. In other areas such as shelf-life and freshness the supply chain plays a vital role. So, the next step is to establish the relevance of the supply chain processes to delivery of various Kano requirements.

Table 6.8 Role of the Supply Chain in Delivering Consumer Requirements

Consumer Value	Kano Category	Can S.C. influence?	Supply chain Objective	Supply Chain Metric
Low Food Miles	Attractive	Y	Reduce total transport miles	Total food miles
Local sourcing	Attractive	Y	Total supply chain traceability	Changes in supply chain market share
Speed of transaction	One-dimension	N	Good store operations and housekeeping	In-store housekeeping score
Ease of identification	One-dimension	Y	Good store housekeeping (e.g. presentation)	In-store housekeeping score
More than 3 days shelflife	One-dimension	Y	Reduce end-to-end lead-time	Supply Chain lead-time
Available in right size and fat-content	One-dimension	Y	React quickly demand changes (flexible production and transport). Effective ordering system across the whole chain.	On shelf availability (OSA) per line
				On-time / in-full delivery performances in the chain
Right price	Must-be	Y	Cost effective production, transport and farming	Average ppl farm costs
				Equipment efficiency and utilization (OEE) at processor
				Right first time quality at the processor
				Farm Quality Indicator
				Transport efficiency measures at distribution
Correctly chilled	Must-be	Y	Not break the chilled chain	Customer complaints (ppm)
At least 2-3 days shelflife	Must-be	Y	Reduce end-to-end lead-time	Customer complaints (ppm)
				Supply Chain lead-time
No leakage	Must-be	Y	Improve quality at the processor (every time with no variation) Handling practices in the chain.	Customer complaints (ppm)
Product safety	Must-be	Y	Correct quality at processor (every time with no variation) Not breaking the chilled chain	Customer complaints (ppm)
Right taste	Must-be	Y	Correct quality at farm and processor	Customer complaints (ppm)

(Source: Author)

Table 6.8 shows which value elements could be delivered through improved supply chain management. A series of relevant supply chain metrics and objectives are set against consumer requirements. This can be regarded as translating VoC into a meaningful supply chain language. In Figure 6.5, the supply chain metrics are depicted in Section 2. As illustrated in Table 6.8, it is possible, and often desirable, to have more than one metric against each consumer value. For example, two metrics are set against ‘availability in right size and fat-content’, i.e. on-shelf-availability and on-time/in-full delivery along the chain. The reason is that the combination of the two measures works better in terms of pointing to the root causes of out-of-stock situations.

The next step in the ‘Supply Chain Kano-QFD’ approach is to build a relationship matrix between the supply chain metrics set against the consumer value in Table 6.8 and the supply chain improvement opportunities in Table 6.7. The resultant matrix (Figure 6.6) demonstrated the relevance of the improvement projects in terms of consumer satisfaction. The existing supply chain improvement methods often fail to acknowledge the need for such comparison. Therefore, plenty of supply chain improvement projects remain limited to efficiency gains and fail to realize the true potential of the supply chain in terms of creating individualized sources of consumer satisfaction. Figure 6.6 illustrates the relationship matrix as suggested for the studied chain. The team excluded one of the attractive consumer value elements (i.e. low food miles) in Figure 6.6. It was decided that very sophisticated environmental branding was outside the remit of the work and a strong local brand could convey the positive messages the consumers require. However, the author recommends that ideally direct involvement of shoppers is needed at this stage to select the right value attributes in the *Supply Chain Kano-QFD* model ensuring effectiveness opportunities are not missed.

Each box in the relationship matrix shows the impact of a supply chain improvement project on satisfaction of a consumer value attribute. In order to get a meaningful importance rating, it is proposed to assess the importance of each improvement project against each consumer requirement on a numerical scale of 1, 3 and 9 where 9 represents strong impact, 3 represents medium impact and 1 represent weak influence. Such rating method is biased towards stronger relationships which are far more important to be taken forward to the action plan. The ratings are arrived at from discussions among the team and represent panel consensus. It must be noted that the

priority ranking of the improvement opportunities is sensitive to the ratings. Care must be taken in obtaining the consensus view of the supply chain panel to make sure the final rankings represent team consensus. Since the same panel of supply chain experts will implement the improvement opportunities, the consensus based approach ensures due consideration at the implementation stage.

Then, the numerical values in the relationships matrix are given an importance weighted according to the respective Kano category. In Figure 6.6, the attractive attributes are multiplied by 4, one dimensional by 1 and the must-be attributes are multiplied by 0.5 which weights the relationship towards the attractive value elements considerably (Shen *et al*, 2000). The cumulative ratings, at the bottom of the matrix indicate the relative importance of the improvement opportunities in terms of impact on consumer satisfaction and the priority implementation.

	S.C. Metrics	Projects Kano Categories	Promotion of local milk	Ordering System	Farm KPI's	Production Efficiency	Transport efficiency measures
Locally sourced product	Changes in supply chain market share	Attractive	9 x 4				
Ease of identification	In-store housekeeping score	One-dimensional		3			
More than 3 days shelf-life	Supply Chain lead-time	One-dimensional		1			
Available in right size and fat-content	On-shelf-availability (OSA) per line	One-dimensional		9			
	On-time / in-full delivery performances along the chain	One-dimensional		9		1	
Right price	Average ppl farm costs	Must-be			9 x 0.5		
	Overall Equipment Effectiveness	Must-be				9 x 0.5	
	Right first time quality at the processor and farm	Must-be		9 x 0.5	3 x 0.5	3 x 0.5	
	Farm Quality Indicator	Must-be			9 x 0.5		
	Transport efficiency measures at distribution	Must-be	1 x 0.5	3 x 0.5	1 x 0.5		9 x 0.5
Correctly chilled	Customer complaints (ppm)	Must-be		1 x 0.5			
No leakage	Customer complaints (ppm)	Must-be				1 x 0.5	
Product safety	Customer complaints (ppm)	Must-be				1 x 0.5	
Right taste & odor	Customer complaints (ppm)	Must-be			1 x 0.5		
Relative impact of projects on KPIS			36.5	28.5	11.5	8	4.5

Figure 6.6 Fresh Milk Supply Chain Kano-QFD
(Source: Author)

Based on this ranking the supply chain team is able to make informed decisions regarding the future action plan. In this chain, the action plan reflected and directly followed on from the rankings in Figure 6.6, i.e. re-branding of milk as the top priority project and so on. It was decided to implement improvements through a supply chain continuous improvement office. While in this example none of the five improvement projects required heavy investment, there are other factors which also need to be taken into account when putting together an action plan such as ease of implementation and availability of resources. These parameters can also be integrated into the proposed S.C. Kano-QFD technique in the form of additional weightings. The action plan should clearly identify the team members involved and responsible for the execution of each project. In this chain, two senior managers, from the dairy firm and the retail store, were assigned as the owners of the re-branding project with the whole team involved in the delivery of the project.

There are other theoretical features in the presented Kano-QFD model which were not deployed in this case study (i.e. Sections 6, 7 and 8 in Figure 6.5). It is proposed that future work should cover these areas. Feature 6 in Figure 6.5, shows the cumulative satisfaction of each value element. If any aspects of the consumer value are rated low (or zero) in Section 6, the improvement team needs to investigate whether superior sources of consumer value can be developed to deliver better consumer satisfaction, in the context of the supply chain. This feature is used in the final case study in this chapter (Section 6.5). Feature 7 shows the performance of direct competitors in terms of satisfying the value attribute. It is argued that the supply chain should at least match the performance of the key competitors. The values under Feature 7 should ideally come from the consumers and not the supply chain group. This feature is not discussed in this thesis due to lack of data on competitor performances. However, in practice Feature 7 presents a powerful business tool for supply chain managers and is recommended for further investigation. Feature 8 highlights the potential correlations between supply chain improvement opportunities. For example, a low inventory strategy may lower the price while having a potential negative impact on availability. The correlation analysis can be particularly useful for the future action plan; this feature is also recommended for further research in Section 6.6.

6.3.3 Discussions, Conclusions and Recommendations

As discussed in Chapters 3 and 5, the existing body of supply chain analysis and improvement knowledge is largely focused on the mapping and analysis of efficiency constraints. This case study puts forward a systematic and structured method of improving chain effectiveness, i.e. alignment and enhancement of the consumer value through capturing the capabilities and enthusiasm of all supply chain participants. The proposed method drew upon existing techniques in New Product Development (i.e. Kano and QFD) while building on the existing body of supply chain analysis and improvement as discussed in the previous case study such as value stream mapping (Hines *et al*, 1998; Hines and Rich, 1997; Rother and Shook, 1999) and value chain analysis (Zokaei, in press). The technique is best implemented as part of the VCA 10 days data collection approach and when deployed by a panel of experts from across the whole chain. The team first walked the entire chain to identify all (efficiency and effectiveness) improvement opportunities including activities misaligned with the consumer requirements. The *Supply Chain Kano-QFD* technique was then deployed to link those opportunities to value and to find ways for enhancing or exceeding consumer value.

In the previous case study the sanity check proposed by Hines and Taylor (2001) was criticised for merely checking efficiency against efficiency. That was because their approach limited supply chain KPI's to a series of QCD measures, whereas *Supply Chain Kano-QFD* (see Figures 6.5 and 6.6 and Table 6.8) allow free brainstorm of various aspects of value. The proposed technique will allow the improvement team to make informed decisions taking into account supply chain effectiveness as well as supply chain efficiency. For example, in the presented case study the opportunity for a new local milk brand was revealed only when the team applied the technique. The Kano model enabled the team to gain an insight into the consumer delighters (e.g. the local brand). Moreover, the end-to-end mapping allowed the team to connect all aspects of the supply chain together and revealed that the product was 100% locally sourced which matched the consumer needs. It is imperative to ask what consumer value is throughout the mapping exercise. Finally, the *Supply Chain Kano-QFD* method translated the consumer requirements into supply chain improvement projects and showed their relative impact on consumer fulfilment. It is noteworthy that this technique emerged

during the mapping as a result of continuous refinement of methods and feedback between the researcher and the supply chain team (denoting an action research oriented approach).

The proposed method can be further adapted in the design of new supply chains (Hines *et al*, 1998). The limitation of this case study was in not using sophisticated market/consumer data; this limitation is addressed in the next case studies in Sections 6.4 and 6.5. It is recommended that further effectiveness tools and techniques should be developed in the supply chain management arena. Tools and techniques can be borrowed from the marketing stream to understand and characterize different aspects of consumer value (Khalifa, 2004).

6.4 Case Study 3: A UK Cereals Supply Chain

6.4.1 Project Background and Introduction to Participating Companies

The fieldwork for this case study was conducted in 2005 and 2006 as part of the VCA programme. The scope of the case study encompasses an extended supply chain from seed breeding and fertilizer manufacture through a large cereals farm, a flour mill, a retail distribution centre to a convenience retail store in the Midlands. The companies involved were: one of the UK's largest fertilizer manufacturers, a large seed breeder, a cooperative PLC owning both the farm and the retail chain and a medium size flour mill. A team of senior company representatives and the author (acting as an academic facilitator) followed 1.5Kg private label bag of white (plain) flour from farm to the point of sales. The following table lists the companies involved and representatives from each company. This chain was unique in terms of breadth since the main inputs to the farm were also subjected to analysis, i.e. fertilizer, seed and even agri-chemicals were partially looked at.

Table 6.9 Supply Chain Improvement Core Team Members

No.	Company	Representative
1	Fertilizer manufacturer	Sales Representative
2	Seed breeding Company	Commercial Director
		Marketing Agronomist
3	Farm	Farm Manager
4	Mill	Supply Chain Director
5	Retailer	Head of Commercial Operations
		Managing Director
6	Cardiff University	The author

6.4.2 Case Study Findings and Analysis

The panel of supply chain executives (Table 6.9) got involved in chain analysis and identification of the key improvement opportunities as well as putting together an action plan and taking on the responsibility for implementation of the findings. The project was carried out in 9 sessions over four months. The author deployed the 10 days implementation roadmap and data collection protocol discussed in the previous cases. Accordingly a current state picture of all processes along the chain was created through detailed mapping; then a future state was derived allowing all participant firms to work towards a common goal. Some specific aspects of the data collection which are deemed relevant to this case study are explained in the following alongside the resultant current state. The first step in the project was to construct a big picture map of the whole chain in order to become familiarised with the existing processes, chain relationships and structure. This was followed by detailed mapping of individual firms looking at the physical and information flows. Individual firm data were then consolidated to create a current state map of the whole chain (Figure 6.7).

The current state map:

A key process in the cereals sector is the development and maintenance of new wheat varieties. However seed breeding is often overlooked and left out from supply chain analysis exercises. This case study was unique in that it linked the breeding process with the rest of the cereals system. Mapping showed that it takes up to 12 years to breed and launch a new variety. Despite its strategic importance, the breeder is often disconnected from the end consumer and market demand.

Similar to the first case study activities were divided into value-adding and non-value-adding against consumer value by means of PAM technique. Value adding steps are those steps that the consumer is willing to pay for and the rest are either unnecessary non-value-adding or necessary but non-value-adding. The lead-time from grain store to flour stock at the RDC was nearly 53 days out of which only 50 minutes (or 0.07%) were value adding. The big difference between total time and value adding time is typical in most agri-food supply chains and shows the scope for improvement. The figure can be normally up to 5% in the manufacturing sector for a single firm. The total lead-time from the shipment of fertilizer to shipment of the flour bag into the RDC was

513 days (including 6 months growing and 6 months, on average, in grain stock). Further detailed mapping revealed that the product travels about 600 miles to get to the retail shelf (fertilizer to the retail shelf). The total in-plant travel distance of the product was estimated to be about 1 mile.

As evident from Figure 6.7, complicated information flows and communication links existed between the companies along the chain (illustrated in red). In reality, there were many more informal routes which could not easily be mapped but added greatly to the complexity of the system. Ideally the information flow should be kept as simple as possible, with pure signal and no noise. Also, the information delays are eliminated or minimised to enable the upstream firms to produce to real consumer demand rather than lagged orders. The map also shows large amounts of inventory along the chain often duplicated indicating opportunity for considerable cost reductions. Ideally chains should have as little stock as possible and inventory should be in the right amount, in the right form and in the right place.

Identifying key opportunities for improvement and generating future state maps:

The value chain analysis threw up many opportunities for improvement both within individual firms and across the chain. These opportunities presented potential for improving both efficiency and effectiveness of the chain and were identified through detailed analysis of PAM data, mapping information and physical flows using the VSM approach (Jones and Womack, 2000), applying quality filter map and delivery adherence map techniques (Hines and Rich, 1997) and drawing upon other efficiency measurement and analysis tools from the lean toolbox (Bicheno, 2000). Following identification of the issues they were prioritised through discussion and consensus based on the immediacy of action, ease of implementation and the perceived potential gains. The top six opportunities were earmarked for implementation as illustrated in Table 6.10.

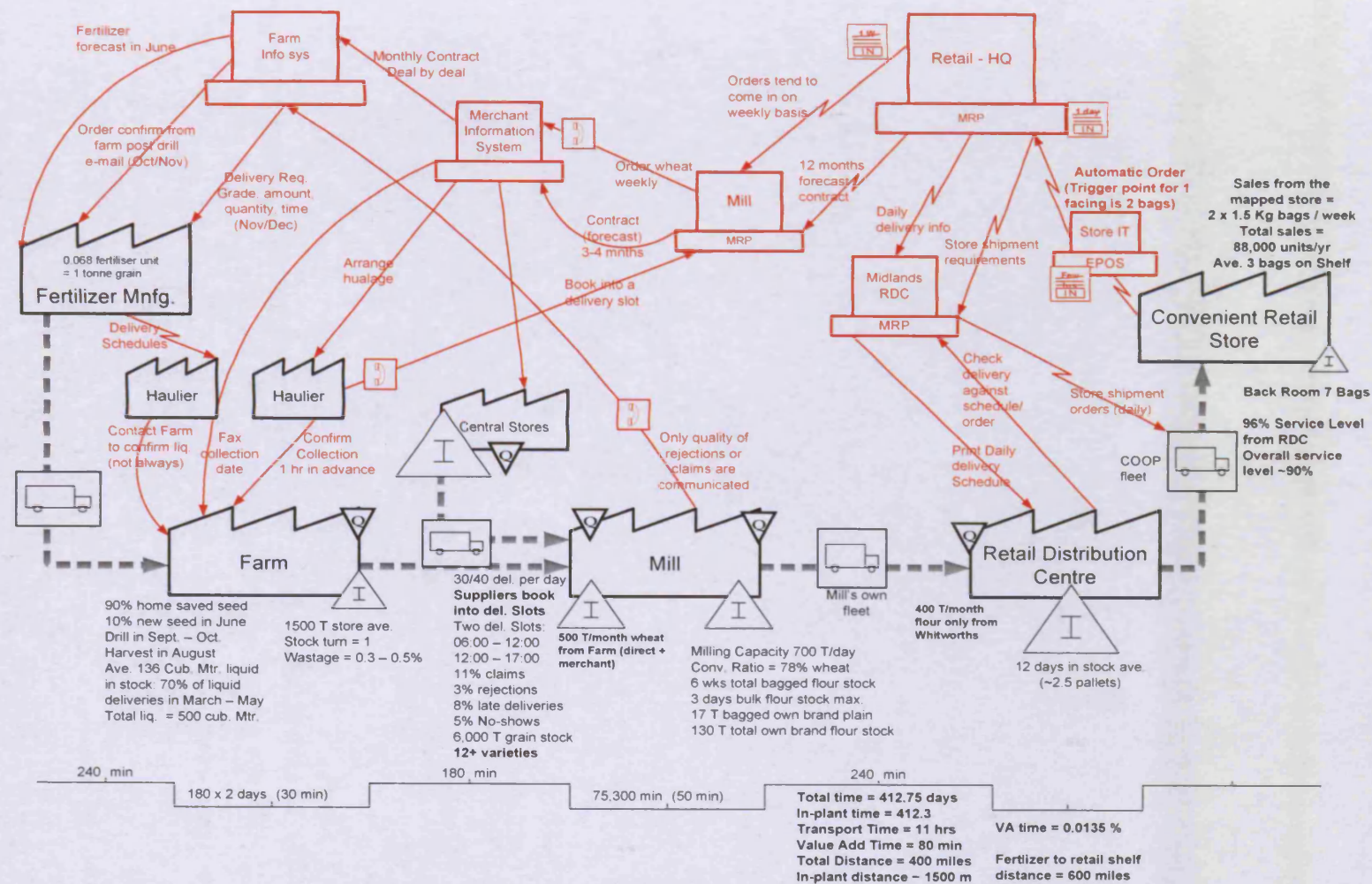


Figure 6.7 Current State Map for 1.5 Kg Flour Bag from Farm to Point of Sales
(Source: Author)

Table 6.10 Key Identified Improvement Opportunities Ranked According to Importance

Rank	Key Opportunities and Issues
1	Rationalise and update the process for preparation of the national grain Recommended List to suit market driven supply.
2	Better and longer term forecast between the mill and the retailer: eliminate erratic ordering patterns, provide direct EPOS transparency, vendor managed inventory (VMI), robust measures, smooth the flow and lower the stock levels.
3	Improve information flow across the chain from the mill to the farm to the seed breeder and better transparency (e.g. what to grow, what to spray and communicating market requirements and trends).
4	Improve transport efficiency into the mill and reduce rejection rate: right quality and condition, better coordination with the third party logistics firm (3PL), rigorous measurement of supplier/3PL performance, reduce noise in information flows between the mill and suppliers.
5	In house improvements at the retail distribution centre (e.g. scanning device at the loading bay, use of barcodes in goods delivered and dispatch areas, reducing rework, better visual management).
6	Promote the fact that the retailer grows its own wheat and bags it as own brand: change the image and branding strategy (emphasize health benefits, support British farmers, etc.)

(Source: Author)

In Table 6.10 opportunities 1 and 6 potentially improve chain effectiveness (consumer alignment) while opportunities 2 to 5 present efficiency improvement potentials. The standard 10 days VCA protocol and conventional lean supply chain mapping approaches such as VSM (Jones and Womack, 2000; Hines and Rich, 1997) have the potential not only to identify efficiency issues but also effectiveness opportunities and the disconnections between the supply chain and consumer value. However, it was also mentioned that the extent to which improvement projects can deliver or enhance value must be evaluated and the Supply Chain Kano-QFD approach was devised to address this shortcoming (gap) in the body of SCM knowledge. The following will mainly focus on the effectiveness opportunities.

The disconnection between the breeders and the market was identified as the most pressing issue for the chain. The farmer's choice of wheat variety has a great impact on the final quality of the grain and ultimately the flour. However, the requirements of the end-consumer are not effectively communicated with the breeders, seed merchants or

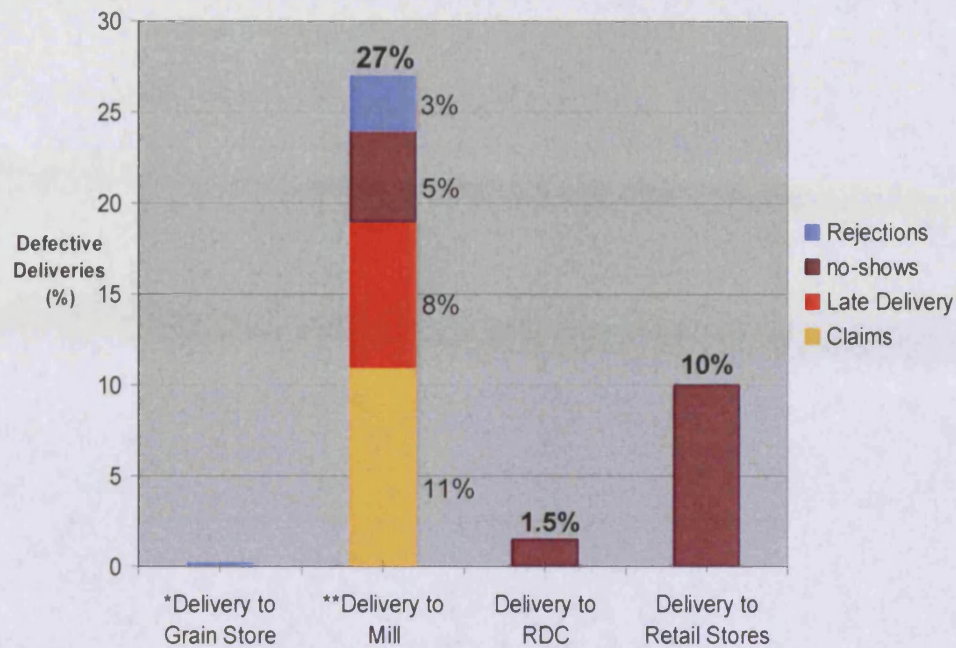
even farmers. Moreover, while the farmer treated the national Recommended List (RL) as a definitive guide for their choice of wheat variety, the same list was no more than an aide memoir for the millers (this issue was verified across the whole sector later on as reported by Zokaei *et al* (2008); also *see* case 16 in Table 5.8). A new wheat variety takes seven years to be bred (from initial cross to fit for purpose). Once bred, it must go through a stringent process usually taking up to five years in order to be listed on the RL. The multiplication and RL processes are regulatory rather than market driven. The RL protocols have been established over forty years ago, for a markedly different UK seed industry. At the time of this study there were only 14 varieties listed for at least four completely different user groups (bread making, biscuits, animal feed and starch). It is very unlikely for a variety that is not recommended to achieve any sort of commercial success.

The process is time consuming and does not always reflect true market needs only addressing the average national performance of varieties excluding regional or niche market requirements. The existing RL process can potentially drive the wrong decisions in making of the new varieties. Seed producers are inclined to pick varieties which are more likely to meet the listing criteria rather than the best variety for a particular end-use or agronomic character. With contract growing schemes and longer term relationships becoming more and more common in supply chains, and with the niche markets demanding specialist varieties, the RL process needed to be brought up to date consistent with the realities of today's markets. Therefore it was recommended that the process needed rationalisation and updating to suit market driven supply. In this case study the farmer decided to trial varieties bred by the seed breeder which have not made it to the RL but can be of great potential for the end customer's specific needs as well as the farmer's geographical requirements.

Another key finding (rank 6 in Table 6.10) was that the retail group owned the farm (very large size farming business), grew its own wheat and bagged ingredients grown on own farms in own brand flour packs. This presented a strategic opportunity for the retailer to differentiate itself in the market by offering home grown products valued by the shoppers. Nevertheless this was neither reflected in the retailer's marketing strategy nor even on the label. It was recommended that the retailer must re-position its flour as healthy own grown product and to capitalise on the product image.

Apart from the effectiveness issues (numbers 1 and 6 in Table 6.10) four other opportunities were also identified which by and large presented chain efficiency improvement potentials. For example, information flows between the mill and the retailer was an area for improvement where erratic ordering patterns and hence large stock levels between the two companies were observed. Transparent communication of the real demand data and sharing responsibility of physical stock (such as Vendor Managed Inventory approach) were recommended to lower stocks and to smooth flow in the supply chain. Moreover, it was noticed that communication between the companies in the supply chain overall is very poor and did not reflect market movements and consumers' changing needs.

Another key project was the improvement of efficiency of deliveries into the mill. A delivery adherence map (Hines and Rich, 1997) was drawn based on historic data (collected by the author) showing on average 27% poor deliveries per day (*see* Figure 6.8). This was a sector wide problem as identified in the sector specific report by Zokaei *et al* (2008) explained in Section 5.2.3 (the top issue in Table 5.6). Further mapping showed that delivery and quality (rejected loads at the mill) problems were hedged against by overbooking deliveries by around 25%, which in turn, distorted the real demand profile and created the need for excessive grain stock at the mill. Unnecessary stock, in turn, hid the quality and delivery errors suggesting that unnecessary inventories, transport inefficiencies and quality rejection are all interlinked problems. It is notable that transport, inventory reduction and quality rejects were the greatest controllable costs in the chain. In other words these issues presented great efficiency improvement potentials. Finally, several in-house improvement opportunities were identified at the RDC, e.g. use of bar-codes and scanning devices at the loading bays to reduce waste and rework and better visual management on the shop floor.



*Grain going into on-farm stores or central stores never gets rejected. The right measure at this stage is farmers' perception of grain quality compared with the test results from the mill

** Delivery to mill measured across all suppliers and the figure does not represent the delivery performance of the farm mapped in this case study

Figure 6.8 Farm to Retail Store Delivery Errors Map

(Source: Author)

Capturing and Understanding the Consumer Value:

Ideally everyone within a supply chain should have the same view of what the consumers require based on good market analysis and dialogue. Nonetheless, often different parts of the chain have differing opinions about what matters to the consumers leading to conflicting behaviour and poor overall effectiveness. Consumer value, by definition, has to come from the consumers themselves. There are a number of methods for capturing the voice of customer e.g. consumer surveys and focus groups. Nonetheless most Small and Medium Enterprises (SME's) especially in the agri-food sector lack the appropriate level of resources required for such time consuming and sometimes even confusing practices (O'Reilly *et al*, 2003). In this case study the supply chain panel deployed the Kano model to identify the relationship between the attributes of the product and the level of consumer satisfaction (Figure 6.9). The attributes in each of the three categories in the Kano model are explained below.

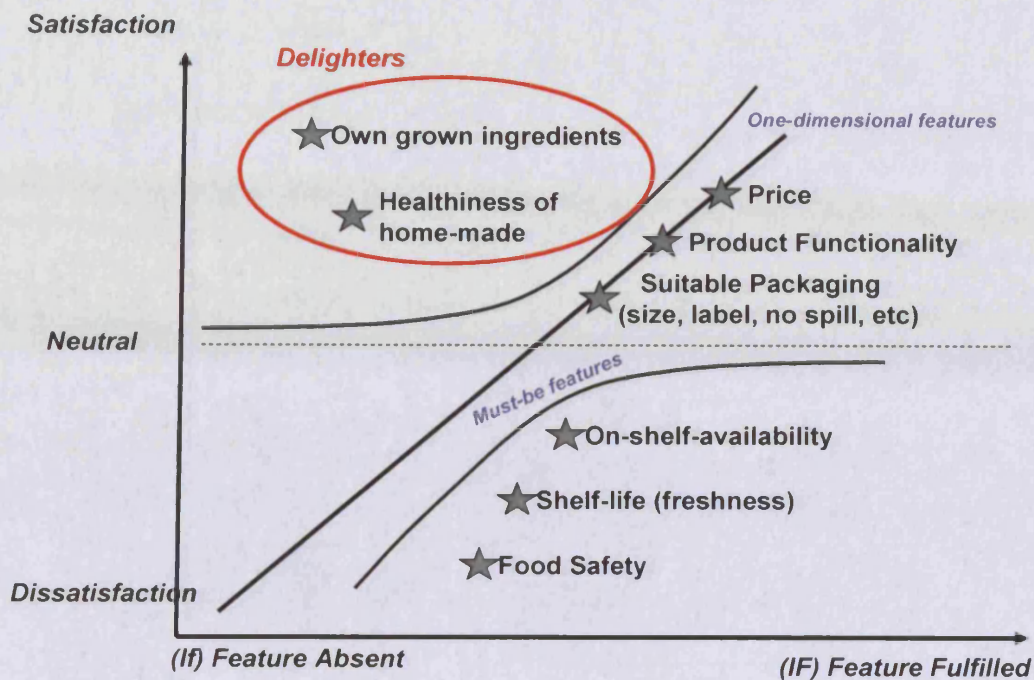


Figure 6.9 Kano Model of Consumer Value for Home Grown Private Label White Flour
(Source: Author)

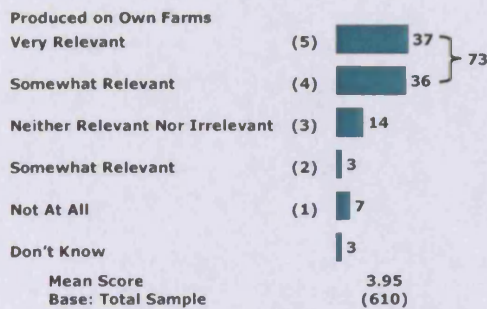
Must-be attributes: In this case, reasonable shelf-life (normally several months), being safe to consume and being available for purchase were taken for granted by the consumers.

One-dimensional attributes: Price, fit-for-purpose product functionality and right packaging (e.g. user friendliness and no spillage) were identified as the main one-dimensional value features.

Attractive value elements: The team highlighted two potential delighters, i.e. own grown ingredients and healthiness of the home-baked products (the latter one is inherent in the product). Market research carried out by the retailer showed that 73% of their shoppers believed that selling produce grown on retailer's farms helps improve the retailer's stance as an ethical/responsible company. Also, 68% of the shoppers perceived their own-grown products as being of better quality. Furthermore, 65% of the respondents in the survey thought having own-produce on the retail shelf will make them trust the retailer more and 70% said it will make them purchase more (Figure 6.10). More interestingly 62% of the shoppers said that they are likely to pay a little

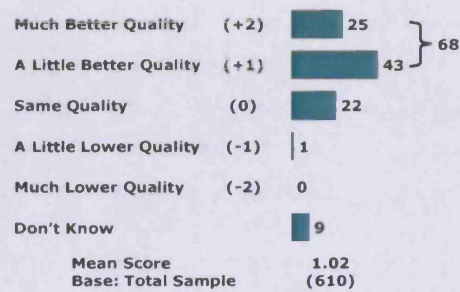
more for own grown produce. As illustrated in Figure 6.11, nearly half of the respondents said they are *quite* likely to pay more. 75% of those who said they will purchase more also were likely to pay a little more (52% of the total population) clearly presenting a huge potential for the retailer to capitalise on own-grown potentials. (Anonymous Retailer, 2006)

How Relevant Are the Following Issues to the Retailer's Stance as an Ethical/Responsible Retailer?



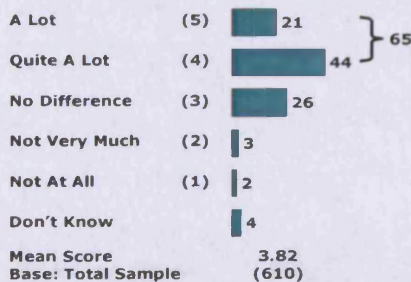
Middle class shoppers view it as most relevant. 35+ 's are more likely than 18-34's to see it as being relevant.

Comparison of Expected Quality Between Retailer's Farm Products and Standard Produce



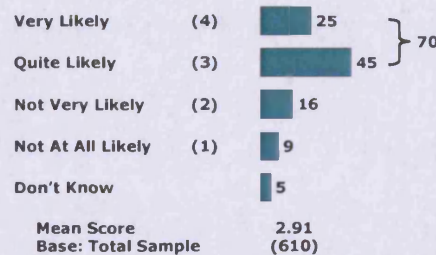
The majority of shoppers think the quality of own grown produce will be better than standard - a quarter think it will be much better quality. 18-34's felt the quality of own produce would be the most similar to standard produce

To What Extent Would "Own-grown" Make You Trust Retailer's produce More?



Two thirds of shoppers would be more inclined to trust Retailer's grown produce one in five would be inclined to trust it a lot more. 18-34's register the least trusting of customers surveyed.

How Likely Would This Be to Make You Purchase More?



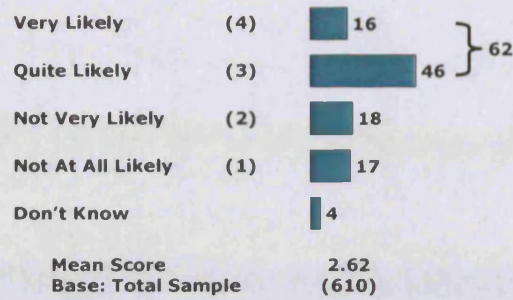
The vast majority of shoppers say they would be more likely to purchase own grown produce - a quarter say they would be very likely to purchase more. Shoppers in affluent areas are the least likely to say they would purchase more.

Figure 6.10 Market Information Regarding Own Grown Produce

(Source: Anonymous Retailer, 2006)

The supply chain decided to capitalize on a change of image and promotion of own grown wheat as a potential to differentiate in the market and to improve sales and profitability. The next stage in the process of creating a more effective supply chain was to link the improvement opportunities identified in Table 6.10 to the consumer value categories discussed in the above following the same technique that was developed in the previous case study.

How Likely Would You Be to Pay a Little More for Produce Grown on Own Farms?



The majority of shoppers say they would be likely to pay more for own grown produce – almost half say quite likely; 75% of those who are likely to buy more said they would also be happy to pay a little more (=52% of the total sample).
18-34's show clear signs of price sensitivity and are less willing to pay more.

Figure 6.11 Consumers' Willingness to Pay a Little More for Own-grown Produce
(Source: Anonymous Retailer, 2006)

Linking Improvement Projects to Consumer Value:

The first step was to set a series of supply chain metrics against various aspects of consumer value identified in the Kano model. Similar to the previous case study the Supply Chain Kano-QFD relationship matrix was deployed as illustrated in Figure 6.12. The supply chain improvement projects from Table 6.10 constitute the horizontal axis and the Kano attributes form the vertical axis. The only key difference is that transport efficiency improvement opportunity (rank 4 in Table 6.10) was not taken forward since the mill lost interest in pursuing this project through the VCA initiative due to various chain dynamics. Each box in the relationship matrix shows the impact of a supply chain improvement project on satisfaction of a specific value attribute.

The rating scores were slightly altered from what was used in the previous attempt; a numerical scale of 1, 3, 6 and 9 where 9 represents very strong impact and 1 represented weak influence. This alteration took place to accommodate the team's concern that the outcome should not be too skewed towards strong impact areas to reflect a more balanced approach in addressing consumer value attributes. The ratings were arrived at through discussions and represent panel consensus. Since the same panel of supply chain experts were going to implement the improvement opportunities, the consensus based approach ensured due consideration at the implementation stage. The numerical values in the relationships matrix were then given importance weighting according to the respective Kano category using 4, 1 and 0.5 weightings (similar to the previous case).

Consumer Value	SC Metrics	Kano	Rationalise and update the RL Process	Smooth flow between mill and retailer	Improve Communication and transparency across chain	In-house Improvements at RDC	Bag own grown Wheat: change packaging and image to promote own grain
Where product comes from	Market Share (Sales)	D			3 x 4		9 x 4
	SC profit		6 x 4	3 x 4	6 x 4	6 x 4	9 x 4
Price	Reduced stock %	P		9		6	
	Farm cost per Hectare	P			6		
	Demand Ampl. Index %	P	3	6	9	3	3
	repeat sales	P	1		3		9
Product functionality	Customer complaints	P	6		3		3
Packaging	Customer complaints	P					
Availability	Service levels	B		6 x 0.5	1 x 0.5	3 x 0.5	
	traceability	B			1 x 0.5		9 x 0.5
Food Safety	Customer complaints	B					
Product Shelf-life (12 m)	SC lead-time	B		3			
Total			34	33	58	34.5	91.5

Key: D = Delighter; P = Performance or one-dimensional; B = Basic

Figure 6.12 White Flour Supply Chain Kano-QFD

(Source: Author)

The cumulative ratings, at the bottom of Figure 6.12 show the relative importance of each improvement project in terms of impact on consumer satisfaction indicating the ultimate implementation priority. By means of this ranking the team was able to make informed decisions regarding the future action plan which in this chain, directly followed on from the rankings in the above (i.e. re-branding of flour as the top priority project and so on) except that the transport efficiency project was handled differently since not included in the matrix in the first place.

6.4.3 Discussions, Conclusions and Recommendations

This case study deployed and developed further the technique formulated in the previous section. Therefore the results (i.e. how supply chain effectiveness can be improved) are replicated in two different settings indicating the *external validity* of the findings and providing further explanation regarding their analytical generalisability. This is the replication logic of multiple cases (Yin, 2003) discussed in Chapter 4.

Moreover, theories are developed under different conditions and the role of case specific contingencies has been investigated.

In the previous case (fresh milk) the key limitation was a lack of sophisticated market / consumer data. This case study addresses this short coming by drawing on an extensive consumer survey carried out through the retail organization rather than second guessing what consumers value. In this case study the team's understanding of consumer needs was backed up by the aforementioned piece of market research; however there are still challenges in implementing the Supply Chain Kano-QFD technique. One key challenge was associated with the use of a panel of experts or the VCA team. It was explained in Chapter 4 that each case study deploys a team of participants and experts to obtain different viewpoints in order to warrant *internal validity* of the research (see Table 4.3). Moreover, involving industry informants is part of research *objectivity* since they can read and comment on reports produced for each case study in several iterations. Finally, participation of the panel of experts means that the findings are directly relevant to the chain, delivering greater *epistemological rigour*. However, the challenge occurred when discussing consumer value and asking the team to set a series of supply chain KPI's against the Kano attributes. It was difficult in both cases to get the team to think beyond the conventional logistical measures to include broader marketing and value metrics. For example, in this case study the key delighter was own-grown product. The team used market share and supply chain profit as KPI for this value attribute backed by the market research which suggested shoppers are likely to buy more and pay a little more. However, a better and more immediate measure would have been consumer satisfaction (after introduction of own-grown product) regardless of whether satisfaction translates into market share and profit in the near future. Nonetheless, it was difficult for the team to introduce and implement a marketing measure that was not being measured as part of a supply chain improvement initiative (apart from one off surveys).

In this case study the farming arm of the retail organisation was eager to revisit strategy to sell own grown produce across many different ranges and to highlight product origin as a differentiation factor. However, the retail side of the company was less receptive to this opportunity denoting silo mentality and barriers within a single organisation. Clearly systems thinking and collaboration are necessary to improve both efficiency and effectiveness of supply chains.

6.5 Case Study 4: A UK Cheddar Supply Chain

6.5.1 Project Background and Introduction to Participating Companies

The fieldwork for this case study was conducted in 2007 as part of the VCA programme. This project looked at a Y-shape chain, i.e. two value streams merging in the downstream, encompassing two products from two different dairy companies and a single foodservice company. Sour cream was mapped from a small farm in Dorset through a medium size specialist creamery to the food service company's National Distribution Centre (NDC) to a chain restaurant near Reading. Mature grated cheddar was mapped from a small farm in Dorset through a medium size specialist creamery to the food service company's National Distribution Centre (NDC) to a chain restaurant near Reading. Mature grated cheddar was mapped from the cut and pack operation to the same NDC and restaurant outlet. The cheese supplier specialised in supplying ingredients to food manufacturing and foodservice companies. Cheddar was sourced from Ireland and matured in the UK; due to practical reasons it was decided not to include farm and maturation processes in the cheddar value stream. The following is a joint-up schematic of the two streams.

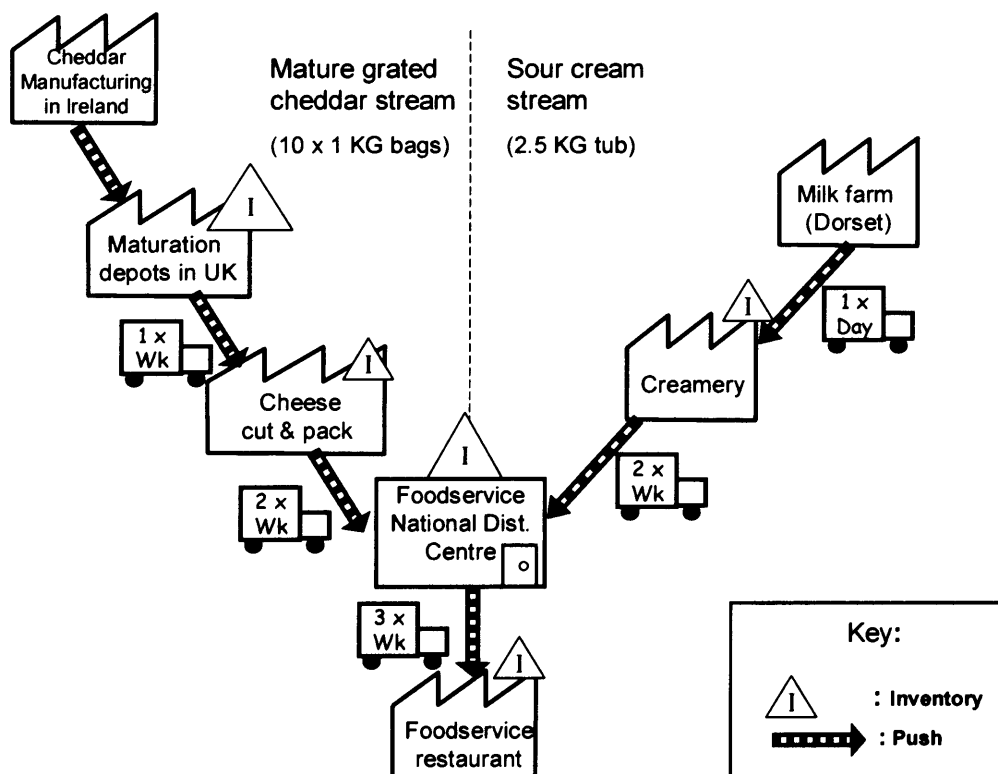


Figure 6.13 Big Picture Map of the Project (Cheddar and Sour Cream Value Streams)

(Source: Author)

A team of senior company representatives and the author (the academic facilitators) analysed the supply chain drawing on the standard 10 days data collection protocol and implementation roadmap. Table 6.11 lists the companies involved and representatives from each. The project was conducted in 11 sessions over nearly five months.

Table 6.11 Supply Chain Improvement Core Team Members

No.	Company	Representative
1	Dairy farmer in Dorset	No representation in the core team
2	Creamery	Sales and Marketing Director
3	Cheese cut & pack	General Sales Manager
		Managing Director
4	Foodservice company	Head of Food Procurement
		Category Buyer
		Head Chef and Trainer
5	Cardiff University	The author

6.5.2 Case Study Findings and Analysis

The dairy firms (the cheese producer and the creamery) were in direct competition and therefore not possible to establish free exchange of information amongst the whole team. As a result the downstream part of the chain was mapped jointly (i.e. the NDC and restaurant) while the upstream parts and the future state workshops were treated separately. The unit of analysis in this case study was a case of ten 1Kg bags of cheddar (the rest of this section focuses on the findings from the cheddar chain). The following will first report the key improvement opportunities and then explains how supply chain effectiveness was improved by means of the *Supply Chain Kano-QFD* technique. This is followed by discussion on the potentials and limitations of supply chain management for better consumer satisfaction as one of the key contributions of this section.

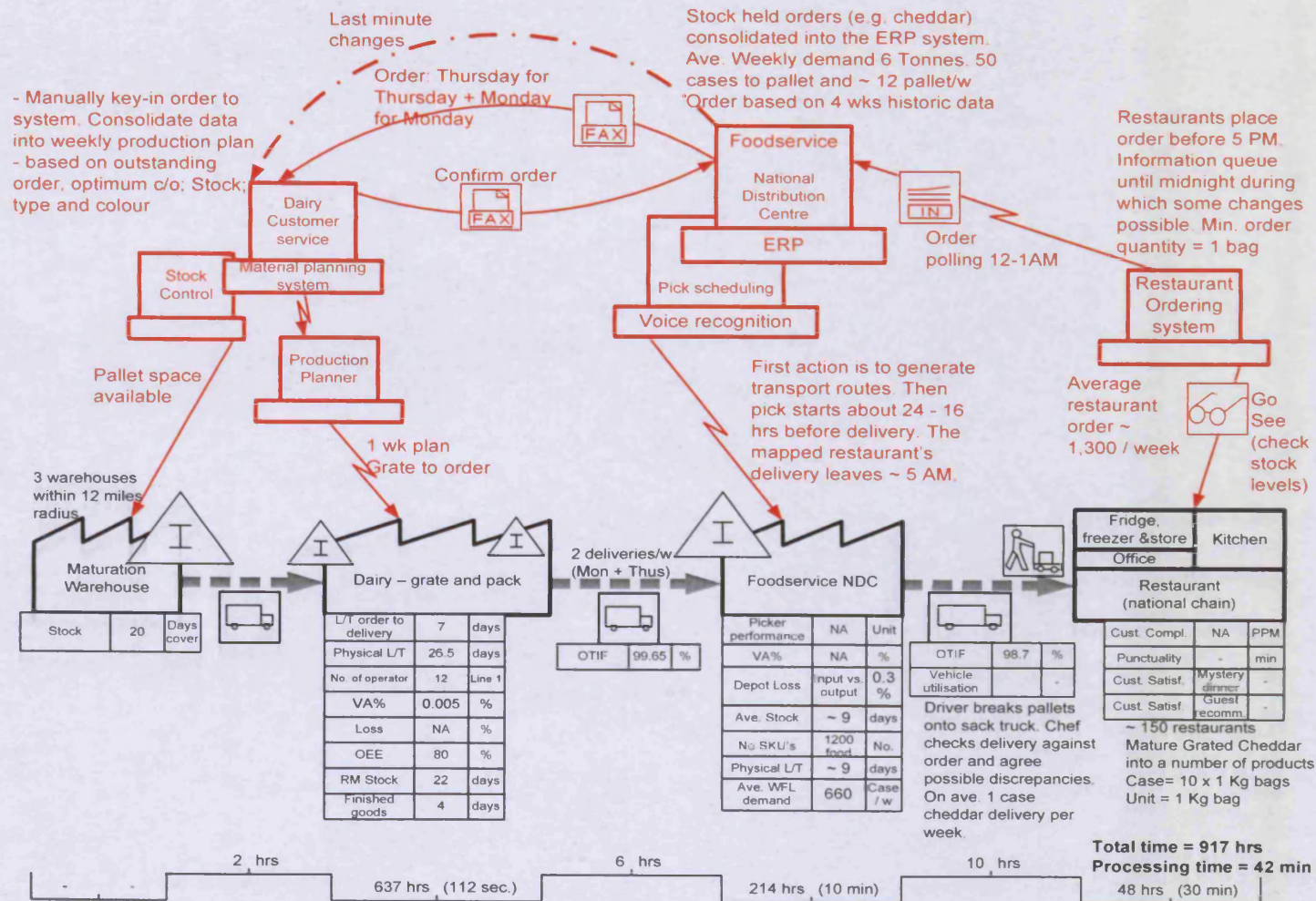


Figure 6.14 Current State Map for 1 Kg Bag of Mature Grated Cheddar from Cut & Pack to Restaurant

(Source: Author)

The current state map:

The above diagram shows a map of the whole chain for mature grated cheddar. A typical value chain map illustrates the physical and information flows as well as a number of key metrics. One of the crucial factors in creating the current state map is choosing the appropriate metrics or the Key Performance Indicators (KPI) both within companies and between firms. Choosing the right KPI's is critical to sustaining change. Some key lean KPI's for a supply chain include: time (e.g. lead-time and % value-added time), delivery performance (e.g. on-time/in-full deliveries), quality (e.g. loss ratios and defect ratios) and inventory.

The total lead-time measure of 917 hours is a calculation of the average length of time from the time blocks of cheddar cheese are dispatched from cheese suppliers to the dairy company to the point when a consumer buys a dish containing mature cheddar product in the restaurant. This measure reflects a combination of processing time, inventory holding and transportation times across the whole chain. Only 42 minutes (less than 0.08%) of the time spent in the chain is actually value adding; this highlights significant levels of non-value adding activities in the chain. Where possible these non value-adding activities were targeted for reduction. However, historically most chain improvement initiatives have focused on the value-adding element of the lead-time, e.g. perfection of value-adding operations through automation. What's more, 19 processing steps were mapped from cheese maturation supplier dispatch to the finished product being consumed on a dish at the end of the chain. Of these steps only 3 steps (15.8%) were considered to be adding value in the eyes of the consumer. The whole chain average travel distance was around 430 miles from the time it left the maturation warehouse to the point of consumption.

Identifying key opportunities for improvement and generating future state maps:

The current state map was used as a basis for identifying main issues and opportunities for improvement. In the future state workshop key issues and opportunities were highlighted both within companies and across the whole chain. The team members debated and classified opportunities based on perceived benefit vs. cost of implementation. As a result, seven key projects were identified in Table 6.12. As in the previous cases the ranking is subsequently altered through application of the Supply

Chain Kano-QFD technique by checking projects impact against consumer satisfaction. One of the improvement opportunities (i.e. backhaul from dairy to NDC) was trialled during the project and was taken forward for full implementation while the rest were implemented to a detailed action plan once the analysis was completed. Three out of the seven projects in Table 6.12 potentially improve chain effectiveness (i.e. ranks 1, 5 and 7) while opportunities 2, 3, 4 and 6 present efficiency improvement potentials. As already discussed in the first case study (Section 6.2) *consumer realignment often inadvertently leads to improvement of chain efficiency as for example in Table 6.12 changing the bag size not only meant that chefs were more satisfied (eradicating the need to open two bags at the same time) but also the bagging line at the cheese cut and pack operation could run 9% faster eliminating a bottleneck process*. This case study corresponds with chain 14 in Table 5.8.

Table 6.12 Key Improvement Opportunities for Mature Grated Cheddar Ranked on Importance

No.	Improvement Opportunity
1	Change case size: The product was bagged in 1 Kg packs. This was not value to customers since chefs opened at least two bags at the same time. 1 Kg bags created waste of double handling in the NDC as well as the rest of the chain. There were other savings such as line efficiency in the dairy (i.e. 9% faster in terms of tonnes grated per hour), less film usage in packaging, fewer line stoppages due to less pressure on bagging. Time and motion studies showed that the bagging process in grate and pack operation was the <i>bottleneck</i> for smaller bags. Cases of 6 x 2kg bags were replaced.
2	Electronic Data Interchange (EDI) ordering: Orders were sent by email. Orders were then manually keyed into the system and double checked by a different individual to ensure correctness. EDI was proposed to directly link the ERP system at the foodservice to the ordering system at the dairy.
3	Backhaul: Backhaul from dairy factory to the NDC was trialled and subsequently rolled out.
4	Change order/delivery pattern: There were two orders per week and two manufacturing slots to meet the orders with seven days lead-time, i.e. Monday order for Monday delivery and Thursday for Thursday. The alternative was for Monday orders to be delivered on Thursday. In this scenario, orders were polled Monday morning (as opposed to the usual afternoon polling) and manufactured Monday afternoon. There was a 48 hours chill time post manufacturing and cheese was ready for transport Wednesday afternoon; therefore same week Thursday delivery was achieved. There were still two manufacturing slots and two deliveries, i.e. Monday for Thursday and Thursday for Monday (4 and 3 days lead-time).

5	Use only medium cheddar: It was cheaper to use medium cheddar as opposed to mature cheddar due to shorter stay in maturation stock. Moreover, shorter end-to-end lead-time allowed better stock control and lower overall stock. Consumers hardly noticed the difference; those who did preferred medium cheddar in certain products. Therefore, no advantage in mature cheddar.
6	Change shred size from 6mm to 9.6mm: 9.6 mm instead of 6 mm grates size. Potential saving of cheese since larger cheese melts better and chefs need to use less cheese. It also made the line run faster because the smaller grate size required more grating and packing time.
7	De-list mozzarella: Cheddar and mozzarella mix products were sometimes used interchangeably by the chefs. Focus group information provided by the foodservice company showed that consumers hardly noticed the difference except for when mozzarella-cheddar mix was used in sandwiches which gave an inferior end-product. It was suggested that mozzarella should be de-listed to reduce supply chain complexity only using cheddar delivering potential savings both to the manufacturer and the foodservice company.

(Source: Author)

Capturing and Understanding Consumer Value:

The Kano model in Figure 6.15 illustrates the panel's view of various attributes contributing to consumer satisfaction. This was a complex case in terms of identifying consumer value and somewhat different from the previous case studies in that the product itself is not directly used by the consumer but as part of a dish – varying from a small to very significant ingredient. In this case the panellists drew upon both their respective organisations' consumer research and personal insight. Moreover, the author conducted an interview with a marketing executive at the foodservice company accessing considerable amount of market research information. It is notable that Figure 6.15 is an illustration of value elements for cheddar cheese. Nonetheless, the marketing data were obtained from consumer (satisfaction) point of view with cheddar being a fraction of the menu which itself is only a part of the overall consumer satisfaction as will be explained below. In the context of a foodservice organisation it is unusual and even challenging to gather consumer data with regards to a single ingredient. Foodservice consumer preference information was translated from whole menu back to single ingredient to help with categorisation of the value features below.

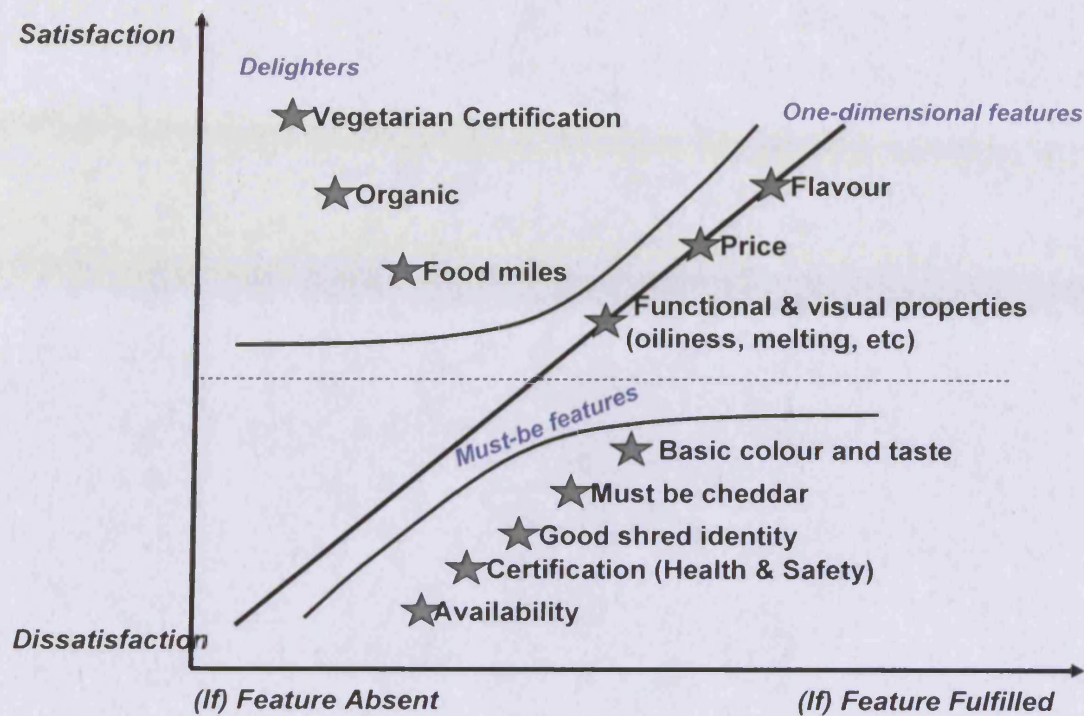


Figure 6.15 Kano Model of Consumer Value for Mature Grated Cheddar
(Source: Author)

Consumer value, by definition, has to come from the consumers themselves. The methodology used for collecting market information by the foodservice company was robust and consisted of both in outlet face-to-face surveys which reflected 'at the time of the experience' opinion of the consumers and telephone interviews capturing post event opinions. The foodservice company owned several outlet brands; the author deployed information from the relevant outlet chain for this case study only. However, consumer preference was interestingly consistent across various brands and within the chain in different outlets and across various regions. Based on the market information from the foodservice organisation the key drivers of overall consumer satisfaction respectively were: meal, staff, menu, hygiene and cleanliness, atmosphere and appearance of the outlet, quality and price of the drinks, and the way children are accommodated and catered for. Meal referred to the quality, taste, presentation, value for money and generally the overall satisfaction of the consumers with their meal. *Supply chain effectiveness has got a direct impact on this category.* Staff referred to the restaurant staff's attentiveness, appearance, attitude, knowledge, ease of ordering and

the overall speed of service. Menu refers to the *range and availability* of dishes listed, measuring the extent of which the menu range appeal to the consumers. Clearly supply chain has a significant role in delivering this, i.e. supply chains must be in place in order to offer range and should perform well to deliver availability. The rest of the categories contributing to the overall consumer satisfaction had lower relative impact as illustrated in Figure 6.16; these categories are self explanatory.

In Figure 6.16 the ‘quality of drinks’ falls outside the remit of this case study. Furthermore, arguably, supply chain management has little if any impact on hygiene, staff, atmosphere and children. Although, as discussed in Chapter 3, a broader definition of SCM should include all different aspects of consumer moments of truth spanning the entire chain from concept to launch and from farm to fork. For example the ambience of the outlet can ultimately be looked at from the supply chain effectiveness perspective since a tasty meal delivered through an efficient chain will not compensate for very poor ambience, failing to create satisfied consumers. Nonetheless it was perceived impractical to include all various aspects of consumer satisfaction and therefore this case study by and large focuses on the two obvious drivers of consumer satisfaction which the cheddar supply chain can most obviously influence, i.e. meal and menu. In a different setting and where companies have the readiness at a more strategic level it could be possible to extend the project to *look at all consumer moments of truth for creating a truly effective supply chain*.

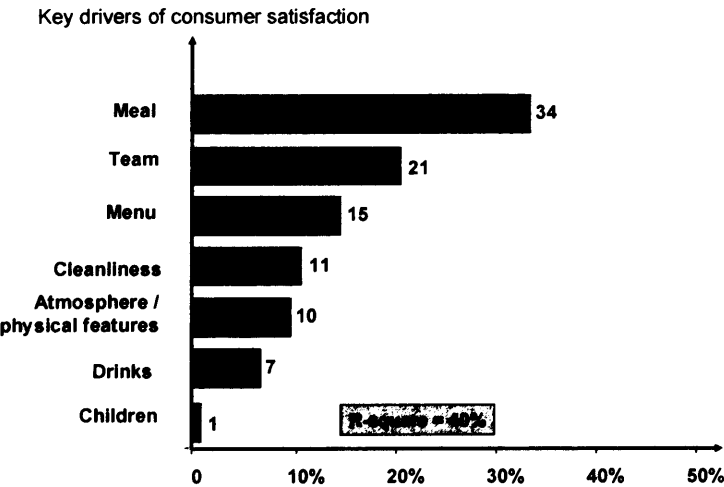


Figure 6.16 Impact of Various Drivers of Consumer Satisfaction
(Source: Anonymous Foodservice Company, 2006)

In the Kano model above five basic or must-be attributes have been identified. The market information showed that one of the biggest dis-satisfiers was unavailability. In other words dissatisfied customers were more likely to have encountered unavailability and unavailability was high amongst dissatisfied customers. *“A single dish often consists of 7-8 ingredients and dish availability impinges on availability of all items”* (interview with a marketing executive at the foodservice organisation in 2007). Data showed that dish unavailability (availability of dishes against listed items on the menu) was around 7-8% against a much higher delivery performance into houses. This was partly because a dish consists of several ingredients unavailability of every single one of which results in unavailability of the whole dish. For example if a dish contains seven ingredients and availability of each is at 99.6% then the overall availability is $(99.6\%)^7$ or 97.2%.

Moreover, healthiness of the product, basic flavour and look, and the fact that it is cheddar were taken for granted by the consumers. For example it was intolerable for the consumers to be presented with substandard tasting or abnormal coloured cheddar. Another must-be criterion brought into the model by the dairy company was shred identity. In order to generate optimum melting properties (i.e. evenness, coverage on the surface, not fragile, etc.) 6 mm cross section and 25-40 mm long shreds were desired. Consumer research also showed that another key dissatisfier within the value elements that this supply chain can (directly) influence was punctuality (lead-time from order placement in the outlet to arrival of the meal). There were also dissatisfiers that related to value categories that the chain couldn't influence such as atmosphere or the meal not being adjusted to the consumer's personal taste (around 5-7% depending on the food category). The latter example is similar to case 5 in Table 5.8 presenting a massive opportunity for improving chain effectiveness.

In this chain the one-dimensional attributes were identified by the panellists as flavour, price, and functional and visual properties. Basic taste is categorised under must-be features while flavour can go beyond the basic standard to achieve (one-dimensional) satisfaction of consumers. Similarly, price (value for money) was considered a one-dimensional attribute, i.e. the cheaper the product the more satisfied the consumer (thresholds were considered for this relationship). Functional and visual properties include right level of oiliness, very good melting properties (beyond the basic level as with the taste), robustness of cheese, etc.

The team highlighted a few possible delight factors as well, such as organic offering and low food miles. It must be noted that these are delight factors for the cheese ingredient only. However all three required fairly strategic changes at the whole business level and the panel decided not to opt for any of the delighters. Furthermore, the market information showed that in terms of the overall consumer satisfaction staff and meal did most to create delight often occurring even despite lack of complete satisfaction with the menu (i.e. despite lack of range or availability). Delight was measured as exceeding consumer expectations in the surveys. 61% of those who were delighted with the overall service were delighted with their meal (Anonymous Foodservice Company, 2006). Therefore, providing very good flavoured cheddar, though one-dimensional from the single product perspective, could potentially contribute towards creating overall delight.

Linking Improvement Projects to Consumer Value:

The following will first link a series of KPI's to the Kano value elements as illustrated in Table 6.13. Then the application of the Supply Chain Kano-QFD technique is discussed followed by discussions around two key findings of this case study. *Firstly, the following shows that the must-be and one-dimensional categories of the Kano model are equally important in terms of creating effective supply chains. Secondly, the extent to which SCM can influence consumer satisfaction is explained.*

Table 6.13 Role of the Supply Chain in Delivering Consumer Requirements

Consumer Value	Kano Category	This chain influences?	Supply chain Objective	Supply Chain Metric
Vegetarian	Attractive	N	The panel decided not to implement any of the delighters since they required rather strategic changes at the whole business level which made the cost benefit analysis of implementation not in their favour.	
Organic cheese	Attractive	N		
Low Food Miles	Attractive	N		
Flavour	One-dimension	Y	Consistently delivering the right flavour. The significance of quality of meal was explained above; flavour is dependent on quality at production and maturation.	Grading between 1 and 6 (where 6 is very mature flavour); deploy the standard grading system already in place.

Price (value for money)	One-dimension	Y	Reduce cost through lowering stock especially maturation inventory by for example using medium rather than mature cheddar, more efficient transport (OTIF/total miles) and using the right (price/amount of) ingredients in dishes. Value for money is a key to consumers' satisfaction with their meal which in turn most significant to overall satisfaction.	Maturation length (days)
				Stock levels (tonnes or days)
				Transport efficiency (OTIF)
				Total (cheddar) miles
				Bill of Material (right ingredients. e.g. medium cheddar and bigger shred are cheaper ingredients for same quality if not better).
Functional and visual properties	One-dimension	Y	Right texture, oiliness and melting. Robustness of cheese is important and the number of touches in the chain is another key factor for good visual appearance. Melting properties are dealt with under shred identity.	Robustness of cheese (qualitative measure)
				Number of touches in the chain
Basic colour and taste	Must-be	Y	This attribute is already objectified under flavour and visual properties. The team avoided double counting one feature.	None; KPI's already in place against flavour and functional and visual properties.
Must be cheddar	Must-be	N	This was taken for granted. Therefore, it was perceived that the chain needed not to objectify this value attribute.	None; this chain cannot influence.
Good shred identity	Must-be	Y	Deliver right quality cheddar with optimum melting properties, i.e. evenness, coverage, not fragile, etc.	Goodness of melt spread in terms of coverage and fragility (qualitative measure)
Health and safety	Must-be	Y	Obtaining and retaining H&S Cmi certification, e.g. EFSIS and BRC.	Customer complaints (ppm)
Availability	Must-be	Y	- Reduce demand distortion and demand amplification - Improve time to table (punctuality) Availability was integral to consumer satisfaction with menu. Unavailability was around 7-8%.	Punctuality (time taken from order to dish delivered to the table)
				On-time/in-full (OTIF) deliveries along the whole chain

(Source: Author)

As illustrated in Table 6.13, the panel decided that the supply chain cannot influence the attractive attributes unless some very strategic changes were implemented that were rather far reaching for the VCA project to achieve. Also, the team decided that one of the basic attributes (i.e. must be cheddar) did not need to be objectified for this supply chain. Sometimes when cheddar cheese was not available or when mistakes took place other types of cheese were used instead of cheddar; however, it was taken for granted that the same cheese must be delivered as listed on the menu. In Table 6.13 where value attributes appear in more than one Kano category such as in the case of taste and flavour the highest impact category is taken into the Supply Chain Kano-QFD matrix below. This is to avoid calculating the impact of one KPI more than once. The Supply Chain Kano-QFD model below identifies the priority ranking of improvement projects. As expected the initial ranking in Table 6.12 has developed into a more meaningful ranking in Figure 6.17 which reflects the impact of improvement projects in terms of the overall chain effectiveness.

Customer value	KPI's	Kano	Use only medium cheddar	Change shred size: 6 to 9.6	Change case size	Change order delivery pattern	Backhaul	De-list mozzarella	EDI ordering	
Flavour	Graded 1-6	P	9					3		12
Price	Maturation (days)	P	9							9
	Overall stock (T or days)		3	9		9		1	22	
	Transport efficiency			3	1		3		7	
	Bill of Material				9			9		
	Cheddar miles		3	3	3	1	3		10	
Functional and visual properties	Robustness	P			3		1		4	
	No. touches		3	3				6		
Shred identity	Melt spread and fragility	B	3 x 0.5	9 x 0.5					6	
health & safety (certification)	Customer complaints	B					1 x0.5		0.5	
Availability	Punctuality (min)	B					1 x0.5		3 x 0.5	2
	OTIF (especially into outlets)				1 x 0.5				0.5	
			28.5	22.5	16.5	10	8	3	2.5	

Key: P = Performance or one-dimensional B = Basic or must-be

Figure 6.17 Grated Cheddar Supply Chain Kano-QFD

(Source: Author)

What is notable about the above matrix and this case study is the focus on must-be and one-dimensional category attributes of the Kano model, whereas the previous cases emphasised the role of delighters in creating chain effectiveness.

6.5.3 Discussions, Conclusions and Recommendations

The Supply Chain Kano-QFD as a way for improving supply chain effectiveness was replicated showing that the findings can be translated to different settings. This further proves the *external validity* of the research and provides further explanation regarding the analytical generalisability of the findings. Moreover, the role of case specific contingencies were investigated, for example in the previous case study the VCA project looked at the value stream for the entire product (with the exception of packaging which can be assumed is relatively straight forward to be aligned) while in this case what was mapped was a mere ingredient of what potentially constitutes consumer value. In other words cheese would be part of a meal which itself is only partially important in terms of consumer satisfaction. This can be compared to shopping basket in a supermarket chain where the consumer's satisfaction is often in availability and quality of all shopping items rather than a single item.

In the second case study (fresh milk) the key limitation was lack of sophisticated market / consumer data. This case study (similar to the previous case) addressed this limitation by drawing on rigorous market information carried out by the foodservice organisation as well as the panel's insight to what the consumers' value. Again, similar to Section 6.4, a key challenge in implementing the Supply Chain Kano-QFD technique was in asking the team to set a series of supply chain KPI's against the Kano attributes. Although it was not easy to get the team to think beyond the conventional logistical measures to include broader (marketing and value) metrics, compared to the previous case study, greater success was achieved in using consumer oriented measures due to better access to market information and more extensive use of such information during the current and future state workshops.

This case study focused on the must-be and one-dimensional attributes of consumer value and the panel did not opt for introducing any delighters. However, the case

illustrates that it is equally valid in terms of creating effective supply chain to address the must-be attributes to avoid dissatisfaction and to pursue service excellence through attention to the one-dimensional value features. It was also explained that the one-dimensional value features for cheddar cheese could potentially lead to overall delight of the consumers. Consumer surveys showed that overall delight could take place even despite lack of satisfaction with the menu due to satisfaction with the meal.

This thesis explains the importance of integrating understanding of consumer value into the existing body of knowledge to boost consumer satisfaction and/or avoid dissatisfaction. This case study explained the complexities of creating chain effectiveness in situations where conventional consumer insight is difficult to translate into single product or ingredient value.

6.6 Discussions and Analysis of the Findings

This chapter addressed the first research question by expanding the existing – efficiency oriented – supply chain body of knowledge, especially the lean value stream mapping approaches. The case studies illustrated that, often, different parts of the chain have differing opinions of what is meant by consumer value leading to conflicting behaviour and poor overall delivery of value to the end-consumers. They also showed that the role of supply chain was perceived to be limited to delivering logistical value criteria only (i.e. QCD). The supply chain teams, in all four case studies, lacked a rounded appreciation of the consumer value and the role of the supply chain in fulfilling it. In these case studies (more remarkably in the third and fourth cases) the author drew upon marketing information to help with the understanding of consumer requirements and to lead supply chain improvement projects towards consumer enhancement. The SC Kano-QFD technique proved to be very useful to that end.

The first case study (Section 6.2) took discussions around supply chain efficiency and effectiveness, which was previously discussed through 19 cases in Table 5.4, further by illustrating an in-depth analysis of a pork chain. It explained that the supply chain was ineffective while being reasonably efficient. Even though the supply chain partners were

separately measuring and analysing consumer satisfaction, they hardly linked together the requirements of the consumers, the product features and the supply chain activities. This case study established the need for understanding the consumer value, explored the potential of VSM and VCA approaches in realigning the supply chain with the true Voice of Customer and made a degree of progress in terms of addressing supply chain effectiveness. This was followed by the explanation of the inadvertent efficiency gains as a result of implementing a ‘value realignment’ opportunity (i.e. delivering boneless loin). Furthermore, Section 6.2 explained the shortcomings of the existing SCM toolbox in addressing supply chain effectiveness and identified the need for development of more potent approaches.

In the second case study, the author leveraged the supply chain improvement initiative (the VCA project), not only to fulfil consumer needs but to exceed their expectations by means of the Kano model of consumer value. Section 6.3 showed that marketing and NPD techniques for capturing the VoC should be deployed at the supply chain level to improve effectiveness and put forward the Supply Chain Kano-QFD approach. The proposed technique was replicated in three case studies confirming the external validity of the findings.

A key shortcoming in the second case study was the lack of market information and appropriate consumer surveys. The third and the fourth case studies addressed this limitation by drawing upon more sophisticated consumer data prior to categorisation of value attributes in the Kano model. The third case study showed that despite several efficiency improvement opportunities, such as improvement of delivery performance along the chain, the team opted for an effectiveness improvement project as the top line opportunity, i.e. bagging own grown wheat and changing the product image which was strategically very important to the supplier. The level of sophistication of market information increased between Sections 6.4 and 6.5. Section 6.5 showed that ‘menu’ (availability and range) and ‘meal’ (quality and taste), though being the key areas for the supply chain to influence, were only part of the ultimate value and that the supply chain could potentially effect other aspects such as in-house ‘consumer moments of truth’. By comparing the cheese case study with the fresh milk and the plain flour cases, it can be concluded that equal attention should be paid to all three categories of the Kano model and not just the delighters. Section 6.5.3 explained that the one-

dimensional value features for cheddar cheese could potentially lead to overall delight of the consumers since satisfaction with the quality and taste of the meal was highly important.

Cases 1, 3 and 4 were fairly large size companies (i.e. the focal points in the chains and their suppliers being fairly large firms) whilst case study 2 was a constellation of a number of SME's. So in terms of external validity it can be said that the findings have been replicated in very different settings in terms of the size of the companies involved, products and sectors covered, length of the chains and the scope of improvements. In the third case study (plain flour) the retail organisation, and especially the farming arm of the business, was eager and proactive in connecting with the end-user and implementing effectiveness at a strategic level. However, in practice the retailer and dairy in the fresh milk case study showed more agility for strategic change. It can be argued that bigger firms are more rigid to realign the supply chain with consumer requirements.

This author argues that the ultimate effectiveness of the supply chain should take precedence over the efficiency of the value chain. In other words, a very efficient value chain that delivers a less value-adding product could lose market share to a less efficient supply chain offering a similar product with features perceived to be of superior value to the end-consumer. Consumer value must be at the heart of supply chain performance management. This is especially relevant to the UK agri-food sector which is highly commoditised and competition centres on price.

Chapter Seven

7 Achieving Sustainability in the UK Agri-food Supply Chains

7.1 Introduction

This chapter presents one case study exploring and explaining the second research question, i.e. the issue of simultaneous improvement of the environmental and economic sustainability of the UK agri-food supply chains. The chapter contains a case study of a UK biofuels chain which looks at the complexities inherent in addressing supply chain environmental sustainability in practice. This chapter explores the move from the third ring to the fourth ring in the ‘four rings’ conceptual framework put forward in Chapter 5 (Figure 5.3).

7.2 Case Study 5: A UK Biofuels Supply Chain

7.2.1 Project Background and Introduction to Participating Companies

The years 2006 and 2007 witnessed phenomenal growth in the bioenergy sector accompanied by substantial environmental claims; though such claims have more recently abated due to several empirical studies seriously questioning the credibility of bioenergy in general and biofuels in particular (Fargione *et al*, 2008). In December 2005, the European Commission (EC) published the *Biomass Action Plan* targeting an increase in biomass use to the level of 150 Million tonnes of Oil Equivalent (MtOE) by 2010-2011 (EC, 2005). In 2003, around 4% (69 MtOE) of the total primary energy¹¹ consumption across the EU was met from biomass sources making it by far the most important renewable source equal to two thirds of the total energy produced from renewable sources. In a separate report the European Environmental Agency (EEA, 2006) declared that the proposed upsurge would lead to a reduction in GHG's by around 210 million tonnes CO₂-equivalent per annum and that such increase is consistent with various EU targets for renewable energy¹².

Many different types of biomass can be used as a source of bioenergy. These include waste from existing activities (e.g. the biodegradable fractions of municipal waste or residues from agriculture and forestry) as well as dedicated cultivation of various (energy) crops. In medium and long-term, biofuels from crops provide the largest *economic* potential. The Biomass Action Plan report estimates that an increase of biomass use to around 150 MtOE by 2010 leads to direct employment for around 250,000 to 300,000 people, mostly in rural areas (EC, 2005). Accordingly, the EU

¹¹ Primary energy is energy that has not been subjected to any conversion or transformation process.

¹² These targets are 12% overall share for renewable energy, a 21% share in the electricity sector and a 5.75% share for transport biofuels.

countries have capitalised on bioenergy from crops especially biodiesel from oilseed rape. At present, growth in biofuels is supported through government legislation and subsidies. This is very similar to the US where maize production for bioethanol has expanded astoundingly. The rapid growth of the biofuels industry has had far reaching implications for a wide range of stakeholders, from food companies to oil majors and from governments to consumers. It has also created food shortages, pushed the food prices up and has had inadvertent negative impacts on environment.

In the UK, the Renewable Transport Fuel Obligation (RTFO) obliges suppliers of fossil fuels to replace 2.5% (in volume terms) of their total road transport fuel with biofuels by 2008/2009, 3.75% by 2009/2010 and 5% by 2010/2011. The 2010 figure is equivalent to about 1.2 billion litres of bioethanol as substitute for petrol and 1.35 billion litres of bioester as diesel supplement (henceforth biodiesel). If this was to be produced entirely in the UK, 800 thousand hectares would be required or equal to around 14% of the UK arable land¹³. In practice, however, most of the biofuels requirement for the major bio-fuel processing plants is imported based on Soya and Palm oil (in the case of biodiesel) and Sugarcane (in the case of bioethanol). In the UK currently the support is through both fuel duty break and *buy-out* penalty mechanism. If the obligated fuel companies don't meet the required quantities they will have to buy-out the balance by paying a *buy-out* price currently at 15 pence per litre. However, future support has been subjected to meeting sustainability standards, yet to be established by the UK government. In order to understand the environmental performance of biofuels, since April 2008, the RTFO requires companies to report on the GHG savings of their fuels using a carbon calculator developed by the Department for Transport (DfT). (Select Committee on Environment, Food and Rural Affairs, 2008; EEA, 2006; EC, 2005)

This chapter presents a case study of a biofuels supply chain in the North East of England from farm to forecourt. This case study looks at both economic and environmental aspects of the chain. It was discussed in Chapter 3 that it is critical for

¹³ Calculated by the author based on 0.87 Kg/litre density for biodiesel and 3.3 T/Ha yield of oilseed crop (national average) with 45% oil extraction. Total UK arable land estimated at 5.8 Million hectares. (Defra, DfT and Dti, 2007)

SCM to move forward to the systemic issues that exist at the intersection of sustainability and supply chains. It was also explained that environmental sustainability is still peripheral to economic supply chain management despite increasing attention in the recent years. Chapters 3 and 5 showed that in order for industry to transform successfully to more sustainable modes the Voice of Society must be taken into account alongside the voice of the customer and that environmental issues must be ingrained in day-to-day supply chain management rather than being handled separately. The second identified gap in the literature was the lack of focus on simultaneous analysis and improvement of environmental and economic aspects in SCM literature and the lack of practical approaches for improving sustainability of supply chains while being economically competitive. The research question that operationalised research around this gap was defined in Chapter 5: how can the environmental and economic (both efficiency and effectiveness) aspects of UK agri-food supply chains be analysed and improved simultaneously?

Table 7.1 Biodeisel Supply Chain Improvement Core Team Members

No.	Company	Representative
1	Fertilizer manufacturer	Sales Director
2	Seed breeder company	Biotechnology Manager
3	Agri-chemicals supplier	Agronomist
4	Buying group (farmers cooperative)	No representative in the core team
5	Oilseed rape grower	Farm Manager
6	Cereals central storage	General Manager
7	Seed crusher	Chief Executive and Managing Director
8	Esterification plant	Sales & Marketing representative
9	Tank farm	Terminal Manager
10	Refinery and diesel blending	Business Manager
11	Forecourt	Station Manager
12	Cardiff University	The author

The aim of this case study is to explore (and where possible explain) various aspects of fit-performance associations for maximum efficiency, effectiveness and environmental sustainability. While case studies in Chapter 6 were explanatory, the following case is by and large exploratory, mainly due to the fact that the (second) research gap is very broad and less mature requiring a great deal of empirical work which falls outside the remit of this thesis. The fieldwork for this case study was conducted in 2006 as part of the VCA programme. A team of senior managers from 11 different organisations along the chain together with the author (academic facilitator) mapped the entire biofuels chain from primary supplies into the farm all the way through to the vehicle tank. Companies and representative involved are listed in Table 7.1.

The team followed oilseed rape (OSR) to a central store and mapped it through the seed crushing process using design data since the crushing plant was still under construction. Hence, the crusher data are expected rather than observed. The chain was located in the North East of England with easy access to one of the major UK ports and nearby oil and gas infrastructure. The crusher extracts rapeseed oil sending it in pipelines to a tank farm where oil is stored before being sent on to an esterification plant to produce

methylester or pure biodiesel. Biodiesel is sent to the tank farm again before it travels in pipes to the refinery where it is blended with fossil diesel at 5%. The 5% biodiesel blend then goes through the conventional diesel distribution routes to various pumping stations and forecourts. Figure 7.1 in the following section provides an overview of the chain. A detailed environmental Life Cycle Analysis (LCA) was carried out on this chain alongside the VCA project led by a different group of facilitators but involving the same company representatives. The author accessed the LCA data and carried out an interview with the LCA lead facilitator to gain greater insight. Involvement in this project not only was a unique opportunity to address the economic and environmental aspects of SCM simultaneously, but also to touch on one of the most important sustainability issues facing the UK agri-food industry – if not the most important issue, i.e. biofuels. The significance of biofuels is in the ubiquitous debate whether or not to grow fuel. Whilst countries such as Brazil have heavily invested in biofuel production for decades, this is new to the UK agri-food sector.

7.2.2 Case Study Findings and Analysis

Due to the length of the chain and for practical reasons, development of the current state map was split between an upstream and a downstream focus group. Each team carried out detailed mapping of their respective part of the chain and then the two parts were pulled together developing an overview of the whole system, as illustrated in Figure 7.1. The future state development stage was carried out jointly between the two teams as suggested in the standard 10 days data collection protocol. Since the crushing plant was still under development the following analysis represents potential activities (and relationships) based on realistic design and operating data provided by the team. Obviously there were other possible routes to market and different potential suppliers at the crushing stage. However, since the crusher was a joint initiative between companies involved in the rest of the chain it is expected that the processes will pan out in the way described. The rest of the chain was already in operation. This was a local chain with the fertilizer manufacturing, grower, central storage, crusher, esterification and blending all located in the North East, although at the time of the study oil was being purchased from other crushers located farther away in the South East and North West of England and from abroad.

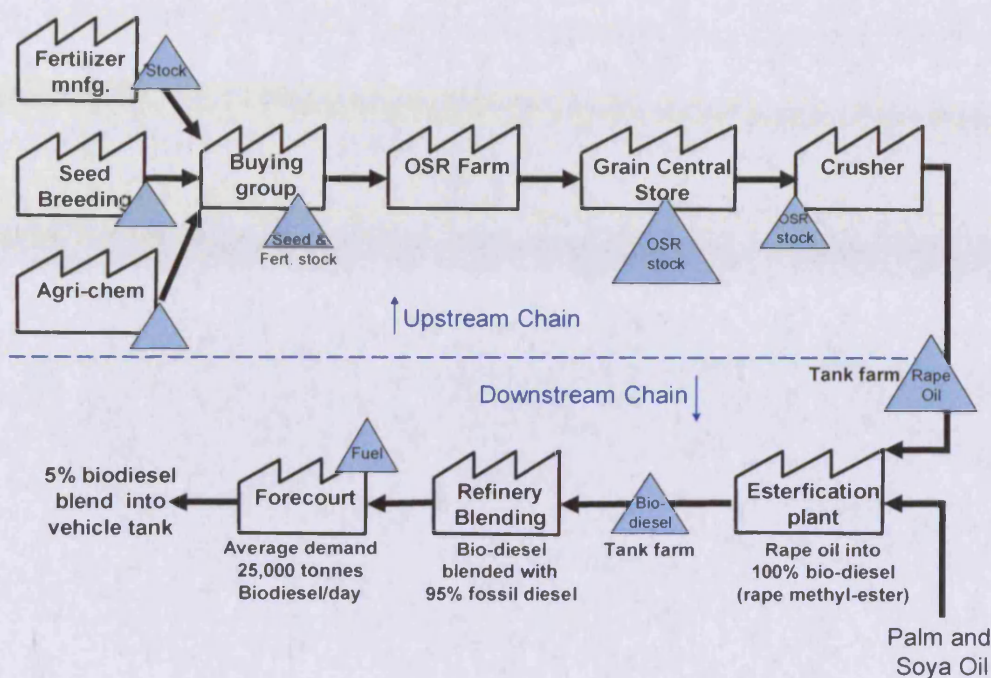


Figure 7.1 Big Picture Map of Biofuels from Seed Breeding to Tank
(Source: Author)

The upstream was a typical agri-food chain whereas the downstream was essentially a petroleum refining and distribution chain. Detailed mapping of the upstream chain showed that the total lead-time from basic seed (i.e. small quantity seed available to seed merchants for multiplication) to crusher was about 920 days out of which 365 days was in multiplication of basic seed, 365 growing on the farm and 180 days on average in the central silo. The total mileage from fertilizer manufacturing plant to the crusher was about 250 miles which indicated the transport advantages of the local chain (assuming the crusher operated from where it was being built). The following map provides a detailed view of the upstream chain. The output from the crusher is 225,000 tonnes of virgin rapeseed oil equivalent to about 20% of the UK forecasted demand to meet RTFO obligation by 2010. The projected UK requirement for pure biodiesel (methyl-ester) in 2010 is 1.35 billion litres which translates into 1,175,000 tonnes of rapeseed oil equivalent¹⁴. At the time of this study around three quarters of the required virgin oil was imported based on palm and soya oil.

¹⁴ 1.35 billion litres of biodiesel is equal to 1.175 million tonnes biodiesel (density of biodiesel is 0.87 KG/Litre) and the conversion ratio of rapeseed oil to pure biodiesel (methyl-ester) at the esterification stage is one to one.

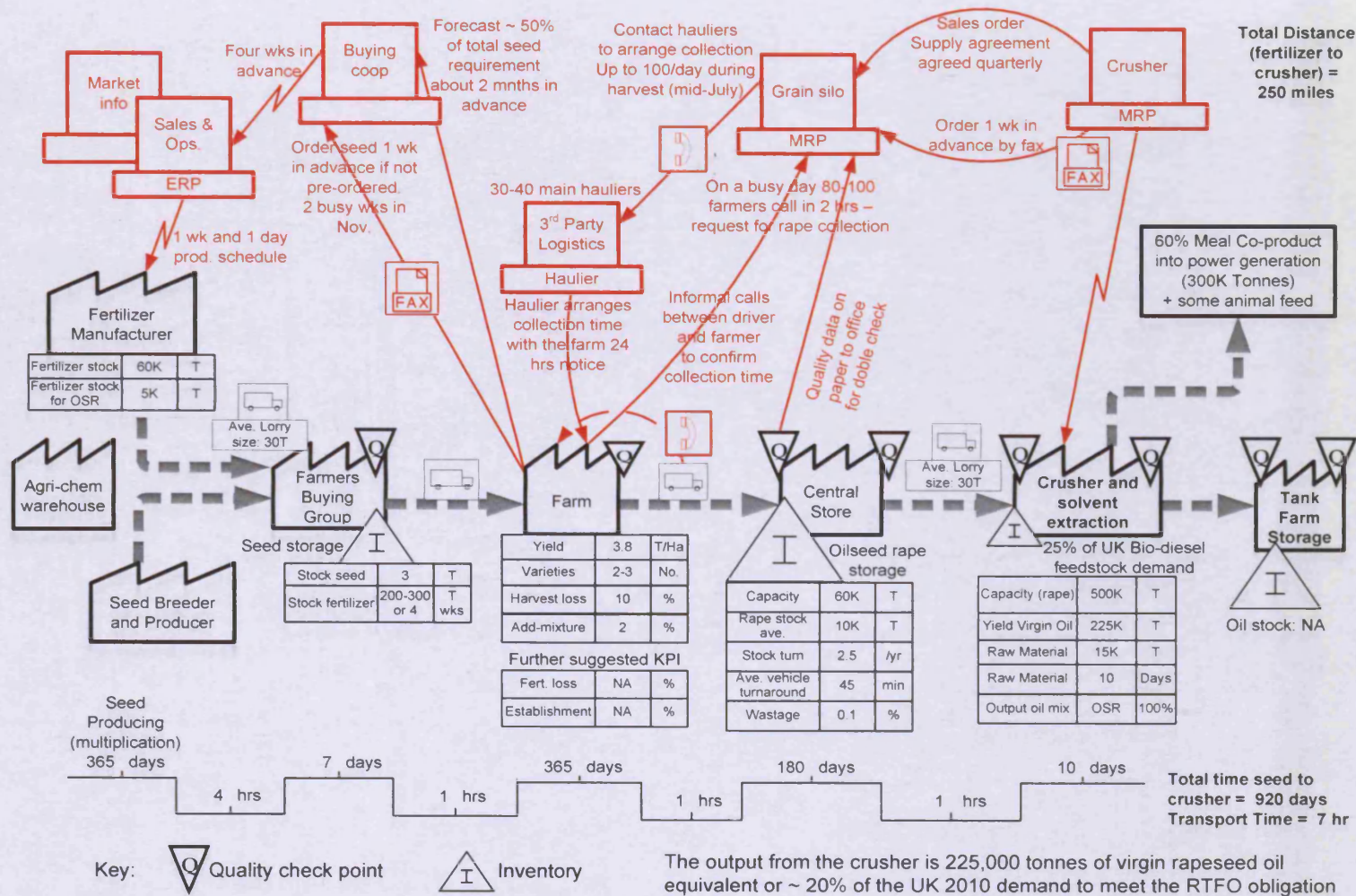


Figure 7.2 Biodiesel Upstream Current State Map

(Source: Author)

A number of issues and opportunities were identified in the upstream as follows:

- According to the information from the anonymised seed breeding company, 4% of the farmers achieved 4.5 tonnes per hectare (T/Ha) yield while 18% hit 4 T/Ha or above and 46% only harvested 3.5 T/Ha or above. Percentages are by cropped area rather than number of farmers and the national average is 3.3 T/Ha. Such a big gap has a great effect on both single chain and whole industry performance. This performance gap is partly due to higher performance of certain cropping areas and partly down to lack of husbandry standardisation at the farm end.
- According to information from the fertilizer manufacturer substantial amounts of the nitrogen fertilizer were wasted, e.g. poor fertilizer spread or too much applied. This could be avoided by adopting better nitrogen application practices.
- Similar to the third case study in Section 6.4, there were several quality checkpoints along the chain – sometimes performing the same tests on the same batch of OSR. Rationalisation of the quality check points and inspection regimes along the chain could prevent unnecessary waste.
- Communication along the chain needed to be improved. For example improving information flows between farmers, hauliers and central store improves delivery performance to the silo. Also, 25%-50% of the farm orders for new seed were received at the last minute forcing the farmers' cooperative firm to keep just-in-case seed inventory and occasionally to return the excess seed stock back to the seed supplier at the end of the season. Last minute orders also meant that some farmers didn't get the desired varieties due to unavailability.
- With the existing technology about 10% of OSR crop is lost during harvest. This will be substantially higher if the wrong setup is done on the harvester. Standardisation of the harvest practices and changeovers will reduce crop loss. Also alternative harvest techniques need to be developed.

Detailed mapping of the downstream chain showed that the total lead-time from the crusher to the vehicle tank was more than 60 days (excluding time in the tank farm due to data unavailability). The total transport in the downstream was about 60 miles which also indicates the transport advantages of this local chain. It is noteworthy that this figure excludes miles travelled in pipelines and that the forecourt mapped in this chain

was within 30 miles radius of the refinery distribution depot. As already mentioned the downstream part was essentially an oil and gas chain; therefore, deemed not relevant to this thesis. Rather than providing a detailed map of the downstream the following illustrates a big picture map of the whole chain for the physical flows in Figure 7.3. It also highlights some key issues and metrics that will be further developed in the following. A number of key opportunities were identified during mapping of the downstream part of the chain:

- The average on-time/in-full (OTIF) delivery rate from refinery to fuel stations was 97%. Additionally, 2.8% of the delivery loads were returned out of which 2.3% were down to customer errors. Returns were only 0.5% by volume but many less-than-full loads were returned. Target OTIF delivery was of 98% and returns target was 2%.
- Another key issue was continuity of supply of locally grown OSR with consistent quality (i.e. oil content and add mixture) into the crusher. This was subject to macro market elements and also required attention to farming practices and storage points along the chain.

Typically the next stage following the development of the whole chain current state economic maps is to proceed to the future state stage (Jones and Womack, 2000). Nonetheless the purpose of this case study is to discuss simultaneous economic and environmental analysis and improvement of the supply chain. Therefore analysis is continued to look into the life cycle environmental impacts of biodiesel from farm to tank.

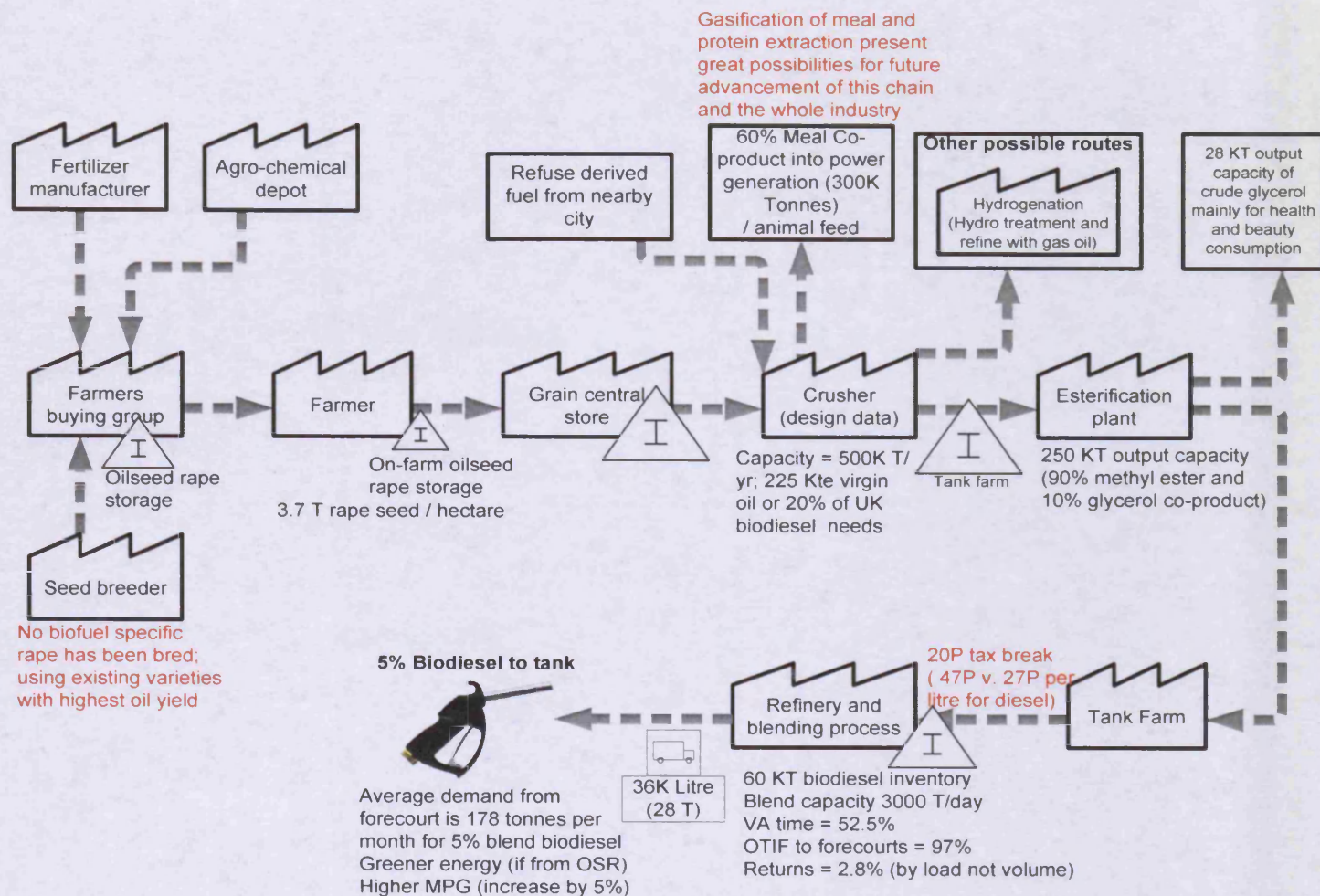


Figure 7.3 Biodiesel Whole Chain Map for Physical Flows

(Source: Author)

Analysis of Biodiesel Life Cycle Environmental Impacts

It was discussed in Chapter 2 Section 2.4, that environmental impacts of products can be measured through an array of metrics and analysed from different perspectives, e.g. global warming, water use and biodiversity. However, it was also mentioned that there is a consensus amongst environmentalists that climate change is the most pressing environmental crisis of all and that Global Warming Potential (GWP) is a key measure. Life Cycle Analysis (LCA) is a technique that captures the environmental impacts of products throughout their entire life cycle from raw material to consumption (Foster *et al*, 2006). In this section an LCA of biodiesel from farm to tank is provided where GWP is measured in terms of Green House Gaseous emissions (GHG's) expressed in CO₂-equivalent. There are several different green house gases with different overall impacts. For example the global warming effect of the refrigerant gases are thousands of times greater than Carbon dioxide (CO₂) while Methane (CH₄) and Nitrous oxide (N₂O) GWP values respectively are 21 and 310 where CO₂ is assumed to have a GWP value of 1 (IPCC, 2007). That is, Methane and Nitrous oxide emissions have much greater impact than carbon emissions. Similar to the economic VCA, the following LCA is based on both realistic design and operative data provided by the participant companies in the chain. The LCA evaluated the total primary energy inputs and the total GHG emissions including CO₂, CH₄ and N₂O associated with the production of biodiesel depicted in Figure 7.3. The following also discusses the relative environmental benefits of biodiesel versus conventional ultra low sulphur diesel derived from crude oil (Mortimer and Elsayed, 2006). The unit of analysis is (one tonne of) pure biodiesel from OSR from the above chain.

In its principal use, biodiesel is a replacement for conventional diesel, although biodiesel delivers lower miles per gallon (mpg) due to less energy content or net calorific value, i.e. 37.27 Mega Joule per KG (MJ/kg) for biodiesel versus 42.38 MJ/kg for ultra low sulphur diesel. The following provides a like for like comparison of the two fuels or in other words GHG emissions per kilometre. A study published by DEFRA shows significant difference in terms of tailpipe emission between the two fuels especially in terms of CO₂ (Table 7.2). It is notable that the net CO₂ emission for biodiesel in the table is illustrated to be nil. The idea is that the CO₂ emissions from vehicles using biodiesel are offset by the take up of CO₂ during growth of OSR (Mortimer *et al*, 2003).

Table 7.2 Tailpipe Emissions from Cars Using Biodiesel vs. ULSD in Grams/KM

Fuel	CO₂	CO	HC	NO_x	SO₂	PM	N₂O
Fossil ULSD	146	0.50	0.08	0.52	0.041	0.06	0.032
Biodiesel	0	0.50	0.08	0.52	0.005	0.04	0.032

(Source: Mortimer *et al*, 2003)

So biodiesel is arguably a carbon neutral fuel since the carbon emissions during consumption are in the first place absorbed from the biosphere during growth. However, fossil fuels are consumed during cultivation, extraction and production of both oilseed rape and methyl-ester. Also, Nitrous oxide (N₂O) and Methane (CH₄) emissions from fertilizer application and production partially offset this CO₂ neutrality as well as the net GHG savings. Furthermore, the overall balance of GHG emissions of the biodiesel chain depends on the effective use of co-products from biodiesel conversion such as OSR meal and glycerine. Clearly a systemic analysis of the end to end biodiesel supply chain is required to give an accurate answer possible by means of LCA.

The first step in preparation of the LCA is to set the system boundaries. In this case the scope of the biodiesel process chain is clearly delineated in Figure 7.3. However, drawing the system boundaries from an environmental perspective can be significantly complex since any activity that takes place during the life cycle of biodiesel, from OSR to tank, requires inputs ranging from energy to raw material to machinery. The environmental impacts of each one of these activities must be taken into consideration in the LCA. For example in this case study the GHG emissions of farm machinery, fertilizer manufacturing, emissions from land before and after fertilizer application, emissions associated with using electricity from the national grid by the crusher and other emissions must be accounted for. Moreover, facilities along the chain require energy and generate GHG emissions during their construction which must be depreciated over their lifetime. This process goes on indefinitely seemingly presenting insurmountable problems. However, in effect, successive contributions diminish in relative magnitude and it is often possible to draw the line around a fairly small group of systems connected to the main process chain (Mortimer *et al*, 2003).

Another key issue in carrying out the LCA exercise was to define the allocation procedures. For example emissions attributed to the crushing process need to be allocated between rapeseed oil and rape meal. In this chain 2.41 tonnes of dried oilseed rape (9% moisture) gives 1 tonne of crude oil and 1.29 tonnes of rape meal. The allocation mechanism deployed in this chain was based on market prices. That is, 1.29 tonnes of rape meal at £84/T and 1 tonne of rapeseed oil at £323/T giving a 75% allocation to biodiesel¹⁵. Clearly the actual market prices have since increased while their relative values are almost unchanged. With regards to allocation procedures, the use of co-products must also be determined. In this case two options were considered for rape meal use: co-firing for power generation and animal feed. Figure 7.4 illustrates mass balance for a tonne of pure biodiesel from sowing the seed to blending with fossil diesel. (Mortimer and Elsayed, 2006)

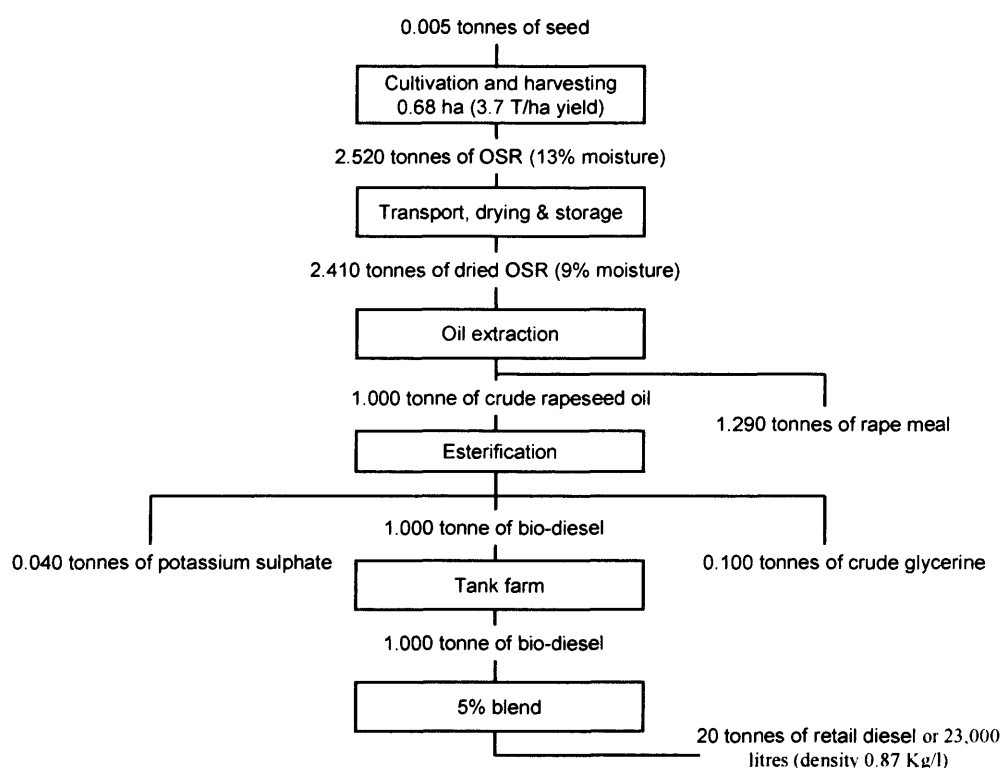


Figure 7.4 Mass Balance for One Tonne of Pure Biodiesel (Methyl-ester)

(Source: Modifications in Mortimer and Elsayed's (2006); Mass Balance by the Author Based on VCA Data)

¹⁵ $(£323 \text{ (crude oil market price)} / [1.29 \text{ T (meal)} * £84/\text{T (meal market price)} + £323]) = 323/431.36 = 74.87 \%$

Table 7.3 compares the GHG emissions of conventional diesel with biodiesel from this chain. The co-firing and animal feed scenarios for rape meal are reported separately. Also the average UK and EU biodiesel GHG emissions are illustrated.

Table 7.3 Comparing GHG Emissions between Ultra Low Sulphur Diesel, Biodiesel from a Supply Chain in the North East of England, Average UK Biodiesel and Average EU Biodiesel

Type of Fuel	Kg CO₂-equivalent / Kg of biodiesel	Kg CO₂-equivalent / MJ¹⁶	% net GHG savings against fossil diesel
Ultra Low Sulphur Diesel (ULSD)	3.876	0.091	-
Bio-diesel (this chain; co-firing)	1.398	0.038	58%
Bio-diesel (this chain; animal feed)	2.004	0.053	42%
Bio-diesel (UK average estimated by DEFRA; animal feed)	1,516	0.041	55%
Bio-diesel (EU average estimated in CONCAWE report)	53% average GHG saving expressed in grams CO ₂ -equivalent per kilometre against ULSD		

(Sources: Mortimer *et al*, 2003; Mortimer and Elsayed, 2006, Edwards *et al*, 2005)

It is evident from the above table that displacing fossil diesel with biodiesel driven from OSR delivers substantial GHG emission savings. The difference in the total GHG's between the two options for rape meal use in this chain is mainly due to the fact that a significant amount of rape meal is co-produced during oil extraction with relatively high calorific value which potentially can displace reasonable amount of electricity generated from fossil fuels in the national grid. Moreover, rape meal has high methane value when used for animal feed. It was not possible to discern which option is more likely since the crusher was not operational and no empirical evidence was available in this sector. Moreover, small difference is observed between the UK average figure and this chain (co-firing scenario) which is mainly due to higher estimates of natural gas consumption during esterification and higher assumed values for net N₂O emissions from soil. The latter is a major source of uncertainty in this LCA since the subject of N₂O released from soils is very complex depending on soil type, region, previous crops and many

¹⁶ Assuming different calorific values for biodiesel and fossil diesel, i.e. 42.38 MJ/kg vs. 37.27 MJ/kg

other factors. Our existing knowledge in this area is its infancy and inadequate (Mortimer and Elsayed, 2006). All in all, assumptions behind the overall GHG contribution of this chain presented in Table 7.3 are fairly conservative.

One major assumption in this LCA was that oilseed rape will be produced on set-aside land. Then the difference between activities on set-aside fallow land and OSR fields were calculated for the purpose of the LCA (Mortimer and Elsayed, 2006). At the time, this was a rational assumption verified by various stakeholders in the chain but subsequently, the UK set-aside farming policies have radically changed. This is one of the key limitations of the research.

In addition, the LCA included a sensitivity analysis using existing knowledge of the relationship between nitrogen fertilizer application rate and OSR yield. The results indicated the overall GHG savings against fossil diesel are very sensitive to the amount of fertilizer used during cultivation with the optimum GHG reduction occurring at 80 Kg nitrogen fertilizer/ha. Considering the national average nitrogen fertilizer application around 190 Kg/ha the above figure is way too unrealistic. The following pie chart diagram shows the level of GHG emissions attributed to different stages of the biodiesel life cycle using UK average figures reported by DEFRA (Mortimer *et al*, 2003). As illustrated, more than half of the GHG emissions arise from the use of nitrogen fertilizer during cultivation. 1 Kg of nitrogen fertilizer produces 6.693 Kg CO₂-equivalent GHG largely due to Nitrous oxides (N₂O) emissions which have an impact 310 times more than CO₂. The second largest contribution is during esterification due to high dependence on fossil energy in this heat absorbing process. Transport in the chain contributed only 2% of the total GHG's. (Mortimer *et al*, 2003)

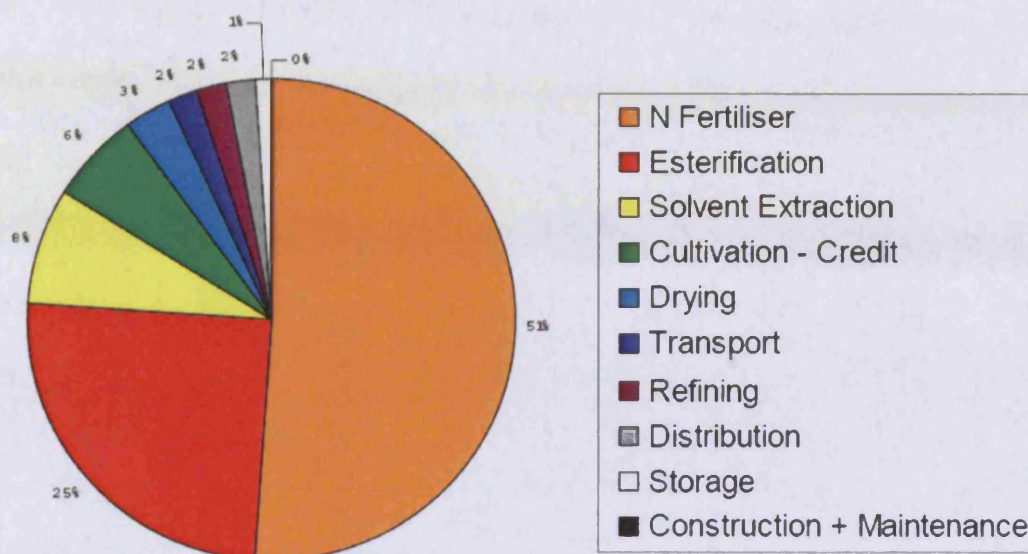


Figure 7.5 Representative GHG Emissions from Average UK Biodiesel Chain
(Mortimer *et al*, 2003)

7.2.3 Discussions, Conclusions and Recommendations

A number of key opportunities that simultaneously improve the economic and environmental sustainability of the chain were identified in this chain as discussed below:

- Fertilizer application:** According to data published by Defra (Mortimer *et al*, 2003) the most prominent sensitivity of the total GHG emissions associated with the production of biodiesel from OSR is due to the variation in yield. In other words, incremental increases or decreases in OSR yield have significant impact on the total GHG balance of the chain. Clearly nitrogen fertilizer makes a significant contribution both in terms of yield and the total greenhouse gas emissions of biodiesel production. Figure 7.6 illustrates nitrogen response rate (fertilizer application vs. yield) based on data from the fertilizer manufacturer.

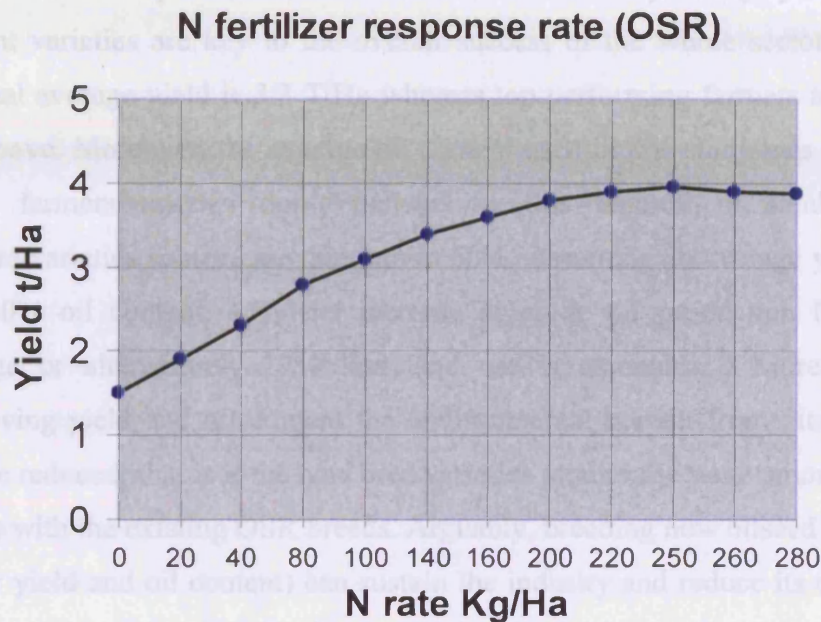


Figure 7.6 Nitrogen Fertilizer Response Rate (Application vs. Yield)

(Source: Market Report Produced by Anonymised Fertilizer Manufacturer)

It is evident that fertilizer application over and beyond the 200Kg/Ha mark will have marginal effect on yield and can be considered as economic waste. Based on the analysis presented in Figure 7.6 it can be concluded that such economic waste will also have serious environmental implications due to the significant impact of nitrous oxides from the excess fertilizer. *It is both economical and environmental to make sure every kg of nitrogen fertilizer is used with maximum efficiency.* The sensitivity analysis carried out for this chain showed that the optimum rate of fertilizer application for minimum GHG emissions is 80 Kg N-fertilizer/Ha (Mortimer and Elsayed, 2006). However this is not a viable option especially considering the existing food and energy crises. On the other hand, information provided by the fertilizer manufacturer suggested that up to 80% of the fertilizer can be lost in a single application due to poor spread, too much applied or other reasons. It is therefore important for growers (and the whole chain) to take great care in applying the right amount using the right methods in order to minimise both environmental and economic wastes.

- **Breeding specific varieties for biofuels:** Currently, there are not any biodiesel specific oilseed rape varieties in the market. Availability of high yield and high oil content varieties are key to the overall success of the whole sector. The existing national average yield is 3.3 T/Ha whereas top performing farmers achieve 4 T/Ha and above. Moreover, the average oil content used in this study was 45%. Whereas many farmers/varieties don't deliver on this amount, a small number of farmers/varieties achieve anything up to 50%. Assuming an average yield of 4 T/Ha and 50% oil content, 17% net increase in crude oil production from the same acreage or alternatively 17% less land use is attainable¹⁷. More critically, by improving yield and oil content the environmental burden from nitrogen fertilizer will be reduced; that is if the new bred varieties require the same amount of fertilizer in line with the existing OSR breeds. Arguably, breeding new oilseed varieties (with higher yield and oil content) can sustain the industry and reduce its dependency on government intervention. Furthermore, historically biodiesel chains are working to maximise *oil* extracted from rape. However, a report by the UN on the future of renewable energies (UN-Energy, 2007) suggested that the aim should be maximising the *energy content* in rape. This is a radically different perspective requiring new breeds and technologies. The issue of yield loss is also linked into farm practices as explained below.
- **Standardise best farming practices, disseminate and educate farmers:** A significant gap was identified between the best performers and the poor performers in the farming side of the chain, e.g. substantial yield differences due to wrong choice of variety and non-standard husbandry, nitrogen fertilizer loss due to wrong or early application, and harvest loss due to wrong setup and lack of standardisation of changeovers. Both economic efficiency and environmental performance could be improved through standardisation and dissemination of the best practices such as in the case of fertilizer application and husbandry practices linked into yield. Sources of variation in farming should be identified and dealt with in a rigorous manner. With regards to the oilseed rape harvest loss (currently averaging at around 10%) new technologies could be investigated such as application of certain resins prior to harvest.

¹⁷ The acreage required for 1 tonne of biodiesel will decrease from 0.68 Ha in Figure 7.4 to 0.565 Ha

- **Carbon reporting seed to tank:** Since April 2008 an obligatory carbon reporting and monitoring mechanism is in place to ensure that the promised carbon reduction targets are met and that the carbon footprint of the end-to-end supply chain (seed to tank) is constantly controlled. Currently the RTFO is not directly linked to carbon savings; however this is expected to evolve to provide more incentive to best environmental practices. It was suggested that the companies should invest time and resources in taking this opportunity seriously.

This case study provides practical solutions on how simultaneously to analyse and improve the environmental and economic performance of a UK agri-food supply chain answering the second research question. On the surface the LCA suggests that biodiesel is between 42% and 58% less GHG intensive than ultra low sulphur diesel depending on how it is produced / sourced throughout the supply chain. Nonetheless, there is solid evidence suggesting otherwise (Fargione *et al*, 2008). *Although biofuels potentially are a low carbon energy source, their overall GHG saving depends on many macro factors that by and large fall outside the boundaries of any single supply chain requiring a truly systemic understanding of the global interconnectedness of environmental issues.* Growing crops for biofuels can indirectly trigger a chain of events leading to clearing native ecosystems such as forests or grasslands releasing 17 to 420 times more CO₂ than the annual GHG reduction these biofuels provide by displacing fossil fuels. Since soil and plant biomass are the two largest stores of terrestrial carbon, converting native habitats to cropland releases CO₂ due to decomposition of organic carbon stored in plant biomass or soil. Fargione *et al* (2008) refer to the substantial amounts of carbon dioxide that can initially be released from biofuels croplands as *biofuel carbon debt*. An estimated 750,000 acres of Brazilian rainforest were deforested in the second half of 2007 most of which was fuelled by the biofuels rush. Similarly, accelerating demand for palm oil is contributing to the 1.5% per annum rate of deforestation in Indonesia and Malaysia. The bottom line effect is that producing biodiesel via clearing carbon rich habitats creates a GHG emissions debt that requires decades or even centuries to be offset through biodiesel GHG savings. (Grunwald, 2008; Fargione *et al*, 2008)

Conversion of natural habitat to cropland can occur indirectly through competition with food production as well. For example most of the deforestation in Brazil results from a chain reaction triggered by maize production in North America. At the moment US

farmers sell around 20% of their maize crops for bioethanol production which attracts soybean growers to switch to maize in turn creating a hole in the soybean market in the US. Brazilian soybean farmers fill this gap chiefly by expanding into cattle pastures forcing cattlemen into the Amazon to find new pasture. Such chain reaction in food and energy markets have depleted food stock to record low levels and caused prices to soar to record high. In 2007 the UN published a report on the future of bioenergy stating that *“price increases have already occurred in major feedstock markets, for example, sugar, maize, rapeseed oil, palm oil and soybean. In addition to raising feedstock prices, increased demand for energy crops might elevate the price of basic foods, such as cereals, which comprise the major proportion of daily dietary intake of the poorest and the least food secure. Thus possible income gains to producers due to higher commodity prices may be offset by negative welfare effects on consumers as their economic access to food is compromised”* (UN-Energy, 2007 p. 34). The report also went on to add *“current research concludes that using biomass for combined heat and power (CHP), rather than for transport fuels and others, is the best option for reducing GHG emissions in the next decade and also one of the cheapest [...]. Analysis from many countries show that biofuels are currently a relatively expensive means of reducing GHG emissions relative to other mitigation measures”* (p. 49). Considering all of the above combined with recent facts about the massive negative environmental effect of biofuels (Fargione *et al*, 2008) it is safe to assume that what is still driving biofuels is mainly political will to lower dependency on crude oil, elevate energy security and boost agricultural economies rather than environmentalism¹⁸.

Interestingly, the above discussions show that the supply chain alone has not been the right unit of assessment in this case. It is argued that the UK agri-food firms must understand the full scale impact of their products and their industry whilst also fully aware of their supply chain's environmental effects. In this case study the VCA and LCA studies used unit of weight of biodiesel as the functional unit of analysis and

¹⁸ In July 2008 the UK government set out a new approach to biofuels, including that the introduction of biofuels in the UK should be slowed down, in the light of the emerging scientific evidence about their sustainability. However it rejected a moratorium on biofuels arguing that biofuels for transport could reduce GHG emissions substantially and that it will monitor the global controls on land-use change.

biodiesel supply chain as the boundaries of the system. Despite detailed input-output analyses the big picture was missed leading to the conclusion that biodiesel is 50% more environmentally friendly while in fact the macro perspective showed that biodiesel from OSR and other types of biofuels can have a grossly negative impact on the environment – both directly and indirectly. As already explained in Section 5.4 two distinct approaches can be adopted for studying the environmental impacts of products: bottom-up and top-down. The bottom-up approach begins with an individual product and conducts a Life-Cycle Assessment (LCA) as in this case study. In a recent paper Garnett (2008) concurs with this author on the limitations of LCA especially when it comes to policy decisions on a macro scale, dealing with subtleties of human behaviour or second order land use impacts of certain products. The omission of the land use dimension in this case study potentially led to a recommendation which on a global level actually leads to increases in GHG emissions. On the contrary, the top-down approach begins with input-output tables at macro-level often produced by statistical agencies. These tables, in the form of matrices, describe production activities in terms of the purchases of each sector from all other sectors and emissions and resource use in each sector (i.e. input-output models). However, the top-down approach has its own shortcomings such as the availability of suitable input-output tables and output tables typically being highly aggregated. Last but not least, technological advancements may (and probably will) change the equation in favour of biofuels, e.g. by genetic modification of new maize varieties it is possible to make their leaves suitable and viable for ethanol production with no modification to corn seeds. Currently only corn seeds are used for ethanol and not the leaves.

All in all, this case study provided rich contextual evidence explaining how to improve economic and environmental sustainability of a supply chain simultaneously. The case study contributes polishing up the theoretical framework put forward for the second research gap by answering some key questions and posing new ones. It was discussed that the body of sustainable development literature that underpinned the second research gap is based on fairly raw and tentative scientific knowledge. This case study confirms some of the shortcomings of the existing sustainable supply chain body of knowledge by, for example, challenging the popular view that biofuels can deliver great environmental benefits promoted both by the UK government and the EU (Select Committee on Environment, Food and Rural Affairs, 2008; EEA, 2006; EC, 2005;

Mortimer *et al*, 2003). The case study was largely exploratory helping to answer how the environmental and economic aspects of UK agri-food supply chains can be simultaneously analysed and improved?

The theoretical framework is refined through this case study since the author shows that the LCA approach could be insufficient when considering the full scale impact of products. *Therefore, setting the boundaries of the system at the supply chain level is not always going to deliver the complete picture especially when involving policy decisions on a macro scale, dealing with subtleties of human behaviour or second order land use impacts of certain products (see Garnett, 2008 for further information).*

On the other hand, carrying out input-output studies will not make companies or supply chains needless of LCA studies. In fact, the author proposes that supply chains must be familiar with the overall environmental impact of their end-to-end chain and act on it. The LCA view combined with an understanding of the top-down perspective will enable agri-food firms to take informed steps forward. Visionary firms have achieved a huge deal by adopting a systemic view of the supply chain. Walkers Crisps for example realised that 44% of their product's environmental footprint is in farming the raw material, 30% in manufacturing crisps from potatoes and only 9% in transport. In the eyes of the consumers, it is ultimately the focal firm in the chain that bears the responsibility or conversely reaps the benefit of being perceived as a green company. Walkers therefore decided to be proactive about reducing emissions from their end-to-end supply chain and also to carbon label every pack of crisps consumers buy. Since 2001 they have achieved 33% reduction of their footprint and have also committed to achieving further reductions year-on-year by setting realistic yet challenging targets. (Carbon Trust, 2006b)

In terms of supply chain environmental analysis, this case study explained ways for simultaneous environmental and economic assessment of the biofuels chain which can be analytically generalised to the entire agri-food sector. The keywords for creating efficient, effective and green supply chains are *whole systems approach* and *innovation*. This case study showed how these two can be combined to take the chain from the third ring to the fourth and final level in the 'four rings' conceptual framework (Figure 5.3).

Chapter Eight

8 Discussions, Conclusions and Recommendations

This Chapter discusses the relationship between the findings, the research problem and the underpinning theories of the thesis. It must be noted that the findings have already been, by and large, analysed and related back to the specific research questions and the theoretical frameworks put forward in the earlier chapters, at the end of Chapters 6 and 7. The following will highlight the key contributions to the body of knowledge and puts forward a considered discussion of the main implications of the findings from both practical and academic points of view. Also, the key limitations of the study are analysed once more following what went in Chapter 5 and, finally, concluding thoughts and recommendations for further research are provided.

8.1 An Overview of the Theories and the Findings

Chapter 1 described the interconnected web of problems that the UK agri-food industry faced in the late 1990's and early 2000's; it was explained that any improvement approach needs to adopt a systems view of the sector rather than point analysis of individual issues. Seminal academic, practitioner and policy reports (Curry *et al*, 2002; Rickard, 2004; RMIF, 2002; Fearn and Hughes, 1999) were reviewed defining the research problem as *a lack of systemic understanding and systemic improvement approaches in the UK agri-food supply chains*. Accordingly, the literature review began, in Chapter 2, by looking at systems thinking and sustainable development literature which together laid down the foundation for systems analysis of the UK agri-food chains. Chapter 3 then narrowed the literature search focusing on supply chain management (SCM) and sustainable supply chain literature leading to the identification of two key gaps in the body of knowledge in relation to the research problem. The first gap related to the improvement of supply chain consumer focus (in other words supply chain effectiveness) and the second gap was defined as a lack of simultaneous analysis and improvement of the environmental and economic performance of supply chains.

Chapter 3 showed that SCM is a rapidly growing body of knowledge comprising a core and a protection belt. Whereas the core largely consists of logistical and operations management topics, the protection belt is multidisciplinary, evolving and in need of empirical research for expansion of the boundaries of the field. The review of SCM contributions, in Chapter 3, revealed that this field of study is evolving beyond efficiency and physical aspects to look at consumer enrichment and more subtle ways of differentiation. This was termed as supply chain effectiveness in this thesis and identified as a key emerging area within the protection belt of the SCM knowledge. Moreover, the review of the supply chain sustainability literature identified another emerging topic area within the protection belt forming the second research gap, i.e. a lack of practical approaches for simultaneous improvement of environmental and economic performance of supply chains. Chapter 3 discussed that the second gap entails pushing the boundary constraints of the SCM body of knowledge forward to address the systemic issues that exist at the intersection of environmental sustainability and economic supply chain management. These two gap areas informed the research questions which in turn shaped the focus of the thesis.

Chapter 4 looked at the research design and methodologies deployed explaining that a case study research strategy has been adopted in line with the research questions, the nature of the study, the philosophical underpinnings of the researcher, and the practical requirements and limitations. In terms of the research design the thesis was organised in PLAN-DO-CHECK-ACT cycles consisting of two key iterations (*see* Figures 4.4 and 4.5). The first iteration began with the research problem which informed the literature review leading to the identification of the gaps in the body of knowledge and ending by contextualisation of the research gaps and proposition of a conceptual model in Chapter 5 (i.e. the four rings model of evolution of the UK agri-food supply chain knowledge). This theoretical framework in turn served as the starting point for the second iteration of the research and guided the data collection and analysis in the case studies in Chapters 6 and 7. The second iteration ends with the analysis of the findings, conclusions and recommendations for further research. Chapter 4 also discussed the rigour of the study against a set of criteria namely, objectivity, internal and external validity, reliability and epistemological rigour.

Since the literature review covered general SCM contributions, the gaps identified in Chapter 3 were not industry specific. Therefore, it was necessary to contextualise the theoretical findings and to assess the extent of the relevance of the research gaps/questions, posed in Chapter 3, in the context of the UK agri-food sector. Chapter 5 set out to conduct contextual research starting with an overview of the industry and continued by investigating each research gap. Chapter 5 looked at 23 agri-food chains and compiled 31 cases of supply chain ineffectiveness from across 19 of them clearly bearing out the immediate importance of the first gap. Moreover, it looked at the extent of the environmental impacts of the UK agri-food chains drawing upon secondary evidence and showing that their GWP contribution is 19% of the total UK GWP against an 8% share in the GDP. The findings and discussions, in Chapter 5, corroborated the relevance of both research gaps to the UK agri-food sector and defined the research questions as will be discussed in the following. Furthermore, the contextual research in Chapter 5 led to the proposition of a conceptual framework of the evolution of the UK agri-food supply chains which encapsulated the theoretical propositions of the thesis and served as a guide to organise and direct data collection and analysis in Chapters 6 and 7, i.e. the four ring model of the evolution of the UK agri-food chain knowledge (Figure 8.1). The research questions, effectively, operationalised this theoretical

framework, i.e. how to move from the second ring to the third and from the third ring to the fourth.

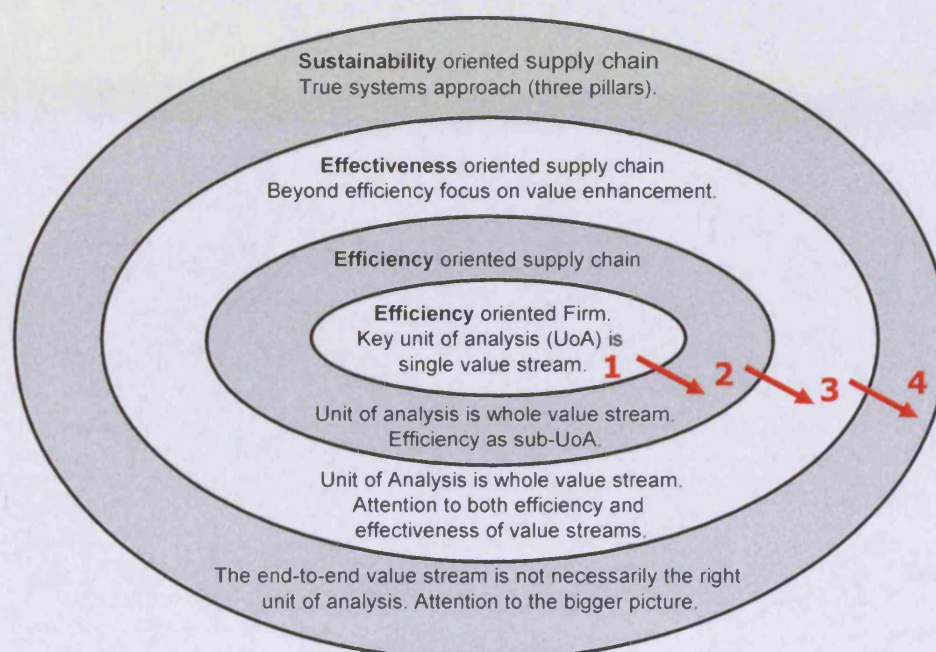


Figure 8.1 The Four Rings Model and Units of Analysis at Each Layer
(Source: Author)

The case studies in Chapters 6 and 7 were carefully selected against the research questions and the preceding theoretical propositions (Yin, 2003). In this sense the five case studies discussed in this thesis represent a purposive sample. As discussed in the methodology chapter, in a purposive sample the researcher selects cases based on the research objectives to best enable answering the research questions. In Chapter 6 the first research question was addressed, at an explanatory level, through four case studies. Explanatory analysis refers to the fact that it was possible to develop significant knowledge about the theoretical propositions and to analyse the causal relationship between phenomena by comparing and contrasting the results of the four case studies. Chapter 7, however, addressed the second research question, at an exploratory level, through one case study. It was discussed in Chapter 5 that the state of knowledge around the fourth ring is in its infancy. Therefore the purposive sample was designed to address the first research question in greater detail realising the full potentials for explanatory knowledge generation, while the second research question was addressed through one case study exploring issues and providing valuable insights for future investigation.

In Chapter 6, across all four cases and within the supply chain functions, there was a lack of understanding of the consumer value and the role of the supply chain in fulfilling it. Different parts of the chain had differing opinions of what was meant by consumer value leading to conflicting behaviour and poor overall delivery of value to the end-consumers. Also the role of SCM was perceived as limited to delivering operational/logistical services only (i.e. QCD). This perception was countered within the four case studies by obtaining consumer information (capturing VoC) and by steering the supply chain improvement initiatives towards greater supply chain effectiveness. The research question was: how can the effectiveness of the UK agri-food supply chains be improved, without compromising the efficiency of the supply chain? The efficiency gains were discussed for each case but not extensively since, as mentioned in the literature review, the efficiency aspects of supply chain improvement are already well documented (Hines and Rich, 1997; Womack and Jones, 1996). *The case studies showed how inter-organisational potentials can be leveraged to improve the overall supply chain consumer satisfaction.* For example in the second case study there was a realisation that the (rather obvious) opportunity to communicate that the product was 100% locally sourced and processed was unexploited. This realisation only occurred once a whole supply chain team was brought together and an end-to-end map of the chain was created. None of the chain members were in the position to realise this opportunity on their own. Similarly in the third case study a strategic decision was taken with regards to the overall value proposition of the supply chain, i.e. own-label bag of flour containing product sourced from own-grown grain. This way the supply chain exceeded consumer expectation which could not have been delivered by any single company on its own.

The fourth case study, then, showed how supply chain effectiveness can be improved in complex situations where conventional consumer insight is difficult to translate into single product or ingredient value. In this case study a cheddar cheese chain was mapped which was a mere ingredient of what potentially constituted consumer value (e.g. quality of the meal, menu range, staff and hygiene in the outlet). In this case it was not easy to get the team to think beyond the conventional logistical measures to include broader (marketing and value) metrics compared to the previous cases due to these complexities. However, the supply chain improvement opportunities were directed to focus on effectiveness aspects by accessing a great deal of market information and

extensive use of such information during the current and future state workshops. Moreover, this case study explained that, in terms of creating an effective supply chain, it was equally important to address the must-be and one-dimensional attributes of the Kano model to avoid dissatisfaction and to pursue service excellence; unlike the second and third case studies where the supply chain panels focused on introducing delighters. Again, inter-organisational opportunities were exploited to deliver and enhance overall chain effectiveness (e.g. changing shred size and bag sizes) which were realised once the whole team walked the chain and compared and contrasted improvement opportunities against the consumer value.

Chapter 6 drew upon the existing – efficiency oriented – supply chain body of knowledge to discuss the importance of integrating the VoC into SCM and to explain how to boost consumer satisfaction and/or avoid dissatisfaction. An evolutionary trend can be observed from the first to the fourth case study in Chapter 6 in terms of understanding of the issues, the sophistication of the methods deployed and the level of access to information outside the traditional boundaries of the supply chain function (e.g. consumer surveys obtained from marketing departments in the third and fourth case studies). The case studies put forward and replicated an evolutionary technique (i.e. the Supply Chain Kano-QFD approach) for supply chain value re-alignment and enhancement.

Chapter 7 addressed the following research question: how can the environmental sustainability of the UK agri-food supply chains be improved without compromising their economic competitiveness? The biofuels case study presented in Chapter 7 showed that potentially the overall GHG emissions from a biodiesel supply chain could be lower than a fossil diesel supply chain. Nonetheless, it was discussed that the actual GHG saving depends on many factors that, by and large, fall outside the boundaries of any single supply chain, e.g. the economic knock on effect which has triggered deforestation and caused a huge carbon debt globally. Chapter 7 concluded that the macro effects require a truly systemic understanding of the global interconnectedness of environmental, social and economic issues and that the supply chain is not – necessarily – the right unit of analysis as in the case of biodiesel. Therefore the case study contributed to polishing up the theoretical framework put forward for the second research gap by answering some key questions and posing new ones. It illustrated that

the LCA approach could be insufficient when considering the full scale impact of products and called for both LCA (bottom-up) and macro level (top-down) analysis of supply chain environmental impacts. The findings in Chapter 7 confirmed that the body of knowledge surrounding the second research question is underdeveloped (e.g. by challenging the popular view that biofuel is a green energy) and that a great deal of empirical work is required by the research community interested in understanding the dynamics of simultaneous environmental and economic improvement of the UK agri-food supply chains. (Select Committee on Environment, Food and Rural Affairs, 2008; EEA, 2006; EC, 2005).

8.2 Principal Contributions of the Thesis

The key contributions of the thesis are summarised in the following:

1. This thesis looked at the evolution of the agri-food supply chains and provided a systems analysis of the sector. Discussions provided in the first five chapters culminated in the introduction of the four rings conceptual model of the evolution of the agri-food chain management body of knowledge. In Figure 8.1 the two inner rings relate to the present time while the outer rings represent *should be* situations and future advancement of the boundaries of knowledge based upon the critical gap areas and the requirements of the sector. One of the principal contributions of this thesis is the conception of this model as a constructive instrument for understanding the interconnected web of the problems the UK agri-food chains face in a systemic and systematic way and to develop our body of knowledge accordingly. Chapter 5 discussed that, so far, improvement attempts have been limited to point analysis of individual rings, whereas the case studies presented in this thesis took an holistic approach to improvement from efficiency to effectiveness to sustainability. The thesis provided some discussions on the characteristics of each ring and tools deployed at each level. However the principal focus of the study was on addressing *how to* move from the second ring to the third and from the third to the fourth. Addressing the model itself could be the subject of a different study and the author recommends further investigation looking at both macro and micro factors influencing the future of agri-food supply chain management in the UK.

2. Another key contribution of the thesis was to show how the UK agri-food supply chains' effectiveness can be improved. Extensive discussions were provided and significant knowledge was generated regarding various approaches deployed and results achieved both in Chapter 6 and in the above, especially the S.C. Kano-QFD technique. It is expected that the approaches developed in this study can be replicated in the context of other industries and the author recommends further comparative studies.
3. Moreover, this thesis contributed to the discussions on how to improve the environmental sustainability of the UK agri-food chains whilst improving economic performance. The case study presented in Chapter 7 showed how the LCA techniques can be deployed in conjunction with value stream mapping providing detailed economic and ecological (GWP) analysis of a given agri-food chain. Clearly such analysis is the cornerstone of any improvement attempt. However, the discussions showed critical shortcomings in both the scientific (e.g. frequent changes in the IPCC reference indices for GHG contributions) and supply chain management bodies of knowledge (e.g. the supply chain is not necessarily the right unit of assessment as in the case of biofuels). These findings paved the way for further investigation towards more definitive approaches for improvement. For example, they showed the importance of understanding the macro level environmental impacts alongside LCA for a single chain which can be achieved by means of input-output analysis and by considering various socio-economic effects.
4. Finally the thesis contributes to the research methodology debate in the field of SCM by putting forward the two-by-two model of the key dimensions of research in management (*see* Figure 4.2). The author argued that an additional dimension needs to be introduced into the research methodology debate taking account of those strategies which engage in addressing the practical problems of the industry. It was also discussed that currently a great deal of the knowledge creation, including most supply chain management research, is of a participatory nature. Several recent authors, such as Näslund (2002), McCutcheon and Meredith (1993) and Tranfield and Starkey (1998), have pointed out that an explicit understanding of action oriented research has been absent from the management literature in general and operations and supply management in particular. They argued that management

research should adopt a dual approach to knowledge production addressing both theory and practice. Chapter 4 discussed '*Mode 2 knowledge creation*' as a generic concept for knowledge generation associated with participatory, case based, contextual and action oriented research. The research strategy and the data collection techniques deployed in this thesis were positioned in this context in Figure 4.2. Also, the importance of the practical relevance of the research was discussed under epistemological rigour. Chapters 6 and 7 considered the practical relevance of the findings, the role and the importance of the panel of company representatives in each case study and the role of the researcher as the change agent/facilitator. Therefore, this study not only contributes to the theoretical discussions around action oriented research methods, but also puts forward empirical evidence of how 'action oriented' case study research strategy is operationalised in practice.

8.3 Key Implications of the Findings

There are several implications from the findings of this thesis. Naturally the main implication concerns the UK agri-food industry as the main focus of this study. Not surprisingly, the findings of this study have similarities with the recommendations in the Curry Commission report (Curry *et al*, 2002). The Curry report offered in excess of 100 suggestions for improvement of the UK agri-food industry. Although, on the surface, the report might seem fragmented, systems thinking and holistic approach underlie most of those recommendations. As discussed in Chapter 5, a close look at the operational suggestions in the Curry report shows that they can be broadly categorised under three areas, i.e. waste reduction and efficiency improvements along the whole chain, de-commoditisation of agricultural goods and adding more value to the consumers, and preservation of the environment. These three categories are aligned with the second, third and fourth rings in Figure 8.1. *The thesis provides solid evidence as to how agri-food chains can implement the improvement paths put forward in the Curry report.*

Moreover, there are key implications for the supply chain body of knowledge in terms of the overlap with the marketing discipline. Chapter 6 showed the critical role of SCM in delivering consumer value and consumer enhancement. *In all four cases considerable overlaps occurred between chain management and marketing.* This was especially

remarkable in the third and fourth case studies where sophisticated market information were deployed to improve supply chain effectiveness (in both cases the author tapped into the expertise and information within the marketing departments). This was due to the nature of the first research gap which, as discussed in Section 3.3, verged with the discipline of marketing. Chapter 3 explained the – rather illogical and unhealthy – gap between SCM and marketing both in the literature and in practice; it also discussed the theoretical need for addressing their linkages and integration where possible. Min and Mentzer (2000) called for case studies, surveys and qualitative supply chain analyses to plumb the role of marketing in SCM. This thesis contributes to the debate by showing how marketing insight and marketing tools can be used in the context of the supply chain for improving the overall performance of the entire chain. The case studies in Chapter 6 also showed how the supply chain functions (and operations departments) can contribute to the enhancement of the consumer value. Prominent marketers such as Levitt (1960) and Doyle (2000) have emphasised the role of product augmentation for single firm competitiveness. Also, some logisticians have described the role of logistical services for enhancing the firm's core offering (Christopher, 2005). Christopher (2005) argued that the reason for SCM occurring is to produce value in the form of products and services in the hands of the ultimate customer. This thesis goes beyond logistical criteria of value and service delivery (i.e. QCD) to address more subtle aspects of consumer value by putting forward the concept of supply chain effectiveness and emphasising that the ultimate purpose of any chain is value creation and enhancement. The suggestion here is that there is much potential for consumer enrichment at the intersection between firms as explained in the case studies presented in Chapter 6.

In fact, Ford's exemplary efficient supply chain can be looked at in a radically different way from a consumer value or marketing perspective. It is well known that Henry Ford established the first flow assembly line and created a vertically integrated supply chain all the way back to the production of raw materials such as glass from silica mining to glass works to windscreen production (Levinson, 2002; Hounshell, 1984). Ford's vertically integrated supply chain, flow assembly and mass production have been noted as signs of an extremely efficient system. Nonetheless, Levitt (1960 p.8) argues that Ford's real genius was in creating an effective system through market orientation: *"What Ford put first: The profit lure of mass [efficient] production has a place in the plans and strategy of business management, but it must always follow hard thinking*

about the customer. This is one of the most important lessons we can learn from the contradictory behavior of Henry Ford. In a sense Ford was both the most brilliant and the most senseless marketer in American history. He was senseless because he refused to give customers anything but a black car. He was brilliant because he fashioned a production system designed to fit market needs. We habitually celebrate him for the wrong reason, his production genius. His real genius was marketing. We think he was able to cut his selling price and sell millions of \$500 cars because his invention of the assembly line had reduced the costs. Actually he invented the assembly line because he had concluded that at \$500 he could sell millions of cars. Mass production [efficiency] was the result, not the cause, of his low prices". Therefore, Ford clearly put supply chain effectiveness first.

Last but not least, there are implications for the lean thinking body of literature. Elimination of Muda – which is Japanese for waste and futility – is often taken as the tenet of lean thinking. However, in fact lean should be as much about value creation as it is about waste elimination (Hines *et al*, 2004). In a recent seminar broadcast on the World Wide Web, Womack (2008) said: *"from [the] society's standpoint the reason organisations exist is to create value for consumers. So successful organisations [...] are the ones that actually solve consumer problems [...]. People are looking in the wrong end of the telescope when they think that the purpose of the organisation is cost reduction. So much of the lean movement up to this point has been focused, I think in an unbalanced way, on cost reduction as opposed to value maximisation which is what the customer really wants"*. Similarly, recent publications by several lean thinkers draw attention to the understanding of the consumer value (Hines *et al*, 2004) and the consumption end of value streams (Womack and Jones, 2005). The evolutionary trend presented in Figure 8.1, shows that the agri-food SCM body of knowledge is moving away from a narrow focus on efficiency to look at effectiveness and consumer enhancement. Chapter 6 borrowed from and expanded a number of approaches from the lean supply chain improvement body of knowledge such as VSM. There is an inadvertent contribution in terms of integrating the voice of customer into value stream improvement initiatives and the existing lean toolbox, i.e. contributing to the development of the lean value stream mapping literature.

8.4 Limitations and Recommendations for Future Research

Jaworski and Kohli (1993) found a positive correlation between a firm's market orientation and financial performance, e.g. return on investment. Similarly, Desphande *et al* (1993) found that profitability, market share and growth rate relative to competitors are positively related to a firm's degree of market orientation. It is desired to establish whether such correlation exists between a firm's supply chain effectiveness (consumer focus) and supply chain efficiency. Therefore, the author suggests a (positivist) survey of chains in the agri-food sector and statistical analysis of the result to establish whether such relationship exists. Moreover, further case study and action oriented research is required to look into both supply chain's ability and agility to address chain effectiveness, i.e. develop new value propositions into structural and relational adaptation requirements for the whole chain on an ongoing basis.

Moreover, this thesis did not address whether the improvement projects stuck over the long term. That is, the sustainability of both efficiency and effectiveness improvement projects need further investigation to understand which types of improvements, efficiency or effectiveness, are more likely to sustain over a long period and why?

The next limitation concerns the scope of the study. As discussed in Chapters 2 and 4, the research questions were derived, mainly, by looking at the literature through an operations and logistics management perspective. Therefore the thesis is arguably limited to the economic/technical sub-system. From a methodological perspective, this limitation concerns the *internal validity* of the thesis since 'cause and effect' between events have been by and large studied from the perspective of the economic/technical sub-system. However, this concern, to some extent, has been counteracted in Appendix F where several key academic and industrial informants have been interviewed each looking at the research problem from different perspectives and offering new insights. Together, these informants, offered a diverse array of approaches including some that fit with the managerial and structural sub-system (e.g. balance scorecard approach) or the psycho-social sub-system (e.g. relational and control issues). The interviewees unanimously confirmed that the agri-food body of knowledge has evolved and needs to continue to evolve along the lines of the four rings model. Nonetheless, the author suggests that this limitation (i.e. looking at the research problem only from the

economic-technical sub-system's perspective) need to be addressed further by repeating this research and by looking at the research problem/questions from other sub-systems' perspectives.

Furthermore, the thesis developed knowledge and theories concerning the future of the supply chain management body of knowledge by focusing on the forces from within the field. However, in doing so it did not look at the external factors which also influence the future of (agri-food) supply chain research. Nevertheless, the macro factors which may shape the future of the subject play an undeniable role. Other studies such as the '*MIT Supply Chain 2020 programme*' take into account both macro-factors and internal evolution of supply chain visions (Singh and Cottrill, 2004). The purpose of the MIT Supply Chain 2020 programme is to analyse the prevalent supply chain visions and the prevailing macro factors in the literature to understand the conditions in which future supply chains operate. Moreover, it investigates the most suitable future supply chain models through scenario planning. This thesis, however, aimed to develop (futuristic) supply chain frameworks and especially focused on developing theories about implementation of those frameworks by recommending new guidelines and tools. This also concerns the *internal validity* of research since for example there may be macroeconomic factors influencing supply chains to opt for de-commoditisation strategies and value enhancement or vice versa. It is recommended that this limitation should be countered by carrying out further research which adopts both inside-out and outside-in perspectives in studying the evolution of agri-food chains.

With regards to the measures deployed to address the second research gap, only climate change was investigated in this thesis. The field of sustainable development is vast and adverse environmental trends are measured in many different ways such as water use, biodiversity and ozone layer depletion. However, global warming is often considered to be the most pressing environmental issue of all and global warming potential (GWP) is taken as the key measure of sustainability by many authors (Garnett, 2008 & 2007; Carbon Trust, 2006a). Therefore, this thesis focused on GWP and Green House Gaseous (GHG) emissions as the leading environmental indicator. A purely environmental thesis would have required consideration of a wider range of indicators, understanding their interdependencies and conducting sensitivity analyses amongst those indicators (Tukker *et al*, 2005). However, in this thesis environmental analysis

came alongside economic analysis; in this case it was appropriate to deploy a leading measure of environmental soundness such as GWP (Sarkis, 2001).

In addition, the S.C. Kano-QFD approach, which proved very useful in supply chain effectiveness improvement, can be further developed by looking at techniques for systematic product/service functionality enhancement such as Value Analysis / Value Engineering (Pawar *et al*, 1993; Bicheno, 2000) and systematic innovation such as TRIZ (Mann, 2002) or 'po' thinking (de Bono, 1972).

Finally it is desired to understand the scope of the *external validity* (replication) of the findings outside the UK agri-food sector and across other industries. Chapter 6 replicated the findings across four agri-food sectors and the author argues that the findings are *analytically generalisable* to the whole agri-food sector assuming contextual conditions that are not radically different. However, the findings cannot be generalised beyond the UK agri-food industry, although many of the concepts and approaches developed in the thesis are expected to be applicable in other industries too. It is also expected to see similar results in terms of the evolution of other sectors, and the requirement for rethinking the role of SCM in delivering consumer value.

9 References

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10 Appendices

Appendix A

The author's estimates show that the ECR movement only covers less than 30% of the UK agri-food industry in terms of the total value added per employee. Table 10.1 shows the value added per employee contribution of various parts of the UK agri-food chain. As illustrated in the table 29.6% of the sector is certainly excluded from the ECR movement. A conservative estimate is used for the food manufacturing, food wholesale and retail sectors. It is assumed that one thirds of the manufacturing parts and half of the retail parts are currently included in the ECR movement. That is, half of the companies in retail and one thirds of food manufacturers actively participate in ECR initiatives. Accordingly, only around 26.8%¹⁹ of the sector potentially benefit from the ECR movement's activities and learning, measured in value added per employee. The excluded groups are farmers, caterers, most wholesalers, and smaller food manufacturers and retailers.

Table 10.1 Value Added Per Employee within the UK Agri-food Sector

No.	Sector	£ M	1000 people	000' £ / employee	%
1	Food mnfg.	21,260	423	50.26	50.4
2	Wholesale & Retail	27,580	1,383	19.94	20
3	Catering	21,800	1,401	15.56	15.6
4	Agriculture	7,590	546	13.90	14
5	Total ~	78,240	3,753	99.60	100

(Source: DEFRA, 2002; Bourlakis and Weightman , 2004)

¹⁹ $(50.4 * 0.33 + 20 * 0.50)\% = 26.8\%$

Appendix B

Figure 2.5 showed the evolution of corporate sustainability paradigms between 1960s and 2000s. The following is narrative of this evolution.

1960s – The Wake-up Call

Publication of Rachel Carson's seminal book, *Silent Spring*, (Carson, 1962) was a wake-up call for both the industry and green activists. It drew attention to the precarious conditions of the natural environment and portrayed a dark yet scientifically sound picture of the impacts of chemicals on the wildlife.

1970s – Rise of Environmental Consciousness: Limits to Growth

This decade witnessed a rise of the concept of *Zero Growth* (Meadows *et al*, 1972) advocated by a group of academicians and policy makers recognised as the Club of Rome. The tenet of their belief was that the rate of human growth is beyond the capacities of the planet. The concept of *Zero Growth* which coincided with the first global oil shock had adverse consequences for industry especially in the developing world. Some prominent advocates of Zero Growth later took a more moderate position; their recent publications denote positive solutions which equally benefit industry and the environment (Meadows *et al*, 2004).

1980s – Sustainable development: Moving Beyond the Limits to Growth

By the 1980s the conflict between economic development and the limits of the natural environment and human society in sustaining human growth had created massive problems all around the world. As discussed in the above, the concept of Sustainable Development was introduced during this decade by a United Nations appointed international commission which published a landmark report in 1987 (known as the Brundtland report) (WCED, 1987). The concept of sustainable development denoted a paradigm shift from extreme environmentalism towards industry friendly environmentalism. SD implies that industry should pursue economic prosperity in harmony with the long-term well-being of nature and society. Since its introduction, the concept of SD has received increasing international acclaim from the part of the governments, local authorities, companies and individuals. Prior to the introduction of

the concept of Sustainable Development the dominant view among the management theorists was that industrial development and protection of the natural environment can't go hand in hand. SD opened new horizons to academics and entrepreneurs (Anderson, 1999). According to Mann (2002), powerful management solutions don't accept trade-offs. The win-win-win visioning of this new concept has exactly been why it has appealed to management theorists as well as industrialists. Furthermore, during the 1980s, David Ehrenfeld published his seminal book '*The arrogance of humanism*' (Ehrenfeld, 1981) which marked the emergence of the Industrial Ecology (IE) school of thought. IE promotes a radical shift in how industry is viewed as isolated from the natural environment and nature as passive and peripheral to the process of humans' development.

1990s – The Road to Kyoto

The decade began with planning for the 'Earth Summit' in Rio de Janeiro in 1992 which marked one of the key moments in the history of environmentalism. The Earth Summit was unprecedented for a United Nations conference, in that it involved the whole international community and also in terms of the scope of concerns. The summit sought to help the international community rethink economic development and find ways for more sustainable development (Dalal-Clayton and Bass, 2002). Moreover, during the 1990s many business and management solutions emerged mostly aiming to marry the goals of industry with the long-term considerations of sustainable development, for example, Natural Capitalism (Hawken, *et al* 1999), Factor Four (von Weizsacker, 1998), Eco-efficiency (Schmidheiny, 1992), Eco-effectiveness (McDonough and Braungart 2002), and The Natural Step (Robert, 2002). It must be noted that although some of these publication came in early 2000's the concepts were out during the 1990's. The Kyoto Protocol was adopted in 1997 in Kyoto-Japan as an amendment to an earlier convention adopted in Rio in 1992. The significance of the Kyoto agreement is in that it has been the first real practical step in battling the climatic change upon which developed countries have committed to reduce their Green House Gas (GHG) emissions by around 5.2% below their 1990 levels by 2010 (or otherwise to engage in emissions trading as an alternative mechanism). 160 countries have ratified the treaty to date. By the end of this decade still little attention was given to the management and measurement of the social pillar of sustainable development.

2000s: Beyond Kyoto

In December 2000 the UK government published its first white paper on the alleviation of global social crisis, e.g. poverty reduction and combating global pandemics (DFID, 2000). This marked a new era in terms of adaptation of the social aspects of SD in the UK and one of the first such policy statements across the industrialised countries. In 2002, the World Summit on Sustainable Development (WSSD) was held in Johannesburg to expedite the adoption of the principles of SD and to help overcoming some of the key problems facing implementation of past policies since Rio 1992. The Johannesburg summit became the UN's first conference formally named after SD. During the 2000s environmental awareness has become considerably heightened both amongst the practitioners and academicians. By the early 2008 resource depletion is once more challenging the prospects of global economical developments when the oil prices are closing in on a \$150/barrel record. Many analysts predict a global recession partly due to high oil prices.

Appendix C

Table 10.2 presents the list of 32 scholarly, peer reviewed, journals articles listed on ABI-Inform Global (ProQuest) database when searching for the following two keywords: 'supply chain management' and 'sustainable development'. Five contributions hardly discussed economic supply chain management at all which have been highlighted with '*', i.e. numbers 2, 8, 14, 20 and 26.

Table 10.2 The List of Peer Reviewed Articles Searched on ABI-Inform Global (Pro-Quest)

No.	Citation
1	Klimley A. (2005) Sustainable Development Becoming Integral Part of Business Strategy. <i>Research Technology Management</i> Vol. 48, No. 5 (September 1): 2-3.
2*	Irland L. C. (2007) Developing Markets for Certified Wood Products: Greening the Supply Chain for Construction Materials. <i>Journal of Industrial Ecology</i> Vol. 11, no. 1 (January 1): 201-216.
3	Roome N. (2005) Teaching sustainability in a global MBA: insights from the OneMBA. <i>Business Strategy and the Environment</i> Vol. 14, no. 3 (May 1): 160-171.

4	Vidal O. (2006) Revoir les paradigmes de la chaîne d'approvisionnement. <i>Réalités Industrielles</i> (May 1): 33-38.
5	Roberts S. (2003) Supply chain specific? Understanding the patchy success of ethical sourcing initiatives. <i>Journal of Business Ethics</i> , Vol. 44, No. 2/3 (May 1): 159-170.
6	Seuring S. 2004. Industrial ecology, life cycles, supply chains: differences and interrelations. <i>Business Strategy and the Environment</i> Vol. 13, No. 5 (September 1): 306.
7	Fossgard-Moser, T. (2003) Promoting Sustainable Development through the Enhancement of Local Employment and Supply Chain Opportunities Generated by Energy Companies: The Case of the Shell Group. <i>Greener Management International</i> , No. 43 (October 1): 79-92.
8*	Wehrmeyer W. (2004) Editorial. <i>Greener Management International</i> No. 46 (July 1): 3-4.
9	Setthasakko W. (2007) Determinants of corporate sustainability: Thai frozen seafood processors. <i>British Food Journal</i> Vol. 109, No. 2 pp. 155.
10	Yao W. (2005) Logistics network structure and design for a closed-loop supply chain in e-commerce. <i>International Journal of Business Performance Management</i> Vol. 7, No. 4 pp. 370-380.
11	Jorgensen, A. L. and Knudsen J. S. (2006) Sustainable competitiveness in global value chains: how do small Danish firms behave? <i>Corporate Governance</i> Vol. 6, No. 4 (August 10): 449-462.
12	Corbett C. J. and Klassen R. D. (2006) Extending the Horizons: Environmental Excellence as Key to Improving Operations. <i>Manufacturing & Service Operations Management</i> Vol. 8, No. 1 pp. 5-22.
13	Yang, C-L. and Sheu C. (2007) Achieving supply chain environment management: an exploratory study. <i>International Journal of Technology Management</i> , Vol. 40, no. 1-3 (September 30): 131.
14*	Schmidt, I., Meurer, M., Saling, P. and Kicherer, A. <i>et al</i> (2004) SEEBalance®: Managing Sustainability of Products and Processes with the Socio-Eco-Efficiency Analysis. <i>Greener Management International</i> No. 45 pp. 79-94.
15	James R D Taplin, David Bent, David Aeron-Thomas (2006) Developing a sustainability accounting framework to inform strategic business decisions: a case study from the chemicals industry. <i>Business Strategy and the Environment</i> 15, no. 5 (September 1): 347.
16	Jonathan D Linton, Robert Klassen, Vaidyanathan Jayaraman. (2007) Sustainable supply chains: An introduction. <i>Journal of Operations Management</i> 25, no. 6 (November 1): 1075.
17	Joy M Field, Robert P Sroufe (2007) The use of recycled materials in manufacturing: implications for supply chain management and operations strategy. <i>International Journal of Production Research</i> 45, no. 18/19 (September 1): 4439.
18	Goldbach, M., Seuring, S. Back, S. (2003) Co-ordinating Sustainable Cotton Chains for the Mass Market: The Case of the German Mail-Order Business OTTO. <i>Greener Management International</i> no. 43 (October 1): 65-78.

19	Marianne Forman, Michael Sogaard Jørgensen (2004) Organising Environmental Supply Chain Management: Experience from a Sector with Frequent Product Shifts and Complex Product Chains: The Case of the Danish Textile Sector. <i>Greener Management International</i> no. 45 (April 1): 43-62.
20*	Jones, P., Comfort, D., and Hillier D., (2006) Corporate social responsibility and the UK construction industry. <i>Journal of Corporate Real Estate</i> 8, no. 3 (July 1): 134-150.
21	Senge, P. M. Lichtenstein, B. B., Kaeufer, K., Bradbury, H. and Carroll J. S. (2007) Collaborating for Systemic Change. <i>MIT Sloan Management Review</i> Vol. 48, no. 2 (January 1): 44-53.
22	Rao, P. Holt D. (2005) Do green supply chains lead to competitiveness and economic performance? <i>International Journal of Operations & Production Management</i> Vol. 25, No. 9/10 pp. 898-916.
23	Zhu, Q. Sarkis, J. and Geng Y. (2005) Green supply chain management in China: pressures, practices and performance. <i>International Journal of Operations & Production Management</i> Vol. 25, No. 5/6 (May 1): 449-468.
24	Vachon, R D Klassen S. (2007) Supply chain management and environmental technologies: the role of integration. <i>International Journal of Production Research</i> Vol. 45, No. 2, pp. 401.
25	Matos, S and Hall J. (2007) Integrating sustainable development in the supply chain: The case of life cycle assessment in oil and gas and agricultural biotechnology. <i>Journal of Operations Management</i> Vol. 25, No. 6 pp. 1083.
26*	Panapanaan, V. M., Linnanen, L., Karvonen, M. and Phan V. T. (2003) Roadmapping corporate social responsibility in Finnish companies. <i>Journal of Business Ethics</i> Vol. 44, No. 2/3 pp. 133-148.
27	Vermeulen, W. J. V. and Ras P. J. (2006) The challenge of greening global product chains: meeting both ends. <i>Sustainable Development</i> Vol. 14, no. 4 pp. 245.
28	Klimley A. (2005) Sustainable Development Becoming Integral Part of Business Strategy. <i>Research Technology Management</i> Vol. 48, No. 5 pp. 2-3.
29	Irland L. C. (2007) Developing Markets for Certified Wood Products: Greening the Supply Chain for Construction Materials. <i>Journal of Industrial Ecology</i> Vol. 11, No. 1 pp. 201-216.
30	Roome N. (2005) Teaching sustainability in a global MBA: insights from the OneMBA. <i>Business Strategy and the Environment</i> Vol. 14, No. 3 pp. 160-171.
31	Vidal, O. (2006) Revoir les paradigmes de la chaîne d'approvisionnement. <i>Réalités Industrielles</i> . pp. 33-38.
32	Roberts S. (2003) Supply chain specific? Understanding the patchy success of ethical sourcing initiatives. <i>Journal of Business Ethics</i> Vol. 44, No. 2/3 pp. 159-170.

Appendix D

The Delphi strategy can be classified under both practitioner oriented (Mode 2) and theory testing (Mode 1) depending on the conditions of use. Therefore, Delphi is placed at the centre of the matrix shown in Figure 4.2. ‘Iterative Design Research’ and ‘Design-based Research’ (Barab and Squire, 2004) which are widely used in learning sciences have the same iterative characteristics as Delphi with the exception that, in their nature, they are often more involved with the research object. Barab and Squire (2004, p.6) contend that *“in contrast to other methods focused on producing theory, the most radical shift proposed by design researchers may be the requirement that inquiry involves producing demonstrable changes at the local level. Design-based researchers not only recognize the importance of local contexts but also treat changes in these contexts as necessary evidence for the viability of a theory”*. Thus, design-based research should primarily fall under ‘Mode 2’ as illustrated in Figure 4.2. However, there are also other researchers who adopt somewhat more theory guided approaches to ‘Iterative Design Research’ requiring less involvement with knowable (*see Educational Psychologist* Vol.39 Issue 4 for further information).

Figure 4.2 puts experimental design research largely in the upper-left quadrant. Experimental research is an accepted mode of inquiry in many fields of science and technology; it is often both positivist and practice oriented. In the laboratory, technologists can impose new conditions onto the nature. Alternatively, scientists may deploy ‘experimental design’ to simulate the nature for theory testing experiences (i.e. Mode 1). So, effectively there is a continuum of experimental research from theory testing to imposition of new material and provision of new conditions for creating new applications used in solving real-life problems.

The process of research in this thesis (*see* Section 4.4) does not resemble any of the characteristics stipulated to grounded theory in Table 4.2. Grounded theory is mapped above the line in Figure 4.2, since it calls for involvement of the researcher with the research object and challenges the arbitrary division between field data collection and rigorous academic research (Charmaz, 2000).

Finally, there is a difference between ethnography and Mode 2 type research strategies. Despite the fact that ethnographers immerse in the context of the research, similar to case study and action researchers, ethnography is categorised as Mode 1. The reason is that in ethnography the role of researcher is – passive – observation while Mode 2 demands an active role by the researcher in the process of change.

Appendix E

Quality Function Deployment (QFD) was first developed in Japan and documented during 1960s by Yoji Akao (Akao, 1992). Quality Function Deployment systematically links the needs of the customer with the product or service features. It is often deployed in new product development to arrive at specific product (and production) attributes from the consumer requirements (Akao, 1990; Hauser and Clausing, 1998). QFD can be regarded as a way of identifying the true voice of the customer as it pertains to product and process engineers (Knowles, 2002). It is a mechanism through which companies ascertain that the product being designed is the product that consumers require. The process begins by capturing VoC through conventional market research and consumer engagement techniques. However, VoC in its crude form may not be meaningful to the manufacturer or service provider. QFD provides a structured method for translating customer requirements into appropriate product/process attributes in a language which is meaningful for designers, engineers and operations managers.

Although “*the mechanics of QFD are not cast in stone and can easily be adapted to local innovation*” (Bicheno, 2000 p. 173), the ‘house of quality’ matrix is always an integral part of the process. The matrix is referred to by this name since different parts of it fit together to form a house shaped diagram as illustrated in Figure 10.1. It must be noted that QFD is a much broader concept than the ‘house of quality’ which simply is an organising framework for linking ‘what the customer wants’ to ‘how it can be delivered’ (Akao, 1990; Hauser and Clausing, 1998). Implementation of a typical ‘house of quality’ consists of several stages as follows:

1. Identification of the customer needs, the voice of customer or “the what’s”. This is typically done by the means of market research and consumer studies, e.g. focus groups and customer interviews. The customer requirements are captured in the left hand side of the matrix (Section 1).
2. Structuring and prioritizing customer needs. At this stage the customer needs (which were captured during stage 1) are put together and ranked by importance. Importance should be determined according to customer preferences and should come from the customers themselves. The identified ranking goes in Section 2 in Figure 10.1. The planning matrix could also include other information such as a measureable goal against each consumer requirement.

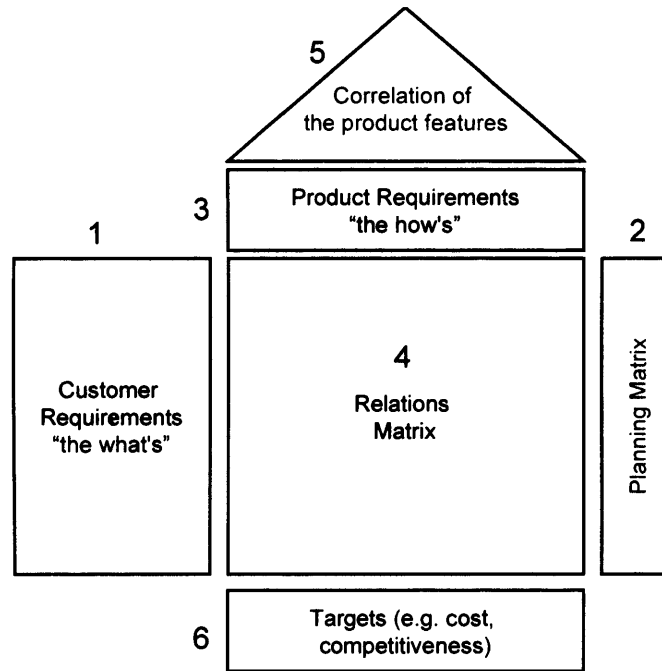


Figure 10.1 The House of Quality Matrix in Quality Function Deployment Method
(Source: Terninko, 1997)

3. The next step is to identify the appropriate product or service attributes that the business provides to meet the customer requirements. These are captured in Section 3 in the house of quality diagram.
4. As soon as the product requirements are identified they are related to customer needs in the (central) relations matrix. Subsequently, it should be judged that how strongly different design attributes influence individual customer requirements.
5. Product attributes may have synergistic or trade off relationship. It is crucial to understand and address such effects during the implementation of the house of quality matrix. The correlations between different product attributes are captured in the roof of the matrix.
6. The last step is to determine the costs associated with each design attribute in order to create a clear picture about the efficacy of various technical solutions and the potential trade offs, i.e. Section 6 in Figure 10.1.

Typically an end-to-end QFD process is made up of several applications of the house of quality matrix in separate yet dependent phases as illustrated in Figure 10.2 (Akao, 1990). At each stage the output features are derived from the input and the relationships

between output and input is plotted in a house of quality matrix. Quantitative values are allocated to the relationships in order to prioritise the output. The most significant outputs from each phase (in terms of features which are important to the customer or difficult to obtain) are passed as input to the following stage. This way all decisions can be traced back to an identified customer need.

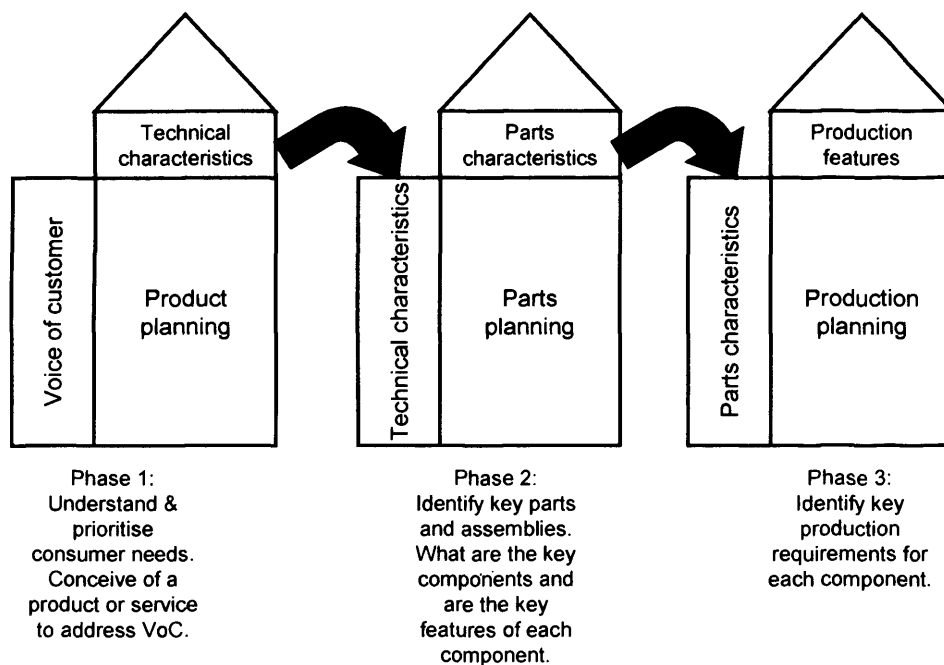


Figure 10.2 Example of an End-to-end QFD Process

(Source: Adapted from Terninko, 1997)

In the above example, in the first matrix the QFD process takes the very non technical VoC (or customer wants), rigorously ranks them in importance and links technical “How’s” to the wants. In the second phase, the product attributes (or technical characteristics as it is referred to in the diagram) are translated into component characteristics. That is, different assembly parts that are needed to deliver the overall design features and the key features of each are identified. In the final stage the component characteristics are translated into manufacturing methods and the key production features for each component are derived. As such, not only the voice of the customer is translated into suitable product features but also component details and manufacturing requirements have been determined.

Appendix F

As discussed in Sections 4.5 and 8.4, arguably, one of the key limitations of this thesis is that the research questions were derived by looking at the literature through a supply chain management lens and that the research is limited to the economic/technical sub-system. This limitation concerns the internal validity of the thesis since cause and effect between events have been by and large studied from the perspective of the economic/technical sub-system. This concern has, partially, been counteracted in the following by interviewing several business and academic informants who come at the research problem from different perspectives offering new insights. Together, these informants, offered a diverse array of approaches including some that fit better with the managerial and structural sub-system (e.g. balance scorecard approach) or the psychosocial sub-system (e.g. relational and control issues). As illustrated in Table 10.3 twelve individuals were interviewed for this purpose, i.e. six academics and six industrial experts or individuals affiliated with industry bodies and NGO's.

Table 10.3 Key Informants Targeted for Interviews

No.	Industry contacts and policy makers	No.	Academics
1	Senior manager at IGD who held a key responsibility in management and delivery of the VCA programme.	7	Senior Researcher at the Lean Enterprise research Centre who assumed a leading responsibility in delivering several VCA projects.
2	Lean manager at Tesco with 40 years experience in the food sector.	8	Lecturer in SCM at Cardiff Business School who had also worked for a large UK retailer for several years.
3	Freelance consultant. Delivered two VCA project as sub-contractor.	9	Senior Lecturer at the Queensland University, Australia. Expert in food supply chain systems.
4	Senior Researcher and supply chain expert at International Car Distribution Programme who also had worked in the FMCG sector for several years.	10	Senior Researcher at the Lean Enterprise research Centre who had a key role in delivering several VCA projects.
5	Founder and manager of an influential NGO specialising in food climate change effects	11	Associate Professor at Bonn University, Germany. Expert in food supply chain systems.
6	Senior manager at HGCA who assumed a key responsibility in the management and delivery of the VCA programme.	12	Senior Researcher at Cranfield School of Management who held a key responsibility in delivery of several VCA projects.

Semi-structured interviews were conducted where the interviewees were presented with the 'four rings model of the evolution of supply chain management knowledge in the UK agri-food sector' followed by examples and explanations. They were then asked to

express their opinion, based on own experience in the FMCG sector, regarding the validity of the conceptualisation (the diagram itself) and if the interviewees would like to include any other aspects in the model. In terms of the ethical considerations, all interviewees are anonymous; interview transcripts were sent back to the interviewees for comments and consent to be used in this appendix.

The interviewees unanimously confirmed that the agri-food body of knowledge has evolved and needs to continue to evolve along the lines of the four rings model. While two of the industrial reviewers decided that the model could be too simplistic to be representative of the real world, all twelve experts agreed that it does capture the evolution of agri-food chain management concepts. The following are some excerpts from the interview transcripts:

Interviewee number 2 *“found the model valid and interesting”* and suggested that *“the most effective and sustainable solution would be found to be aligned with the most efficient solution”*. Moreover, the interviewee recommended that a scorecard (or radar diagram or 360 degrees audit tool) can be deployed to link the four rings model with day-to-day operations of businesses.

Interviewee number 3 *“found the model to be valid to demonstrate evolution of the discipline but not necessarily aligned to corporate strategy of all firms, i.e. some companies may never move from the second to the third ring”*.

Interviewee number 4: *“I think the model is a satisfactory way of looking at the areas of business concern. My general impression is that the model is a reflection of how people think about layers of problem solving in the industry”*. However, the interviewee believed that there is a considerable gap between academic literature and the realities of the UK agri-food business in relation to the two outer layers in general and the sustainability ring in particular. The interviewee suggested that risk should be studied as a fifth layer in the model.

Interviewee number 5 found the model *“valid and relevant to the industry and the supply chain body of knowledge related to agri-food chain and networks”*. The interviewee thinks that certainly there is a major focus on the outer ring evident from

many Corporate Social Responsibility reports where sustainable development is overtly a major attention. However, this general interest and academic focus hasn't always necessarily translated into action.

Interviewee number 9: *"First reaction is that I like this approach and it is very interesting"*. The interviewee believed that the first two rings represent conventional supply chain management which is about managing stock and organising flows whereas the third ring represents 'value chain management' which also covers supply chain effectiveness and consumer value enhancement. The fourth ring in the model is also valid in that it takes supply chain management away from logistics and economics and puts it in a multi-disciplinary systems perspective. Therefore the model is a valid representation of the evolution of supply chain body of knowledge around agri-food chains. The interviewee believed that there is a dearth of conceptual models, theories, tools and techniques for taking the existing supply chain practices in the agri-business industry beyond the second ring into the third and the fourth rings.

Interviewee number 11: *"My first reaction is that the model is a logically derived phased model"*. Drivers and barriers for moving from one layer to another must be studied. Macro drivers and barriers may include legislation, macro-economic factors, and market pressure. Also, it is suggested that the model could become more applicable if a checklist was created against to enable pinpointing companies on the model. The checklist could have the form of a scorecard or set of criteria.

Interviewee number 12: *"I agree to the model and think that the supply chain body of knowledge has evolved from efficiency to effectiveness to sustainability in the agri-food sector. However, whether or not Value Chain Analysis can address all four rings, I don't know. VCA is very effective in the first two rings but somewhat limited in the third ring and useless in the fourth. We need to enhance our knowledge in the third and fourth rings"*. The interviewee explained that it can be myopic to look at the environmental problem from a single value stream/value chain point of view. The interviewee believed that there are fewer indicators and measures available to us in the outer rings. The interviewee also believed that the model can be chronologically explained in the context of the UK agri-food sector. That is, organisations within the industry have by and large grown along those lines.

