A Conceptual Framework for Supply Chain Strategy Formulation

Supply chain systems architecture and integration design based on practice and theory in the North Wales slate mining industry

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A submission presented in partial fulfilment of the requirements of the University of South Wales/Prifysgol De Cymru for the degree of Doctor of Philosophy

March 2014
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3PLs – Third Party Logistics

4PLs – Fourth Party Logistics

AA – Adapting and Aligning

AD – Areas of Decision / Areas of Problems

AD_N – Sum of Areas of Decision / Sum of Areas of Problems

ATC – Analytical Target Cascading

BB – Building Blocks

BCAO – Barriers to Change and Approaches to Overcome

BPOC – Best Product Operating Cost

C_x – Individual Company

C_1 – Company One

C_2 – Company Two

C_3 – Company Three

C_4 – Company Four

C_5 – Company Five

C_1S – Strategy of Company One

C_2S – Strategy of Company Two

C_3S – Strategy of Company Three

C_4S – Strategy of Company Four
CsS – Strategy of Company Five

CASN – Complexity and Adaptability in Supply Networks

CE – Capabilities Evaluation

CS – Corporate Strategy

CEFE – Capture the Essence and Forecast the Effect of supply chain integration and performance

CGSI – Characterise Greenfield project supply chain Strategy and Integration

CM – Conceptual Model

CN – Sum of Companies

CnIPn – Sum of grouped integrated strategic goals

Cn.Pn – Sum of grouped individual strategic goals

CNSC – Sum of individual core strategies

CSSCD – Conceptual System for Supply Chain Decomposition

CSCIOI – Conceptual Supply Chain Inter-Organisational Integration

CPPR – Customer Product Process Resource

DE-DD – Design D for Environment and Design for Disassembly

DSCHT – Decomposing Supply Chain into Hierarchical Three

DSM – Design Structure Matrix

ExD – External Dimensions

EnD – Environmental Dimension

ESM – Engineering System Matrix

EQFD – Enhanced Quality Function Deployment

FCo – Formulation Concepts
FCr – Formulation Criteria
FE – Formulation Elements
FI – Formulation Implementation
FOI – Fit, Intensity FI and Integration
$F_n$ – Sum of Factors
$FP_n$ – Sum Formulation Principles
FSM – Functional Strategy Map
GF – Greenfield project Formulation
GPM – Green G-field Performance Measures
Greenfield project – Project not restricted by constraints imposed by prior work, and that is non-existent until formulated.
GSCM – Green Supply Chain Management
IBC – Identification of Best Candidates
ID – Industry Dimension
IMSC – Integration as a Method for Integrating Strategic Choices
IOC – Interdependence and Organisational Compatibility
IPN – Integrated goals of the supply chain group
ISV – Integrated Strategic Vision
MDD – Market Demand Dimension
MDP – Market and Distribution Planning
NGO – Non-Governmental Organisation
NO – Networked Organisation
OASA – Ontological Approach for Semantic Alignment
OTA – Outsourcing Through Abstention
PAO – Participants Aims and Objectives

$P_n$ – Sum of Problems

$PN$ – Sum of individual goals

RD – Resource Dimension

RED – Regional Economy Dimension

PC-VC – Process Chain and Virtual eChain

PF – Product P and Product Family

PR – Process of getting from the present to the Required stage

PSCS – Product and Supply Chain Strategy

PS-MD – Postponement Strategy PS and Market Demand

PVA – Performance Value Analysis

PuCC – Pugh Controlled Convergence

SA – Strategy Absence

SD – Strategy Dimensions

SC – Supply Chain

SCA – Supply Chain Agility

SCI – Supply Chain Integration

SCOR – Supply Chain Operations Reference

SCPME – Supply Chain Performance Measures and Evaluation

SCSA – Supply Chain Strategy Articulation

$scCnPn$ – Individual strategic pillars

SD – Salient Dimensions

SF – Salient Factors
SG – Strategic Goals

STPC – Separation in space, Time, Parts and Conditions

SV – Strategic Vision

SWOT – Strengths, Weaknesses, Opportunities SWO and Threats

TC – Trust and Commitment

TLISE – Transportation and Logistics Integration Strategic Elements

TLS – Transport and Logistics Strategy

ThD – Technology Dimension

TrD – Transportation Dimension

UF – Underlying Factors
Acknowledgement

‘All that is necessary for the triumph of evil is that good men do nothing’

Edmund Burke (1729 – 1797)

Sincere gratitude to the following institutions that have enabled the completion of this research project: Welsh European Funding Office, Massachusetts Institute of Technology – Industrial Liaison Programme, Massachusetts Institute of Technology - Centre for Transport and Logistics, The Princes Foundation for Building Community and The Prince of Wales Innovation Scholarship.

Sincere gratitude, also, to the following individuals that have enabled the completion of this research project:

Professor Hefin Rowlands – University of South Wales (previously University of Wales, Newport)
Professor Andrew Thomas – University of South Wales (previously University of Glamorgan)
Professor Dylan Jones-Evans – University of Wales (currently at the University of West of England)
Dr Roberto Perez Franco – Massachusetts Institute of Technology
Professor Robert Huggins – University of Wales Institute Cardiff (currently at Cardiff University)
ABSTRACT

The aim of this thesis is to contribute to knowledge in the form of a new theory for supply chain strategy formulation. The objective is to design evaluation criteria, specific to the context of greenfield project architecture and integration design. This study addressed the aim and objective by synthesising existing methods and techniques which are outlined into a research framework of supply chain strategy problems. The study applied the case study and action research methods to pursue conceptual validity from the process of investigating the supply chain strategy formulation in a specific situation and presented the data collection and analysis process.

The thesis derived a conceptual framework for investigating and identifying the relationship between multiple elements, dimensions, forces and factors that influence and affect supply chain strategy formulation in a greenfield project context, specific to the mining industry. The contribution to knowledge emerged from building upon the architecture of the conceptual framework, through synthesising existing techniques and adapting these techniques, to extend and redefine the existing knowledge on the practice of supply chain strategy formulation. Through critical analysis, a number of critical problems emerged and the process of addressing these problems, resulted with a new framework for evaluating the relationship between business and supply chain strategy, specific to greenfield project and integration context.

The contribution to knowledge also derived from addressing the emerging obstacles in the process of identifying, defining and formulating, the visions and goals of individual supply chain participants from implicit into an explicit form. The process synthesised the knowledge for conceptualising the idea, through developing and evaluating information and issues, to derive insights into the complex and abstract concept, of greenfield project business and supply chain strategy formulation.

The conceptual framework and evaluation framework advanced into designing greenfield project supply chain integration strategy. The process involved categorising individual supply chain strategic interests, decisions and problems into formulation areas, and was aimed at defining the process of greenfield project integration strategy as a system of concepts containing formulation areas, formulation principles, segregated into subcategories of formulation imperatives and formulation concepts.

The thesis contributed to knowledge with advancement of the design engineering method, which enables visualisation of the supply chain strategy evaluation process. The design is not personalised for individual company business strategy or supply chain strategy formulation. The method was personalised to evaluate the integration of individual goals, and concepts in a supply chain strategy formulation. The novelty that emerged from the thesis was a conceptual framework for greenfield project architecture and integration design. The greenfield project architecture and design derived in the thesis a proposed conceptual system for applying the conceptual framework and the evaluation criteria.
Introduction

1.1 Overview

This chapter provides an introduction to the research covered in this study. It starts by explaining the background of this study on supply chain strategy, specifically supply chain formulation and integration. The study’s aim and objectives are outlined followed by a brief explanation of the study context of the slate mining industry. Finally, there are details of the structure of the thesis.

1.2 Area of research

The area of research for this thesis is the field of supply chain strategy architecture and design, in a greenfield project and integration context. The subject matter of the thesis covers the discipline of supply chain strategy formulation and the integration of supply chain operations and processes. To evaluate the area of research, the thesis begins with a review of existing supply chain models, which cover the relevant aspects in the context of supply chain integration and formulation. The research areas reviewed in the thesis are: product and supply chain strategy, transportation and logistical aspects of supply chain strategy, supply chain strategy performance, supply chain strategy and integration.

1.3 Research focus

The battle for competitiveness is fought between supply chains not companies (Martínez-Olvera and Shunk, 2006) and the real competition is not company against company, but supply chain against supply chain (Mentzer et al., 2001). In that respect ‘a supply chain is much like a river, with products and services flowing down it instead of water. Whether anyone recognizes the systemic, strategic implications of managing the water basin, the river still exists.’ (Ibid., p.14). Only when companies involved in the flow recognise the need to conserve, preserve and utilise the flow for its own needs, can these companies be considered to have taken a systemic strategic supply chain focus.
The strategy focus is shifting towards integration and collaboration, but collaboration is still focused on company profitability and not supply chain profitability (Kim, 2006). Kim (2006) proposes a paradigm shift based on trust, equitable win-win thinking and sharing of key resources and core competences between the supply chain participants. The ‘process chain’ paradigm, recommends elements for process re-engineering. However, the paradigm falls short of providing the details for applying these recommendations. The notion of the proposed paradigm shift through ‘process chain’ is admirable, however, other literature on the topic advocates a less radical approach and recommends incremental approaches for ‘gradually and systematically’ integrating the structure of the entire supply chain simultaneously (Narasimhan and Kim, 2002, pp. 320). Strategies that are designed and formulated with a singular focus, such as Frohlich and Westbrook (2001) on integration and performance, lead to many questions regarding other aspects of supply chain strategy. Several authors identified limitations in this approach (Rosenzweig et al., 2003, Perez-Franco et al., 2010, Childerhouse and Towill, 2011), because various supply chain aspects should be considered in the design and formulation stage to ensure a wide coverage. Each type of supply chain integration activity has a unique set of benefits and additional study of the external strategic integration activities is required (Swink et al., 2007).

1.4 Supply chain paradox

This thesis defines supply chain strategy as a network of organisations and aims to determine how individual components affect the performance of the entirety and how operations can be optimised and coordinated towards a common goal. This definition is the basis for identifying the supply chain paradox in the thesis. The paradox is created when individual companies are only interested in strengthening their own competitive advantage at the expense of delivering benefit to the whole supply chain. However, in most scenarios a single company cannot singularly perform the process in its entirety and unless all parts are optimised towards a common goal the supply chain cannot be enhanced. The thesis aims to unravel the paradox, by applying a systematic approach and design principles. A System is not represented as the sum of its parts but as the product of their interaction (Ackoff, 1994). Therefore, individual companies in a supply chain are part of a larger conceptual system that has a purpose of its own. Following the same logic, if the supply chain is taken apart individual participants lose their function and so does the supply chain.
1.5 Research approach

A supply chain is defined as: A complex adaptive system (Bozarth et al., 2009, Pathak et al., 2007), a single entity system, confederation (Mentzer et al., 2001), and a networked organisation (Ivanov, 2009). Supply chain design is defined as a consistent interlinking of architecture and design, through focusing on the external and salient dimensions and internal elements, that are system germane to the supply chain (Melnyk et al., 2013). The focus of the thesis is on the supply chain strategy aspect and distinguishes the topic from supply chain management. In this context, the focus of the thesis is on the formulation of a supply chain strategy, and validating the findings during the investigation.

1.6 Research philosophy

The research philosophy in the thesis adheres to the interpretivist philosophy (or anti-positivist) This research methodology outlines the methods employed for building and validating the conceptual framework. This includes justification and details of the ethical considerations and chapter conclusions. The methodology described is consistent with the guidance on building theories of Eisenhardt (1989), Yin (2009) and Glaser and Strauss (1967). The data collection process is described and includes the units of analysis and the pilot study undertaken. Details are provided to address questions related to reliability and validity. The data checking processes are described including the recording techniques and data transformations, followed by a discussion of the missing data and tacit knowledge found in the responses. Finally, the data analysis techniques applied are outlined, followed by a discussion as to why these techniques were selected.

1.7 Summary of the research question aim and objectives

The aim of this thesis is to investigate the relationship between greenfield project architecture and integration design in the context of supply chain strategy formulation. The objective is to perform a detailed review of existing literature and to identify current tools and methods for supply chain strategy formulation. The study’s aim is to identify and synthesise the existing tools and mechanisms and present them in a research framework for building a conceptual framework.
The study’s aim is to build upon the conceptual framework and to develop a supply chain strategy formulation that addresses architecture and design aspects. The study’s aim is to define evaluation criteria and to develop new tools and mechanisms for evaluating and validating supply chain strategy formulation. The aim and objectives are separated into areas of research and relate to formulating a supply chain strategy for a greenfield project. The areas of research emerging from the aim and objectives are:

1. To derive, using the formulation criteria, the formulation of supply chain architecture with multiple supply chain participants.

2. To derive, using the evaluation criteria to eliminate any conflict of interest, the formulation of supply chain integration design.

3. To develop a conceptual framework based on the formulation and evaluation criteria for systematically prioritising individual activities towards pre-defined supply chain formulation and integration areas.

4. To validate the proposed framework by applying it to the case study participants in the mining industry for the following purposes:
   a. To evaluate supply chain architecture in relation to formulation criteria
   b. To determine the evaluation criteria in integration design

The architectural aspects of the thesis are primarily focused on developing original and new ideas, articulating and evaluating individual business goals and integrating the goals into the supply chain. The design aspect is focused on investigating the operational capabilities to determine the right level of integration. The approach is focused on defining and conceptualising the relationship between business and supply chain strategy.

To evaluate the proposed conceptual framework, hierarchical concept summary maps and conceptual diagrams are applied to critically analyse the conversion of implicit ideas into explicit maps and diagrams and to capture the activities from the supply chain participants. The aim and objectives of the thesis are oriented around external and salient dimensions, which directly affect the supply chain strategy and consist of elements, forces and factors. The mining industry in North Wales was used as a single case study to evaluate and define the impact from those factors on the supply chain strategy. The findings from the single case study are generalised and based on diversity of the sample population and not representative of the wider population.
## 1.8 Outline of the thesis

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Chapter One outlines and introduces the content of the thesis, including the background of the study, the researched question in the study, the studies aim and objectives and briefly outlines details of the mining industry in North Wales, including the process of investigation for the study.

Chapter Two describes the motivation for the chosen industry, including an explanation of why the slate mining industry was chosen for the case study.

Chapter Three explains the approaches present in academic literature and reviews the theories, methods and methodologies related to supply chain strategy, present in existing literature. The main concepts and approaches are critically analysed to articulate the key areas of literature that provide insight into the character and influences supply chain strategy formulation.

Chapter Four outlines the research methodology and methods applied in this thesis and the justification for the chosen research approach. The theoretical position for researching supply chain strategy formulation is explained. Based on the interpretivist pattern seeking paradigm, the study uses case study and a qualitative approach. The approach is detailed in the chapter, including details of the research methods applied and the research ethics related to the preparation and application of the field work. The chapter introduces the case study selected for applying the synchronous inductive and deductive theory building and validating the methodology.

Chapter Five outlines the list of data sources, along with the data collection and analysis process. There are details of the process of data collection employed in the field work and a discussion of the approach to data analysis in consideration of the limitations of the research.

Chapter Six introduces the conceptual framework designed for the study. The framework is devised in part through the ideas arising from applying the research approaches and in part from concepts identified in the literature review. The conceptual framework is designed to explicate the direction and the conceptual logic of the study, synthesising the key concepts of relevance to understand supply chain architecture from the perspective of the mining Industry. The chapter contextualises the external dimensions, salient dimensions and the elements, factors and forces that impact the supply chain strategy, architecture and design.
The findings from this chapter are generalised in the process of theory building based on diversity of the single case study sample population investigated.

Chapter Seven develops further the theory behind the conceptual framework and embodies a process of contemplating the relationship between business and supply chain strategies in the context of greenfield project and integration architecting. Greenfield project architecture is characterised and conceived to enable the development of systematic understanding of the topics. The design process engages leading ideas and demonstrates the significance of the logic behind the conceptual thinking in the study.

Chapter Eight advances the theory development into conceptualising the synthesised knowledge to interpret the findings and establishes the conceptual framework for greenfield project supply chain integration strategy formulation. The evaluation process of the emerging theory relies on critical analysis, with the aim of validating the theory. The chapter engages leading ideas and demonstrates the significance of the study’s conceptual logic.

Chapter Nine strengthens the argument, the critical analysis and evaluation through a range of sources, aimed at validating the theory. The critical analysis process starts with identifying, defining and formulating the formulation areas, extracted from individual supply chain participants and converted from implicit into an explicit form. The logic in this chapter is aimed at defining the process of greenfield project integration strategy as a system of concepts containing formulation areas and formulation principles. These are segregated into sub-categories of formulation imperatives and formulation concepts.

Chapter Ten evaluates the conceptual framework, the hierarchical concept, summary map and conceptual diagrams. It critically analyses the conversion of implicit ideas into explicit maps and diagrams aimed at capturing the real-world strategies and activities from the supply chain participants and generalising the findings of the thesis. In this chapter, the logic behind the conceptual framework is evaluated in relation to the case study and in more generally in the conclusion chapter.

Chapter Eleven presents the overall research conclusions and final remarks. The chapter reviews the theoretical purpose, the implications and the contribution of the conceptual framework. The chapter focuses on the study’s main findings from the application of the
conceptual framework, identifies the key strengths and the limitations of the research, and concludes with making recommendations for future research.

1.9 Conclusion

This chapter introduces the study and research on supply chain strategy formulation for the Mining Industry in North Wales. First, the chapter introduces the background of the study and the importance of supply chain strategy as an area for research. Then, it explains the study’s overall aim and objectives. The chapter introduces the North Wales Mining Industry as the context for the case study. The following chapter reviews the literature, key concepts and theoretical ideas related to the study.
Chapter 2 Context of the study

2.1 Introduction

The aim of this chapter is to outline the context of the single case study and the industry selected, and to describe the motivation for the research. The objective of this chapter is to discuss the historic background of the case selected and the culture within the industry investigated. Furthermore, this chapter performs a background review of the industry studied and the related industries. Finally, the chapter introduces the research study in the context of the single case study.

2.1.1 Historic background of culture within the mining industry

Rural Wales has undergone a dramatic transformation during the late twentieth century. This transformation is predominately characterised by economic restructuring and uneven development (Howe, 1999). The technological advancements and international resource exploration have caused a huge decline in traditional industries and rural employment (Howe, 1999). The transformation has also affected the economic and social landscape of Wales, including high unemployment, immigration and a decrease of Welsh language speakers (Thomas, 1960). The small slate mining town of Blaenau Ffestiniog is an example of the latest where this transition resulted in the decline of employment, accompanied with the failure to develop new forms of employment and economic activity. Unemployment has a number of adverse effects both on the individual and on the economy, such as reduced output, reduced aggregate demand and underutilisation of resources (Drinkwater, 1996).

Furthermore, the strict management opposed to the ‘camaraderie’ of the pits, the effeminate clothing opposed to the ‘machismo based culture’, and the low ‘living wage’ are the main reasons for the unpopularity of the low skilled low paid jobs and probably the main reason for the high unemployment in Welsh post-industrial areas, with many people signing on the long term sickness benefits or even in the trade in illegal drugs (Cato, 2000).
2.1.2 Historic background to the regional economy dimension

The Welsh regional economic reality has been reported as notably lower compared to UK standards (MacKay, 1998, Blackaby, 1995). Welsh manufacturing triumphed between the 1980’s and 1990’s with a growth of over 5% and, in addition, employment growth was better than predicted (MacKay, 1998, Thomas, 1991, Blackaby, 1995) and there is no doubt that the Welsh economy has been transformed (Gripaios, 1997). However, compared to the rest of the UK, Wales has been reported as a poor performing region since the First World War (Harvey, 1989). Even in the 1990s it was obvious that the EU was expanding eastwards and Welsh workers would have to compete with the low wage workers in Eastern Europe (Meade, 1995, Ali et al, 2010).

2.1.3 Historic background of the slate industry dimension

The Industrial Revolution and the development of transport facilities led to slate becoming the main roofing material in the UK (Thomas, 1956). Roofing slate was firstly shipped by sea to distant markets through ports developed specifically for this purpose and later was also transported by rail. This created a booming industry and the North Wales slate belt produced the majority of the UK’s roofing slate output (Thomas, 1956). The slate industry was a robust business in the town of Blaenau Ffestiniog, reaching its peak in 1889 producing 139,513 tons of roofing slate and employed 4000 people (Anderton, 1982). Although the slate industry continues to influence the town, the production and employment are negligible compared to its peak times (Anderton, 1982).

The slate industry was crucial to the local economy, culture and history in North Wales between the 1820’s and 1900’s. The slate industry in North Wales was developed to the point of becoming a large exporting industry. The rapid decline in the slate industry was caused with the loss of the export market, the importation of inferior foreign slates and the increase in usage of mass-produced roofing tiles (Thomas, 1956). This left large slate heaps as reminders of the industry, especially in the towns of North Wales where there are many slate waste heaps and abandoned quarries (Begg, 1995). According to some reports, the waste heaps can be turned into a profitable and sustainable recycled aggregate material. Removal of 1 million tonnes of slate aggregate per annum is said to be expected to safeguard 81 jobs and create 45 others whilst the 2 million tonne per annum would create 88 jobs (DTZ, 2004). Furthermore, the waste extraction scheme is expected to create 40
jobs in the rail industry (Parkman, 2001) The additional Gross Value Added to the Gwynedd and Conwy economy has been calculated as £10.4 million per annum (2003 prices) and safeguarded Gross Value Added for the same region was said to be worth £28.7 million per annum (DTZ, 2004). According to these reports, the employment creation in the slate industry is permanent and sustainable for many years.

### 2.1.4 Related industries

Porter claimed that related and supporting industries can produce innovative cost-effective inputs, while motivating other companies in the chain to innovate (Porter, 1998b). The types of cluster connection between companies can be described as ‘horizontal’ and ‘vertical’ (Sheffi, 2013). The stronger the cluster becomes, the bigger the influence has on the government infrastructure investment spending decisions and beneficial regulations (Sheffi, 2013).

In this context, the interviews with local NGO’s confirmed that the related and supportive industries could ‘drive forward the scheme which has hitherto suffered considerable stagnation through lack of the sort of input. Implementing the supply chain strategy formulation for the logistics chain could lead to a new engineering and logistics cluster supported by a rail engineering skills academy.’

The geographical clustering of the companies and corporate functions is well observed fact in academic literature (Marshall and Guillebaud, 1920). The geographical clustering creates economic advantages that Marshall (1920) explained as the advantages of knowledge sharing, specialised supplier bases and specialised workforce. Furthermore, Porter (1998a) developed this explanation of the advantages arising from cluster economics as increased efficiency of the participating companies, increased level of innovation and increased level of fostering new business.

### 2.2 Mining industry in North Wales and the importance of slate aggregate

In the context of the single case study approach outlined above, the problem of not fully realising the benefit of new supply chain strategic approaches could be even more apparent. Therefore, the mining industry in North Wales has provided a suitable context in
which to investigate how to formulate and evaluate greenfield project integration supply chain strategy. To date, very few studies on supply chain strategy formulation have been conducted on the mining industry in North Wales, despite its wide development in other regions. This circumstance, therefore, provides further motivation to seek evidence from the mining industry in North Wales.

Large tips of slate aggregate have accumulated over the past 200 years in North Wales. These tips are potentially a good source of material (ODPM, 2002). There are different ratios of useful slate to waste material produced from extraction. The process of slate quarrying results in a ratio of 20 to 1 waste to final product (Dawson et al, 1993) and between 90% to 95% of the quarried slate is being disposed of (ODPM, 2002). In other literature the ratio was found to represent more than 10 to 1 (Anderton, 1982).

There are various estimates of these quantities, for example Dawson et al (1993) estimated 400 to 500 Mt of usable tips stockpiled and further 6 Mt arising annually in North Wales, of which only 275,000 tonnes is used as aggregate, or 4.5% of the arising’s (ARUP, 2001). WRAP (2005) reported 6.3 Mt arising, consecutively WRAP (2010) reported 6.33 Mt arising and 456.5 Mt in existing usable stockpiles. Complimenting ARUP (2001) report, WRAP (2010) stated that only about 0.56 Mt is being used as aggregate. Trends in aggregate use, although increasing, use is low because the economics of slate waste, mainly dominated by the distance of stockpiles from the main aggregate markets.

In December 2000, the National Assembly for Wales commissioned research entitled ‘North Wales Slate Waste Tips – A Sustainable Source of Secondary Aggregates’ (ARUP, 2001). Its aim was to evaluate the practical potential for the use of slate waste tips in North Wales as a source of secondary aggregates. The following observations came from the report:

- ‘On the basis of material suitability, slate waste could supply some 50% of UK crushed rock sales. This amounts to a market size of some 59 million tonnes per annum, well in excess of current waste generation rates’

- ‘The use of slate waste as a secondary aggregate encompasses the current policy areas of mineral planning, waste, transport and sustainability. Policy is highly supportive, at all levels, of the use of slate waste as a secondary aggregate, provided its exploitation and transport are sustainable’
The demand for aggregates in the construction industry, the road construction and reconstruction industry is likely to continue to increase (Dawson et al, 1993). It is also becoming more difficult to obtain new planning consents for extraction of primary aggregates due to the environmental impact, the public concern and the difficulty of obtaining sites for new quarries (Dawson et al, 1993). Blaenau Ffestiniog is one of these places containing the largest quantities of slate aggregate in Wales (Thomas, 1956). As a result of the slate industry the town of Blaenau Ffestiniog, has slate waste tips slipping down the mountains surrounding the town as well as free standing tips invading within the urban area of the town (Anderton, 1982).

There are a number of incentives to stimulate the utilisation of secondary aggregates, such as: reducing the demand for primary aggregates, preserving finite resources; reducing environmental costs associated with conventional aggregate quarrying and waste dumping; commercial benefit from the use of waste materials financed by other industrial processes and having to be stored resulting in additional costs (Dawson et al, 1993). These incentives can be generalised for supply chain strategies of other mining industries, because of the generic features such as reducing cost and waste, while preserving resources and protecting the environment, that are common for all mining industries. However, the uniqueness of the supply chain strategy in the context of the case study, is that slate aggregate is responsible for one of the largest volumes of dumped aggregate in the UK (Dawson et al, 1993).

2.3 Conclusion

This chapter outlined the context of the case study and provided justification for the scenario investigated, a description of the motivation for the research and the industry selected. The chapter provides historic background of the case selected, including discussion regarding the culture within the industry. Furthermore, the chapter provides background on the regional economy, the slate industry and related industries. The single case study is described, and the research study is defined in the context of the case study. The following chapter describes in more detail the existing research approaches, present in existing literature on the topic selected.
Chapter 3 Literature review

3.1 Introduction

The literature review examines the key concepts used in the study and critically analyses the approaches that have not been pursued in the study. The review begins with a discussion of supply chain strategy and strategy formulation, including definitions and historic evolution and developments. The review then considers formulation criteria, to develop an understanding of the relationship between business and supply chain strategy. The review focuses on supply chain strategy formulation, that involves the issues of: (1) supply chain strategy formulation models and methodologies, (2) product and supply chain strategy formulation, (3) logistics and supply chain strategy, (4) supply chain performance and formulation, and (5) supply chain integration.

3.1.1 Supply chain strategy definition and evolution

The supply chain has been defined as a complex adaptive system (Bozarth et al., 2009, Pathak et al., 2007), consisting of interlinking architecture and design, with external dimensions and system germane internal elements (Melnyk et al., 2013). The supply chain strategy aspect is considered as an investigation into how the supply chain should operate efficiently to compete, by evaluating costs, benefits and trade-offs in the supply chain operational components. Alternatively supply chain management is the process of transforming materials into a finished product, presenting a long term objective where validation should expand over a long period of time (Mentzer et al., 2001, Saad et al., 2002). Recent literature clearly separates between the two topics (Perez-Franco et al., 2010, Schnetzler et al., 2007, Martinez-Olvera and Shunk, 2006). This study is focused on reviewing the formulation aspect of a supply chain strategy, and building a research framework for supply chain strategy formulation.

3.1.2 Theories, models and methodologies

The main focus of the review is to identify existing literature in terms of theories, models and methodologies that explain in a step by step framework the process of formulating a greenfield project supply chain strategy that would serve as the foundation for
integrating multiple partners involved in a given supply chain aspects within these models and methodologies are covered, where relevant, to the context of supply chain integration and formulation.

The complexity of the subject, the multiple environments, dimensions, elements and concepts, resulted in a research process that does not set any limits to the conceptual, analytical or empirical nature of the paper types solicited. Some of the papers solicited were domestic, others were of an internationally comparative nature. Methodologies reviewed covered empirical techniques (case/field study, survey, archival research, action research, conceptual models, etc.) or modelling techniques (optimisation, simulation, algorithms, systems, etc.)

The literature review builds upon the existing models and proposes a framework for addressing multiple problems present in supply chain strategy.

### 3.1.3 Supply chain strategy in the mining industries

Azapagic (2004) proposed a framework for sustainable development indicators for the mining and minerals industry, comprising: economic, social, environmental and integrated indicators, while Strang (2012) illustrated through a case study of a sample of US mining companies, that logistics optimisation can reduce the requirements for marketing in the mining industry. Bodon et al. (2011) combined optimisation and simulation approaches to model the complete mining supply chain from mine to port of a single company in Indonesia. A logistics services innovation strategy for a mining company was also proposed based on a win-win concept for improving the strategic objectives and the relationships between supply chain companies (Córdova et al., 2012). An alternative approach was proposed for integrating the production-transportation planning in the aluminium supply chain network (Steinrucke, 2011). The literature outlined above, covers mostly single supply chain aspects within the mining industries, or combines the most prominent supply chain topics. The literature fails to identify a holistic approach for supply chain strategy formulation for the mining industry which provided the motivation for this research topic.
3.2 Supply chain strategy

Mckone et al. (2009) found indications that companies are often not linking their supply chain strategy to their competitive strategy. These findings raise concerns regarding how strategy is formulated, because successful supply chain strategy requires commitment to long term relationships with partners: sharing the same goals, integrated processes, behaviour and cooperation, and mutual sharing of: information, risks and rewards (Mentzer et al., 2001), while inter-organisational and collaborative integration of the supply chain participants requires a relationship that combines resources, expands combined capabilities and increases the competitiveness of all participating companies (Narasimhan et al., 2008). That combination represents a mixture of beliefs from each participant, that affects the performance of the others (Mentzer et al., 2001) and the competitiveness of the group depends on strategic ‘alignment’ of operations (Sakka et al., 2011).

Following the findings of Mckone et al. (2009) that in practice the supply chain strategy is frequently not related to the competitive strategy, even more concerning are the findings that the progress towards ‘adapting’ the supply chain principles is also weak in certain industries (Saad et al., 2002) and supply chain decisions are commonly based on individual company profitability goals (Leng and Chen, 2012). These findings are a concern because there is extensive support in existing literature confirming that a supply chain strategy is a single entity system and includes all of the participants in a given supply chain (Mintzberg et al., 1998, Narasimhan et al., 2008, Schnetzler et al., 2007, Perez-Franco et al., 2010, Ivanov, 2009). Mentzer et al. (2001) claimed that supply chain as a philosophy involves a network of companies and multifaceted company structures resulting from multiple strategic alliances, which led him to define supply chain as a confederation and a single entity instead of different parts performing individual functions.

The evolution into strategic alliances is not only required for communications across the supply chain, but also for a widespread integration of: demand management, production, distribution and capacity planning, quality and materials management, and delivery of products (Narasimhan et al., 2008). Ivanov (2009) defined the supply chain as a ‘networked organisation’ based on a group of enterprises collaborating in the value chain to acquire and convert raw materials into the final product and deliver the product.
Supply chain is commonly representative of a number of participants (companies or individuals) that are involved in the inbound and outbound or ‘upstream and downstream’ movements of products, services, finances, or information from the point of origin to the customer (Mentzer et al., 2001 pp.4). The networked organisation acting as a confederation of single entities does bring the question of alignment into context and the process of strategically ‘aligning’ the supply chain operations still represents a major problem (Sakka et al., 2011). This is unexpected as some of the earliest literature on supply chain integration (Stevens, 1989) determined that supply chain integration managed as a single entity, considered as a strategic decision, combined with applying appropriate tools and techniques, created real benefits in terms of market share and lower asset base.

To address the complexities of ‘adapting’ and ‘aligning’ supply chain problems, Sakka et al. (2011) proposed an ontological approach to the problem of strategic alignment and presented basics for semantic alignment by arguing that knowledge elicitation, containing, mapping and/or merging should be the starting point for simulations by adapting and applying existing models. The approach proposed by Sakka et al. (2011) is applied in this study in building conceptual logic, because supply chain strategy represents a ‘single entity system’ and ‘confederation’ (Mentzer et al., 2001), ‘networked organisation’ (Ivanov, 2009), requiring integration and cooperation for sharing information, risks and rewards (Mentzer et al., 2001), combining resources and capabilities (Narasimhan et al., 2008). Where, the lack of linkages between the supply chain strategy and competitive strategy (Mckone et al., 2009) challenges the process of ‘adapting’ (Saad et al., 2002) and ‘aligning’ (Sakka et al., 2011).

### 3.3 Strategy formulation

In early literature, Pettigrew (1977) argued that strategy formulation is a continuous and intentional ‘political process’ involving ‘choices’ made and ‘acted upon’ at various levels within a company, that develop into patterns or ‘accepting the world’ and ‘acting’ upon that world. To evaluate the pathways and outcomes of these ‘choices’ Miller and Friesen (1978) configured a large number of variables into 10 architectures for describing commonly occurring modes of company success or failure. While in a similar context to ‘accepting the world’, Bourgeois (1980) elaborated on the relationship between strategy and environment and categorised the concept into: objective (task and general), and perceived state, and further divided strategy into: content, and process (alternative
division: ‘primary’, and ‘secondary’) Bourgeois (1980) argued that the concepts integrate in a manner that primary strategy is related to opportunities in ‘general’ strategy and secondary strategy is related to navigating in a ‘task’ environment. Dess (1987) investigated further the consensus and relationship between strategy formulation and organisational performance and indicated that consensus on objectives and methods is positively related to company performance.

This early literature evaluated the concept of strategy formulation, however, it also brought to light some concerns regarding the extensive prescriptive and descriptive approach in literature and lack of focus on addressing the operational aspect of formulation. Platts et al. (1996) attempted to address these concerns and recommended several evaluation variables for strategy formulation in the manufacturing industry: procedure, participation, project management and point of entry. As a result of applying these variables through case study, multiple concerns related to strategy formulation were raised: ‘the level of participation within the process, the visibility and communication of the process outside the immediate manufacturing area, the high degree of informality within the process’ (Ibid., p. 238). The conclusions and the points of concern raised are specific to a particular case and in other cases, additional concepts could emerge.

### 3.4 Supply chain strategy formulation

Fisher (1997) stated that the first stage in formulating a supply chain strategy should be the consideration of the demand nature for the product supplied. Other crucial factors are stated as: demand predictability, product life cycle, product variety, market standards and influences such as the percentage of demand filled in from in-stock products (Fisher, 1997). Alternatively Narasimhan et al. (2008) in their methodology considered assessment of the internal and external factors as the basics for developing the supply chain strategy. The study argued that the process of formulating a functional level supply chain strategy must ‘assess the internal and external factors that contribute to or limit its potential for competitive success.’ (Narasimhan et al., 2008 pp.7).

Further contribution to the topic is present in Frohlich and Westbrook (2001) who empirically classified different supply chain strategies into five valid types, where different types are distinct in the direction towards suppliers and/or customers and level of integration. Familiarity with the classifications is valuable, however, the method is
constrained with concentration only on integration and undermines other features that make a given supply chain strategy, such as the ‘efficiency’ and ‘responsiveness’ of a supply chain strategy, which Fisher (1997) argue are a fundamental feature for the company’s success.

Mentzer et al. (2001) presented a set of values in which they defined ‘trust’ and ‘commitment’ as enhancing factors for creating confidence with supply chain partners and for achieving the stated goals. The Mentzer et al. (2001) model is focused on supply chain ‘orientation’ and ‘management’ and therefore, does not resolve the aspect of strategy formulation. Nevertheless, a number of concepts from this model present valid postulates for formulation methodology. These postulates are: firstly; an agreement on vision, key processes and nomination of a supply chain leader is crucial in co-ordinating a supply chain. secondly; in a supply chain, companies are required to eliminate their preferred functional strategies, thirdly; companies must develop a process approach involving the reorganisation of all the key supply chain functions, fourthly; the supply chain strategy requires jointly planned and controlled coordinated and cooperative action, fifthly; a supply chain can be viewed from a system perspective, and finally; a supply chain orientation is a pre-requisite for effective supply chain management.

Therefore, the literature reviewed on the supply chain strategy formulation problem, leads towards: (1) anticipating the demand for a product, market standards and influencers, product variety and life cycle (Fisher, 1997); (2) investigating the internal and external factors (Narasimhan et al., 2008); (3) focusing on supplier or customer and level of integration (Frohlich and Westbrook, 2001); (4) considering trust and commitment, or interdependence and organisational compatibility (Mentzer et al., 2001). This literature outlined the rationale for supply chain formulation criteria that has not been combined and applied to build a framework for supply chain strategy.

3.4.1 Hierarchical supply chain design

Supply chain design is a dynamic concept that includes identifying desired strategic goals and developing, implementing, managing through resources, processes and relationships (Melnyk et al., 2013). In this context, Dubois et al. (2004) used ‘dependance’ aspects to investigate supply chain complexities in context of interdependancies and concluded that concepts ‘within’ and ‘between’ supply chains should be analysed in an individual context.
For supply chain design and configuration at strategic level, Dotoli et al. (2005) proposed a three-level hierarchical method for a supply chain network. However, the final, and crucial, stage is not fully developed, because the model cannot accommodate all the parameters and complexities of a supply chain.

More recently, Qu et al. (2010) applied analytical target cascading (ATC) for optimal configuration of a supply chain strategy and tested the results through case study. In this approach individual supply chain companies are represented as separate elements with autonomous and heterogeneous decision systems for optimising decision variables.

The analytical target cascading is applied on vertical collaboration to achieve an overall optimality and a consistency scheme factor with dynamic constraints is introduced to overcome traditional problems in analytical target cascading with a discrete decision variable. The results confirmed that analytical target cascading is effective for resolving supply chain configuration problems. Therefore, the issue with further investigation is how to deconstruct and represent a complete supply chain into a hierarchical ATC tree because ‘the number of autonomous stages and the number of links between these stages define the ATC complexity...’ (pp.6904).

The approaches analysed lead to the conclusion that (1) hierarchical method can be applied for network design combined with case study for verifying the results (Dotoli et al., 2005); (2) Analytical Target Cascading can be applied for deconstructing a complete supply chain hierarchical tree and can be tested through case study and (Qu et al., 2010) similarly to the supply chain design decomposition (Schnetzler et al., 2007). These approaches have the potential to address the complexities in designing supply chain as a dynamic process and to enable the analysing of interdependencies ‘within’ and ‘between’ in individual context,

### 3.4.2 Supply chain candidate selection

Zhou and Chen (2001) designed a decision model for selecting supply chain participants. The model proposes an inter-company comparison of business processes to identify efficient candidates and eliminate the inefficient candidates. Qureshi et al. (2009) designed a similar methodology for selecting a preferred transportation company using the analytic network and the analytic hierarchy methodologies to decompose the functional dependencies into a hierarchical levels, keeping decision elements independent in the
process. Understanding of these methods is valuable because it includes the process of identifying the candidate and places the determining elements in a hierarchy. However, its contribution to a real life supply chain scenario is limited, because the models disregarded the capabilities to perform the operation.

### 3.4.3 Supply chain strategy and activities


The main weakness of the ‘techniques-tools matrix’ is the lack of clarity about building the matrix or identifying the techniques and tools to be applied, even in the case of an individual company. In addition, the ‘techniques-tools matrix’ does not communicate the supply chain techniques linkage to the company's strategic requirements’ and it intentionally disregards the activities that take place inside the companies. Their model also requires a catalogue, limiting the applicability of the model to ranges for which a catalogue exists. Therefore, even if it was possible to build the model to formulate a new supply chain strategy, this would not create actionable formulation of a supply chain strategy because of several weaknesses:

Firstly; although they investigated the supply chain strategy elements for seven industry sectors (grocery, pharmaceuticals, white goods, apparel, book publishing, computers and automobiles) the scope of industries they analysed is somewhat limited in confirming the applicability to other industries. Secondly; they designed a model for each industry they analysed. The individual industry model enabled them to identify the main characteristics of each industry. This makes it difficult to apply their method to diverse industries, because they have a different set of required elements in the supply chain strategy. Thirdly; they
investigated the capability of their model in two key questions while the literature review identified a number of questions in formulating a supply chain strategy. Fourthly; their study falls short of providing a model for formulating a new supply chain strategy.

Regardless of these weaknesses, familiarity with the Cigolini et al. (2004) method is valuable for supply chain strategy formulation because it confirms that a real-world supply chain strategy should be formulated through researching the activities of individual members instead of the desired activities from the joined supply chain strategy. The greatest value of their method is the conceptual framework and the differentiation between ‘philosophical’ and ‘real-life’ supply chain strategy approaches.

3.4.4 Supply chain strategy realignment

Martínez-Olvera and Shunk (2006) provide supply chain structural elements based on six business models and designed the ‘customer-product-process-resource’ (CPPR) framework. This framework links the proposed business models to the values for the supply chain structural elements that outline a supply chain strategy. The CPPR framework is a realignment tool applied in combination with a realignment methodology. The realignment involves four steps; assess the current operation of the companies supply chains applying the CPPR framework, define the possibility of transferring each one of the models in the CPPR framework, calculate the cumulative effort of realignment and select the model that would require from the company the smallest effort.

Martínez-Olvera and Shunk (2006) aimed by realigning the supply chain strategy to one of six pure types to create a reformulated strategy. The limitation of their model clashes with the multiple aspects arising from multiple participants in a supply chain and the involvement with individual business strategies all interconnected to the supply chain strategy. Another weakness of the framework is the concentration on transferring from the present to the desired strategy, disregarding the company’s main aim and objectives in the process. For example this model made no distinction between the variables of the company vision and the path to get there. In that respect, the model appears to have failed to implement the complexity of supply chain strategy phenomenon. In their following paper they matured the methodology (Martínez-Olvera, 2008) and recommended a future research comprising ‘hybrid models’, that would incorporate features from the six outlined but more than one of them by using ‘Quality Function Deployment’. 
In the context of this review, the most limiting factor in this framework is the focus on configuration and lack of consideration to formulation. However, the value of their framework to this review is the implementation of a value chain-based approach that required the supply chain strategy to be conceptualised as ‘one business’. Their framework provides business-driven criteria for supply chain strategy configuration suggesting that it is the value chain that reflects the business models of individual companies working together towards a supply chain configuration.

### 3.4.5 Supply chain strategy decomposition

Schnetzler et al. (2007) constructed a structured system of goals and means based on applying axiomatic design to define what the supply chain strategy desired accomplishments are. The system included ‘pyramidal arrangement’ of aim and methods for the supply chain that they called ‘supply chain design decomposition’ (Schnetzler et al., 2007). The system designed translates strategic priorities into the supply chain strategic operations to generate value and support the corporate strategy. Through applying axiomatic design Schnetzler et al. (2007) presented a scientific method to construct a supply chain strategy as a systematic objective-means system. The system Schnetzler et al. (2007) created, presents a design matrix methodology for systematically analysing the transformation of objectives into functional means by applying design parameters and process variables.

The Schnetzler et al. (2007) methodology consisted of ‘improvement strategies’ for a supply chain and can be applied to developing new supply chain strategies or improving an existing supply chain strategy. Their design parameters can correspondingly be adjusted to accommodate the functional requirements and their method suggests that the simpler design with minimum content is the best design. This methodology is clustered into four segments; intelligence, design, choice and implementation. Whereas; intelligence, involves gathering data regarding the customer needs and analysing the data focusing on ‘order winners’ and ‘order qualifiers’; the design segment involves setting the strategic priorities on achieving the objectives through supply chain management; the choice segment involves determining ‘potential conflicts among objectives’ and ‘synergistic effects’, to substantiate that all aims are achieved; whereas in the implementation segment the arrangements for implementation are completed and monitored.
Despite the enthusiasm in this review regarding the Schnetzler et al. (2007) method, the strategy design is applied below the central objective and their methodology does not take into account the present implementation of the companies involved in the formulation. One could argue that although supply chain can be conceptualised as ‘one business’ companies can be involved in a number of supply chains. Mentzer et al. (2001) pp.17 stated that ‘a supply chain as a whole may have its own identity and function like an independent firm’ but, ‘companies can be a customer in one supply chain, a partner in another, a supplier in a third, and a competitor in still a fourth supply chain.’.

Schnetzler et al. (2007) and Martínez-Olvera and Shunk (2006) methodologies differentiate as Martínez-Olvera and Shunk (2006) concentrate exclusively on transferring from the present to the desired strategy disregarding the company’s main aims and objectives in the process. However Schnetzler et al. (2007) concentrates exclusively on a strategy that targets the highest aims and objectives of the company while disregarding the companies present strategy. In the business world, managers find it difficult to commit to theories recommending supply chain strategies ‘without a vision of the future, or from building without grounding in today’ (Perez-Franco et al., 2010).

Similarly to Martínez-Olvera and Shunk (2006), attempt to categorise supply chain strategies is present in Narasimhan et al. (2008), but in the form of typologies and taxonomies. The taxonomies would classify companies into mutually exclusive or exhaustive groups and typology classifies companies into ideal types reflecting their qualities. This study suggested six different types of supply chain strategies, two of the types correspond with the ‘efficient’ or ‘responsive’ types discussed by Fisher (2003) They considered collaboration and strategic alliances as the means for combining resources and expanding joint capabilities to create competitive position in the market as the core factor for successful supply chain strategy. The methodology is based on the idea that ‘supply chain strategies can be derived by appropriately linking corporate level initiatives and functional level initiatives encompassing internal operations and inter-organizational considerations related to supplier and customer relationships’ (Narasimhan et al., 2008 pp.7) and argued that this linkage is of crucial importance for corporate performance.
3.4.6 Supply chain strategy as a conceptual system

If one organisation is not capable of formulating a supply chain without the other organisations, then the inter-organisational considerations must come before the internal operations (Perez-Franco et al., 2010). The study of Narasimhan et al. (2008) confirmed that a supply chain strategy can be seen as a section of the hierarchical chain of corporate, business unit and functional level strategies. This study argued that a supply chain strategy is related to the main functions, links with the functional level strategies and should directly be ‘aligned’ and ‘consistent’ with the corporate level strategies.

Ivanov (2009) designed a methodology that considers the supply chain strategy, design, tactic and operations as a conceptual system for supply chain planning and adaptation. This method was designed for aligning supply chain strategy as a complex multi-structural decentralised system with active independent elements stating the ‘multi-structural nature’ being the main obstacle in aligning a supply chain. Ivanov (2009) applied supply chain dynamics and mathematical modelling to develop a tool for dynamic feedback based on an adaptive planning process of a supply chain strategy.

However, there are a number of obstacles in applying this method in a real world scenario. The calculation precision is subject to individual decision-maker perceptions and mathematical models cannot calculate individual decisions. Generally the Ivanov (2009) method for concrete application cases requires a series of model simplifications. Nevertheless, their approach highlights some of the principles that distinguish between the planning and functional elements of the supply chain strategy and recognise that they are strongly interlinked. The second principle in this method is that a supply chain is composed of setting goals and measures for achievement.

Therefore, supply chain strategy formulation and design must either anticipate full operational capabilities through internal capabilities, or in a scenario where lack of capabilities are identified, the formulation and design must consider inter-organisational integration in combination with internal operations reformulation (Perez-Franco et al., 2010). The design process could apply a conceptual model and verify the model through case study, action research and grounded theory. Alternatively, conceptual system can be verified with system dynamics and mathematical modelling (Ivanov, 2009), however, such an attempt could hardly calculate with precision the individual decision maker perceptions.
3.4.7 Supply chain strategy and system engineering principles

In an earlier study (Hafeez et al., 1996) made an attempt to address the supply chain strategy formulation complexities by applying engineering systems principles. Hafeez et al. (1996) argued that systems engineering is the best comprehensive tool for associating the attitudinal, organisational and technological problems associated with supply chains. This model claimed that systems engineering enables the application of ‘soft systems’ and ‘hard systems’ for creating real-world simulations to gain the optimum values and corresponding parameters of a corresponding conceptual supply chain system. Through applying a system engineering approach for designing a supply chain as an integrated system dynamics framework this study designed a method ‘to decompose a supply chain into distinct (preferably naturally existing) autonomous business units.’ (Ibid, p.122)

Hafeez et al. (1996) considered the conceptual diagram as a crucial model of the system engineering approach followed by constructing a block diagram for formatting the supply chain simulation model. The process recommended in this study involves dividing individual business units into block diagrams and applying conceptual models and validating the block diagrams through presenting the work to the relevant people involved in the process. This method interlinks the concepts and diagrams to form a model of the internal supply chain to be tested through further dynamic analysis afterwards. However, this methodology was never advanced into a fully working model. The method lacks the necessary details regarding how the method was applied, or can be applied in additional real world scenarios. Other studies also applied engineering principles to the supply chain strategy problem. The Lertpattarapong (2002) system dynamics approach offered the causal loop diagram as a visualisation method for the insight of an existing supply chain problem. This study reconfirms the potential for applying system dynamics as perspective visualisation tool.

3.4.8 Conceptualise supply chain as a system

Adding to the growing literature linking engineering principles with supply chain strategy, Perez-Franco et al. (2010) applied established data collection methods as mechanisms for capturing, evaluating and reformulating a supply chain strategy of a single company. This method applies the collected data to engineering design techniques. The techniques start with the Pugh Controlled Convergence (Pugh, 1990) for conceptual design followed by
multiple versions of evaluation matrices to create superior design. In the design process a series of interrelated and interconnected evaluation matrices are used including the Enhanced Quality Function Deployment (Clausing, 1992). The conceptual system is evaluated using the Design Structure Matrix (Eppinger et al., 1994) and the Engineering System Matrix (Bartolomei et al., 2007), which are established tools for evaluating systems.

Perez-Franco et al. (2010) similarly to Cigolini et al. (2004), argued that executed activities should be analysed to create realistic strategy instead of strategy based on desired goals. The method used content analysis and narrative inquiry to capture the ‘as is’ supply chain strategy. The process suggests investigating the functional and operational activities before the ideas and principles behind the activities and choices. This method also corresponds with Narasimhan et al. (2008) and advocates designing graphical strategic maps. The key concepts are presented in conceptual diagrams clustered around functions, presented in a larger diagram displaying abstraction and generality in the top level and specific and concreteness in the bottom layers. This process is represented as ‘functional strategy map’ and is described in existing literature as ‘cascading strategy’ because of the ‘hierarchical cascade’ (Narasimhan et al., 2008). The ‘functional strategy map’ is later separated in ‘nominal’ and ‘executed’ which corresponds to the ‘techniques tool matrix’ (Cigolini et al., 2004).

### 3.4.9 Supply chain strategy architecture and design

Melnyk et al. (2013) proposed a framework for understanding supply chain design by following three key level factors: ‘influencers’, ‘design decisions’ and ‘building blocks’. ‘Influencers’ are considered the high end external elements such as business and political environment, the active business model, the company desired outcomes and the supply chain life cycle. ‘Design decisions’ represent internal/external elements that define the supply chain in terms of social, behavioural, and physical/structural design. ‘Building blocks’ are operational elements that implement the supply chain; inventory, capacity, transportation, and technology decisions. Melnyk et al. (2013) argued that supply chain design ultimately consists of company decision investment patterns that are ‘system germane’ and affect the supply chain; performance, degree of visibility, overall vulnerability, the ‘fit’ between capabilities and strategic objectives and the supply chain environment/setting and the requirements of the main customer.
The most relevant aspect of this study is the recognition and implementation of planning (architecture) and execution (design) in a framework for understanding supply chain. The architecture aspect is described as driven by need and system oriented focuses on ‘fitness for purpose’; while design is described as implementation of feasibility, effectiveness and efficiency. Melnyk et al. (2013) claimed that future research is needed for ‘Uncovering the factors driving supply design’ (Ibid., p.6) because the topic is strongly context sensitive (ex. design elements from demand-driven would not be applicable to supply-driven supply chains) Melnyk et al. (2013) recommended that for ‘uncovering the DNA of supply chains similar and distinct features’ must be identified along with the ‘underlying factors’ driving design and shaping the ‘resulting systems’. The study concluded that richness of the supply chain design concept cannot be comprehended or generalised in a single ‘dimension’ and no single study can explore all factors simultaneously and should focus on ‘salient dimensions’ and various pieces working together to orchestrate an overall architecture design.

3.5 Product and supply chain strategy

Lamothe et al. (2006) proposed an optimisation model for selecting product and designing its supply chain strategy. The design involved firstly proposing a set of product families and secondly determining the best product in the process of architecting the supply chain. Product quality and the quality control strategy can significantly improve the overall performance of a supply chain (Liu and Hipel, 2012). A hierarchical decision model has been developed to assist companies in determining the optimal quality control strategies for outsourced products (Liu and Hipel, 2012). In a different study in a similar context, Lo and Power (2010) conducted a survey based investigation on the relationship between product and supply chain strategy using the Fisher (1997) model as a framework. The research identified that cost efficiency is the mostly pursued in the current climate, but also challenged the established Fisher (1997) method by claiming that the relationship between supply chain strategy and product nature does not appear to be significant. Such result does give a new perception for investigation, however, the limitations of this study was inherited from Fisher (1997) and classification included only two distinct product groups.
3.5.1 Reverse logistics and environmental problems

Reverse logistics in context of supply chain networks refers to the process where an empty rail freight container is on its journey back after delivering the products. The design, acquisition, production, distribution, use and reuse, and disposal of goods and service is increasingly more relevant to the context of environmental supply chain policies (Zsidisin and Siferd, 2001). The product development design should anticipate the aspects of design for environment and design for disassembly, however, the recovery in this context is not completely dependent to the return of reusable units (Clendenin, 1997). Reverse logistical activities are also influenced by avoidance of disposal costs (Lee et al., 1997). The process of companies pursuing environmental sustainability to reduce the environmental impact from their activities, product and processes, refers to integration of an environmental approach for ‘end-of-life management’ after a product’s useful life (Srivastava, 2007). The process promotes cross functional co-ordination of activities, synergy and efficiency between supply chain partners, aimed at improving environmental performance, reducing waste and saving on cost, and therefore, can also be seen as a tool for creating competitive advantages (Rao and Holt, 2005).

3.5.2 Postponement supply chain strategies

Bowersox and Closs (1996) described three types of postponement strategies: time, place and form postponement. Aviv and Federgruen (1999) claimed that postponement can be achieved through multiple production and distribution processes, while Ernst and Kamrad (2000) evaluated supply chain structures and categorised into: rigid, postponed, modularised and flexible. The categories discuss the product and process design concept of postponement. Gavirneni and Tayur (1999) studied the benefits of information sharing and delayed differentiation through analysing four inventory control models by using a discrete time framework. The study found that in a scenario of high holding cost, penalties and moderate demand, the information sharing should be a preferred option to postponement strategy. The frameworks discussed implemented measurable variables such as cost and benefits. These frameworks would benefit from building less measurable factors, such as environmental policies and company readiness in terms of capabilities, infrastructure and technology. Postponement strategies must anticipate market demand volatility, cost
elements, service level and product life cycle for postponement strategies to be adequately modelled.

### 3.5.3 Marketing and distribution planning

Martínez-Olvera and Shunk (2006) argued that the supply chain functions must be based on the business model whereas the business model must be based on the targeted market. Namely, the production and marketing elements must also be understood prior to the strategic supply chain structural elements being formulated through combined efforts of the supply chain partners. To enable such design, Korpela et al. (2001b) proposed a cost based framework that includes service elements and company strategy for optimising the internal supply chain, while Bogataj and Bogataj (2001) described a customer traveling problem to analyse customer behaviour under uncertain demand. Narasimhan and Kim (2002) examined the relationship between diversification and competitive advantages and concluded that coordination between marketing strategies and SCI strategies leads to better performance than pursuing the strategies independently. However, confirming that a connection exists and evaluating the connection does not address the question on how such integration is performed in a supply chain strategy.

### 3.6 Transportation and logistics

The traditionally distinct areas of operations management, sourcing and logistics have been integrated into the supply chain operational area (Bozarth et al., 2009). The supply chain transportation and logistics area at present, deals with the flow of goods in a supply chain and covers specific problems related to transportation, warehousing, material handling (Bodin, 1990, Anily and Bramel, 1999, Gendreau et al., 1996, Baker and Ayechew, 2003, Disney and Towill, 2002, Johnson, 1997, Johnson and Brandeau, 1999). Altering the logistics operations occurs to gain competitive advantages when functional integration is pursued (Fuller et al., 1993). While economic improvement and logistic value of products can be achieved through integration of the logistics chain (Perona et al., 2001). Lee et al. (2010) investigated industrial supply chain problems and concluded that it is required that third party logistics ‘3PLs’ companies design the network and operate the transportation. Lee et al. (2010) compared results between a number of heuristic algorithms and concluded that ‘In terms of real time application, the size of the problem might be larger than that of the
test data. In such environments, it is not feasible to find an optimal solution in a reasonable amount of time.’ (Ibid., p.3974).

3.6.1 Transportation and logistics integration

Logistics is defined as the process of planning, implementing, and controlling the effective flow and storage of goods, services and information from point of origin to point of consumption focused on meeting customer requirements (Bowersox et al., 1999). Considering the wide span of activities, logistics enables cross functional integration (Morash et al., 1996) and coordination of integrated activities (Langley and Holcomb, 1992). Competitive supply chains in general have strongly integrated logistic processes (Stank et al., 2001). In some literature the focus is on functional logistic integration within a company (Bowersox and Closs, 1996), other literature focused on logistic integration across the supply chain companies (Stock et al., 1999). In the context of the latter, logistics integration is defined as integration of activities across functional departments and company activities with activities of other supply chain participants (Stock et al., 1999). This strengthen the argument that logistics can serve not only as coordinating mechanism between supply chain participants, but also as a source for customer value and competitive advantages (Chen and Paulraj, 2004).

There is strong evidence in the literature that greater logistic integration within and across company and supply chain activities results in increased organisational and operational performance. For example, Larson (1994) concluded that there is a strong relationship between inter-organisational logistic integration and cost reduction, while Ellinger et al. (1997) confirmed that increased customer service performance can be achieved through integrated management of logistic activities. Also, Stock et al. (1999) claimed that internal and external logistic integration leads to improved performance in lengthy manufacturing supply chains. The relationship between logistic integration and increased operational performance is also supported by empirical evidence (Bowersox and Closs, 1996, Stank et al., 2001). The wide span of logistics activities enables cross functional integration (Morash et al., 1996) and coordination of integrated activities (Langley and Holcomb, 1992). However, research on supply chain strategy design has to some extent neglected the value of logistic integration on strategy formulation.
3.6.2 Strategic elements of transport and logistics integration

Frohlich and Westbrook (2001) analysed the upstream supplier and downstream customer integration and presented evidence that greater integration with suppliers and customers creates improved supply chain performance. The result of their analysis concluded that since greater collective operational activities need to be advanced through integration, then the strategic problem grows into one of a degree. The authors claimed that without an ‘over-arching’ operations strategy, an isolated manufacturer will probably restrain the supply chain participants from achieving their utmost performance.

Resulting from the Frohlich and Westbrook (2001) conclusions, Jayaram and Tan (2010) attempted to investigate an example of the widest ‘ark of integration’ on company integration with a third-party logistics provider or ‘3PLs’ and confirmed that ‘there are significant differences in the postures of firms that include logistics providers in their supply chain management efforts versus these that do not.’ (Ibid., p. 262). Jayaram and Tan (2010) performed analysis of alliances between companies and ‘3PLs’ and concluded that seeking various forms and degrees of integration with 3PLs, anticipating positive influence on performance, could be inappropriate and recommended seeking the right level and form that optimises the company performance.

A similar attempt to Jayaram and Tan (2010) was made by Prajogo and Olhager (2012) who examined the effect of SCI from the aspect of logistics integration, long term relationships, and information and technology sharing. Prajogo and Olhager (2012) provided a framework on the drivers and enablers of logistics integration and concluded that integration in information and material flows create a significant effect on performance. However, the result of the testing also concluded that SCI is a challenging task and requires communication and information exchange mechanisms to support the logistics integration activities related to material flow. The study has limitations in terms of factors included in the analysis. The study is limited because the focus is on the ‘focal firm’ while research in supply chain relationships requires investigation of multiple parties and multiple perceptions regarding complexities of reciprocity and mutual effect.

Schnetzler et al. (2007) contributed to this argument through defining a supply chain strategy as a set of strategic objectives and the process of operationalising appropriate measures to develop and capitalise on logistics potential that would result in improved
business performance. Their methodology measured the supply chain cost related to logistics, inventory and infrastructure and the impact on strategic value drivers: inventory, transport, infrastructure and information (section 3.1.3 explains the methodology in greater detail) However, without an over-arching strategy it is unlikely that supply chain participants will achieve best performance (Frohlich and Westbrook, 2001), and in strategy formulation the right level and form should be identified to optimise performance (Jayaram and Tan, 2010).

3.6.3 Supply chain agility

Agility of supply chains is measured by the ability to respond quickly and efficiently to changes in demand and to supply the required product at the determined price in the desired time to a consumer (Christopher, 2000). ‘Agility’ can be achieved through establishing a ‘seamless’ supply chain where all participants ‘act as one’ and think as a ‘predator’ with a drive and vision to re-engineer the entire supply chain just to satisfy the end customer needs (Towill, 1997). Mason-Jones and Towill (1999) argued that agility can only be attained if a supply chain is focused on information flow instead of material flow. However Narasimhan and Das (1999) suggested that operational flexibility and manufacturing agility can be achieved through investing in the correct supply chain practices.

Apart from practices, Tolone (2000) argued that the critical factor for achieving agility is effective supply chain integration followed by an investment in technology that integrates suppliers and enables adaption effectively to market variations and secure a fast response to customer demands. In the context of developing a supply chain strategy, Fisher (1997) stated that the strategy must facilitate the demand matching through anticipate sales predictability and the relationship between product types. Naylor et al. (1999) claimed that agility must be applied downstream from the supply chain decoupling point, while lean manufacturing must be applied upstream from the supply chain decoupling point. In this context, Mason-Jones et al. (2000) discussed a combination of lean and agile paradigms in a supply chain strategy and recommended the positioning of the decoupling point to respond to uncertain demand downstream, and provide level scheduling upstream.
3.7 Supply chain evaluation

The process of merging distinct operational areas into the supply chain operational area created an urgency to integrate the information and physical flow into relationships that link these areas with supply chain partners in the form of a ‘complex adaptive system’ (Bozarth et al., 2009). Pathak et al. (2007) designed a framework called ‘complexity and adaptability in supply networks’ CASN for generating, validating and refining theories on supply networks. Soni and Kodali (2010) applied performance value analysis (PVA) and strengths, weaknesses, opportunities and threats (SWOT) analysis for diagnosis of global supply chains where the ‘focal firm’ is operating in multiple countries. While such analysis could present results in supply chains owned by one company, in supply chains operating as ‘networked organisation’ there are far more variables to consider. Bryceson and Slaughter (2010) proposed a case study approach and participative action research to investigate the disconnect between operational and strategic goals, to develop a conceptual performance assessment model.

3.7.1 Performance measurement and supply chain evaluation

Performance measures and metrics are aimed at guiding, supporting and monitoring the supply chain performance, therefore, establishing the appropriate measurement system is a critical aspect in supply chain design (Beamon, 1998). Supply chain performance depends on the performance of all supply chain participants (Lee and Billington, 1992) and there are different measures for evaluating supply chain effectiveness and efficiency (Mentzer and Konrad, 1991, Neely et al., 1995).

Traditionally, supply chain performance is modelled on factors such as: cost, customer responsiveness, inputs (resources), outputs and flexibility, and is based on effectiveness, efficiency and flexibility (Beamon, 1999). Kaplan and Norton (1996) designed a ‘balanced scorecard-based framework’ and described five ‘dimensions’ of performance measurement: customer, finance, business, innovation and learning, and described the relationship between the ‘dimensions’. The framework was expanded by Brewer and Speh (2000) who used the cross-company supply chain nature to encourage coordination and integration of supply chain functions. Considering that supply chains operate in multiple business and regional environments, the approach of extracting all wide sample data for generalising performance measures is a challenging task. Shah and Singh (2001) addressed
this complexity by computing performance measures through publicly available information to benchmark the internal supply chain, the areas of opportunities for improvements, and reasons for specific supply chain performance levels, while, Korpela et al. (2001a) demonstrated how the ‘Analytical Hierarchy Process’ can be applied for supply chain development, with a core-process redesign for high performance being used as a framework. The process is based on concurrent engineering consisting of simultaneously implementing analysis, design and implementation.

Bozarth et al. (2009) investigated the impact of supply chain complexity on plant performance and concluded that; ‘Upstream complexity, internal manufacturing complexity, and downstream complexity all have a negative impact on manufacturing plant performance.’ (Ibid., p.78). A broader study of concepts in an individual context is undertaken by Qi et al. (2011) who conceptualised and empirically examined the effect of business environment uncertainty on competitive strategy, supply chain strategy and business performance. The study resulted with the conclusion that ‘environmental dimension’ determines if a company can adopt lean or agile supply chain strategy.

van Donk and van der Vaart (2005) investigated the uncertainty and SCI in the process industry with shared resources. This investigation applied the case study method using a variety of data gathering techniques; process mapping, semi structured interviews, studying and observing procedures and analysing production-related data as recorded in the company’s information systems. The study concluded that in certain business environments, a low level of integrative practices is the best strategy to engage.

The study is limited in description and a more detailed study seems required to investigate the relationship between business conditions, level and scope of integration, financial and performance measures specific to the case of shared resources. Regardless of the limitations, the authors claim that the single case framework developed ‘clearly shows that shared resources limit the possibility to integration, but also that different levels of integration exist in each of the five supplier–buyer relations depending on the amount and type of uncertainty.’ (Ibid., p.97).

Sukati et al. (2012) studied the relationship between supply chain strategy and practices effect on supply chain performance by applying mean, standard deviation and correlation between independent and dependent variables. Contradicting the previous studies
reviewed, this study concluded that there is no significant correlation between; strategy and performance; practices and integration; practices and flexibility; practices and customer responsiveness; and weak correlation between strategy and flexibility; strategy and customer responsiveness. However, the generalisability of these findings is questionable because of the analysis being based on a convenience sample, and self-reported questionnaire, opening the possibility of responses based on desirable or acceptable instead of actual.

Contemporary and advanced methodology that integrates the processes of business reengineering, benchmarking, and process measurement into a cross-functional framework is the Supply Chain Operations Reference or SCOR model (SCC, 2001). The model is based on a supply chain process view and applies four processes: plan, source, make and deliver, where every process is divided into sub-processes, firstly at configuration level, then at a process element level. The weakness of this advanced method is that companies must provide information regarding their performance to receive a ‘benchmark’ and compare their own performance against the benchmark. This step, as simple as it seems, creates a great deal of obstacles in cases of strategy ‘absence’ (Inkpen and Choudhury, 1995).

The methodologies outlined in the earlier stages of the review (Martínez-Olvera and Shunk, 2006, Martínez-Olvera, 2008, Perez-Franco et al., 2010, Narasimhan et al., 2008) are limited to measuring performance and evaluation of existing supply chain strategy to determine best approach for strategy reformulation. Existing models would benefit from a framework that would evaluate and measure performance of integrating supply chain participants in strategy formulation (Sukati et al., 2012).

Supply chain performance depends on the performance of all supply chain participants (Lee and Billington, 1992) and establishing the appropriate measurement system is critical aspect in supply chain design (Beamon, 1998). Kaplan and Norton (1996) designed a framework for measuring performance. The framework was expanded by Brewer and Speh (2000), however, the applicability of specific and categorised performance measures have not been applied to evaluate strategy formulation where measuring performance in effect refers to forecasting performance. Furthermore, the supply chain performance measures are developed in a specific supply chain context (van Donk and van der Vaart, 2005) or for categorising existing performance measures (Shah and Singh, 2001). The balanced scorecard framework (Kaplan and Norton, 1996) represents an advanced approach for
measuring performance, but disregarded measures, such as flexibility and feasibility. In an uncertain market, demand and continuous new product development, flexibility and feasibility should also be included in the performance measures (Beamon, 1999).

3.8 Supply chain integration

3.8.1 Outsourcing and strategic alliances

Outsourcing represents a contractual relationship where a supplier is obliged to provide the buyer predefined goals (JB and Hilmer, 1994). A strategic alliance represents greater level of integration through sharing values, goals and corporate strategies with an on-going coordinated relationship between parties that require each other’s abilities (Razzaque and Sheng, 1998). Existing studies of the concepts are present in terms of supply chain outsourcing, third party logistics outsourcing, transportation outsourcing, global sourcing, supplier sourcing, and information technology sourcing (Bardi and Tracey, 1991, Sheffi, 1990, Daugherty and Pittman, 1995, Smith et al., 1998).


In the context of supply chain strategy formulation, Gilley and Rasheed (2000) investigated the effect of outsourcing of peripheral and near-core tasks effect on performance and concluded that outsourcing creates a number of negative effects; such as declining innovation, competition from suppliers and transfer of specialised knowledge. These negative effects are caused because supply chain is effectively a result of aggregated and evolved innovation from internal and external coordination, integration and cooperation (Saad et al., 2002). Regarding outsourcing non-core strategic activities Gilley and Rasheed (2000) concluded that there was no significant direct effect. Also, outsourcing through ‘abstention’ caused by lack of capital and experience, represents the only choice and is representative of a network organisation. The study argues that further investigation is required on the potential ‘fit’ between companies outsourcing intensities, business
strategies and business environments suggesting the development of a ‘generic strategy’ and ‘environmental dynamism’. (Gilley and Rasheed, 2000).

However, Jayaram and Tan (2010) claimed that the companies applying the widest ‘ark of integration’ (Frohlich and Westbrook, 2001) should benefit from better performance, while companies relying on outsourcing will be ‘more concerned with boundary spanning integration’ (Ibid., p.265), because companies are failing in their attempts at internal and external integration ‘largely due to trends of outsourcing and because a significant part of a products value-added function is committed and traced to external functions.’ (Ibid., p. 262). Therefore, in supply chain strategy formulation, companies should be focusing on core-activities and outsource non-core activities, such as logistic services that are commonly considered as a non-core activity (Gilley and Rasheed, 2000). Third party logistic partnerships enable cost reduction combined with improvement in service and operational efficiency (Sheffi, 1990). In this context, further investigation of potential ‘fit’ between companies outsourcing intensities and vertical strategic integration could strengthen existing understanding of the problem (Gilley and Rasheed, 2000).

3.8.2 Supply chain competencies, relationships, integration and performance

Closs and Mollenkopf (2004) investigated the relationship between supply chain competencies and performance and stated that the supply chain competencies lead to diverse performance advantages in various business environments. However, Van der Vaart and van Donk (2008), pp.52 argued, ‘not all relationships require the same practices and patterns to achieve superior performance’. Vickery et al. (2003) confirmed that even if in one industry or context the effects are strong, in another industry or context the same links individually could be strong but the total indirect effect may be insignificant.

3.8.3 Supply chain integration and performance

In the context of supply chain integration and performance, Frohlich and Westbrook (2001) developed five different supply chain ‘ark of integration’. Knowledge of the suggested five integration strategies is valuable because it confirms that vertical alignment is not sufficient and a degree of horizontal upstream and downstream integration needs to be considered as part of the operational strategy. However, the greatest limitation of this study is the
singular focus on integration and in the author’s own words ‘many questions remain unanswered about how best to characterize supply chain strategies’ (Ibid., p.185)

Rosenzweig et al. (2003) expanded upon Frohlich and Westbrook (2001) highest level ‘ark of integration’ and partially contradicted Frohlich and Westbrook (2001) results regarding generalizability of the outward-facing consumer good claiming that ‘supply chain integration intensity leads directly to improved business performance... in the consumer products sector.’ (Rosenzweig et al., 2003, pp.437). The greatest limitation of the study is that it provides empirical evidence that supply chain integration is important, but it does not explain how to acquire high levels of internal and external integration.

Childerhouse and Towill (2011) continued building upon Frohlich and Westbrook (2001) and examined the ‘arks of integration’ to verify the link between SCI and performance. The methods applied are described as ‘triangulation in the large’. The study argued that the difficulties in investigating the link between SCI and performance should not be underestimated because ‘all field-based research is extremely resource-intensive. It is also intolerant of missed opportunities.’ (Childerhouse and Towill, 2011, pp.7448).

The study concluded that most supply chains are not fully integrated and companies prefer to focus on internal integration before integrating with suppliers and in the final stage companies integrate with customers. The topics for further research identified in the study are the ‘low uptake of supply chain integration observed in practice’ and ‘the identification of both the barriers to change and best approaches to overcome these obstacles.’ (Childerhouse and Towill, 2011, pp.7459).

3.8.4 Supply chain strategy, integration and performance

Swink et al. (2007) analysed the effect of integration in strategic objectives on competitive capabilities and business level performance. The study found that strategic supplier integration is linked to market performance. Synchronising the processes internally and externally and jointly planning the execution to achieve a common goal leads to supply chain effectiveness (Kim, 2006). However, internal integration is less important in smaller sized companies (Closs and Mollenkopf, 2004) and reduction of internal integration may not have significant direct effect on performance (Gilley and Rasheed, 2000).
He and Lai (2012) designed a conceptual model that describes the relationships between operational and strategic SCI on company performance. He and Lai (2012) examined the effects of operational and strategic integration, in the form of internal and external integration, and upstream and downstream integration, and provided further empirical evidence that different types of SCI create different effect and do not contribute in the same manner.

Nikulin et al. (2013) described an operative algorithm for selecting best supply chain integration strategy through formulating a new procedure representative of: focalising the present situation and mapping the present SCI strategy; creating a diagram of the process elements to provide insight into the supply chain operations; building a system operator model based on: past, present and future of the supply chain to scale levels of the company strategic vision; resources classification; building a network of problems through: separation in space; separation in time; separation between the whole and its parts; separation upon conditions. However, there are several limitations that raise concern regarding the algorithm developed. Despite the aim to do the opposite, the study followed the path of many authors in the past and ignored the Van der Vaart and van Donk (2008) recommendation by constructing a limited measurement and ignoring the vast list of measurements in existing literature.

3.8.5 Information sharing and supply chain integration

Frohlich and Westbrook (2001) argued that internet technologies, such as e-procurement software or advanced supply chain planning systems can greatly simplify implementation, and companies with traditionally narrow ‘arcs of integration’ have an opportunity to quickly catch up. Vickery et al. (2003) identified that integrated information technology and SCI have direct positive relationship elements with supply chain strategy integration. Manthou et al. (2004) went a step further by advocating ‘Virtual e-Chain’ for supply chain collaboration where individual companies are operating in a virtual network towards a common goal or to explore a particular opportunity. Al-Mudimigh et al. (2004) also argued that the I.T. represents a critical component of the supply chain and value chain and that companies should invest significantly in I.T. Therefore, supply chain strategy should embrace a new vision of collaborative commerce and synchronisation of supply chain information flow, promoting flexibility and effectiveness (Kim, 2006, Frohlich and Westbrook, 2001, Vickery et al., 2003, Manthou et al., 2004, Al-Mudimigh et al., 2004).
3.9   **Key points of the literature reviewed**

The summary of key points in this section is performed to identify and to present the gaps in existing literature on the subject area by using a summary table and to relate these gaps by using a conceptual diagram. The review revealed a number of tools and mechanisms from existing literature, that enable the process of architecting and designing a framework as guidance in formulating a greenfield project integration supply chain strategy. Those are critically summarised using a brief discussion of the main contributions, and related to emerging research themes that are outlined using bullet points for clarity.

3.9.1  **Conceptual system approach**

In the context of strategy formulation, conceptual approach can be applied to evaluate supply chain decision makers strategic goals (Cigolini et al., 2004, Narasimhan et al., 2008, Perez-Franco et al., 2010), while operational level employees can be interviewed to identify relationship between the vision and goals in the context of explaining or predicting the relationship between concepts (Platts et al., 1996, Menda and Dilts, 1997). Furthermore, conceptual vagueness can be addressed by designing a conceptual framework (see Figure 3-1) that prevents confusion regarding the type of knowledge generated.

- Conceptual framework approach (**CM**)
- Conceptual system for supply chain decomposition (**CSSCD**)

3.9.2  **Characterising greenfield project integration**

The literature review in this chapter investigated supply chain complexities that represent a real life phenomenon with multiple variables (Table A-1) Supply chain strategy is described as representing a ‘single entity system’ and ‘confederation’ (Mentzer et al., 2001), ‘networked organisation’ (Ivanov, 2009), requiring integration of processes, behaviour, cooperation and sharing information, risks and rewards (Mentzer et al., 2001), through combining resources and capabilities (Narasimhan et al., 2008). Furthermore, the functional activities should be investigated to identify actual instead of desired strategy outcomes (Cigolini et al., 2004).

- Supply chain integration (**SCI**)
Capture the essence and forecast the effect of supply chain integration and performance (CEFE)

Characterise greenfield supply chain strategy and integration (CGSI)

3.9.3 Business and supply chain strategies

The most concerning findings in recent literature are the indications that supply chain strategy and competitive strategy are commonly not linked in industry (Mckone et al., 2009). Adding to these concerns are the findings that challenges still remain in the processes for ‘adapting’ supply chain principles (Saad et al., 2002) and ‘aligning’ operations (Sakka et al., 2011). There is confirmation in recent literature that the supply chain strategy formulation topic remains inconclusive (Mckone et al., 2009, Saad et al., 2002, Sakka et al., 2011), which comes as a surprise considering some of the findings in the early literature. The review of early literature relevant to the topic of strategy formulation came to the conclusion that strategy formulation represents a process of accepting the reality and acting upon that reality by designing patterns of choices and evaluating the outcome of these choices (3.3) The outcomes evaluation involves architecting the objectives and the perceived state in a given business environment (Miller and Friesen, 1978).

Corporate strategy (CS)

Adapting and aligning (AA)

Barriers to change and approaches to overcome (BCAO)

Capabilities evaluation (CE)

3.9.4 Ontological semantic alignment

These complexities can be addressed by applying an ontological approach for semantic alignment (OASA) where knowledge elicitation, containing, mapping and merging should represent the foundations for adapting or aligning supply chain strategy principles (Sakka et al., 2011). The process should conceptualise strategy as a system of choices, patterns or decisions to address the phenomenon of strategy ‘absence’ (SA) in strategy formulation (Inkpen and Choudhury, 1995). The process should start by reaching a consensus on strategic objectives, but should avoid prescriptive and descriptive approaches and should address the operationalisation aspects of formulation (Platts et al., 1996) Furthermore, research in this context that involves interviews, should consider separating the topics of
strategy and operations to avoid confusion regarding what is being asked (Menda and Dilts, 1997, Platts et al., 1996). The process can be further clarified by applying formulation criteria (FC), such as: procedure, process and participation, which require communication mechanisms to enable concept understanding (Inkpen and Choudhury, 1995). The concept understanding should apply evaluation criteria. The evaluation criteria (EC) can be applied through the process of systematic innovation (Sheu and Lee, 2011), as a method for distilling innovation to strategy. However, strategy absence must be addressed through the formulation criteria prior to applying the evaluation criteria, because systematic innovation brings strategy dynamics through the feedback mechanisms, whereas strategy absence effectively disables the feedback mechanisms.

- Preliminary salient dimensions (PSaD)
- Process chain and virtual eChain (PC-VC)
- Supply chain agility (SCA)

The feedback mechanisms enable the process of anticipating the demand for a product, market standards and influencers, product variety and life cycle (Fisher, 1997); investigating the internal and external factors (Narasimhan et al., 2008); must determine the supplier or customer focus and level of integration (Frohlich and Westbrook, 2001); and enable building trust and commitment, or interdependence and organisational compatibility (Mentzer et al., 2001). These feedback mechanisms enable building upon the supply chain formulation criteria and until present, the formulation criteria has not been built upon and combined with the evaluation criteria (EC): visibility (Inkpen and Choudhury, 1995, Fisher, 1997, Fisher, 2003), acceptance (Saad et al., 2002), participation (Menda and Dilts, 1997, Karl-Erik, 2001, Zhou and Chen, 2001, Qureshi et al., 2009), communication (Tracey et al., 1999), formality (Andrews et al., 2009), adaptability (Sakka et al., 2011, Saad et al., 2002), integration (Bozarth et al., 2009), effectiveness (Fisher, 2003, Fisher, 1997) flexibility (Narasimhan and Das, 1999, Beamon, 1999, Kim, 2006) and responsiveness (Fisher, 1997). Building upon and combining the criteria would represent synthesising existing knowledge for deriving new findings.

### 3.9.5 Supply chain strategy decomposition

Supply chain design is a dynamic process (Melnyk et al., 2013) and interdependencies should be analysed ‘within’ and ‘between’ in individual context (Dubois et al., 2004). One
approach for building and combining the criteria is a hierarchical method for network design and case study for verifying the results (Dotoli et al., 2005). This approach can be strengthened by building upon the principles from Analytical Target Cascading in context of decomposing a complete supply chain hierarchical tree (Qu et al., 2010), similarly to Schnetzler et al. (2007).

- Decomposing supply chain into hierarchical tree (DSCHT)

### 3.9.6 Planning of strategic processes

Schnetzler et al. (2007) decomposed supply chain strategy through axiomatic design and composed it as a structured system with pyramidal arrangements. The Schnetzler et al. (2007) method, combined with the techniques from CPPR (Martínez-Olvera and Shunk, 2006) and analytical target cascading (ATC), provide the background for designing a new formulation method. The formulation method should anticipate the supply chain elements that arise from multiple supply chain participants, should include the participants’ main aims and objectives, and should include the process of getting from the present to the required stage.

- Process of getting from the present to the required stage (PR)

### 3.9.7 Inter-organisational integration

Supply chain strategy formulation and design must also anticipate operational capabilities through internal capabilities, or if there is a lack of capabilities, the formulation and design must consider inter-organisational integration in combination with internal operations reformulation (Perez-Franco et al., 2010). The design process could apply a conceptual approach and verify the findings through case study.

- Conceptual supply chain inter-organisational integration (CSCIOI)

### 3.9.8 Process of integrating strategic choices

Alternatively, conceptual system can be verified with system dynamics and mathematical modelling (Ivanov, 2009), however, mathematical modelling could hardly calculate with precision the perceptions of the individual decision maker perceptions. Other attempts to
design supply chain as a system are present in engineering systems literature (Hafeez et al., 1996). Hafeez et al. (1996) integrated a system dynamics framework to decompose supply chain into separate business units, recomposed into conceptual diagrams, then block diagrams and tested the approach through dynamic analysis. This approach was never advanced into a fully working method. The approach could be applied as a visualization tool for presenting and interlinking multiple supply chain areas with external business dimensions (Lertpattarapong, 2002), but such approach could hardly comprehend the supply chain complexities and multiple variables from: industry, company and individuals, leading to the conclusion that conceptual diagrams and supply chain decomposition are strong visualization tools. However, formulating supply chain strategy as engineering system represents a constraining paradigm.

- integration as a method for integrating strategic choices (IMSC)

### 3.9.9 Strategy formulation

Engineering design techniques such as the Pugh Controlled Convergence (Pugh, 1990), the Enhanced Quality Function Deployment (Clausing, 1992), the Design Structure Matrix (Eppinger et al., 1994) the Engineering System Matrix (Bartolomei et al., 2007), and the ‘techniques tool matrix’ (Cigolini et al., 2004), can be applied in combination with ‘cascading strategy’ (Narasimhan et al., 2008), to case study, action research and grounded theory to capture, evaluate and reformulate supply chain strategy as a conceptual system (Perez-Franco et al., 2010). Such an approach can be combined with supply chain decomposition (Schnetzler et al., 2007) to address the formulation problem.

- Formulation criteria (FCr)

### 3.9.10 Individual decisions in multiple business environments

In a similar context, various algorithms have been applied to several supply chain problems, however, in some environments the problem is larger than the test data and optimal solutions cannot be found in reasonable time frame (Lee et al., 2010). Metaheuristic algorithms could in the future provide a solution for identifying optimal logistic solution for a supply chain (Griffis et al., 2012). Such a method would be useful for addressing the logistics as a specific problem in strategy formulation, but metaheuristics would hardly
anticipate aspects such as the individual decisions of decision makers in the vast numbered dimensions in multiple business environments. In this context, the conceptual system approach has been proven effective for all wide strategy evaluation and optimal solution detection (Perez-Franco et al., 2010).

- Participants aims and objectives (PAO)
- Strategy absence (SA)
- Supply chain strategy articulation (SCSA)

### 3.9.11 Salient dimensions

Most recently, Melnyk et al. (2013) proposed a framework for understanding supply chain strategy design that separates between ‘architecture’ (planning) and ‘design’ (execution) and concluded that supply chain design concept cannot be generalised within a single ‘dimension’. The topic for future research identified in this most recent study is to uncover the factors driving supply chains, through exploring various pieces that orchestrate the overall supply chain architecture and design, by investigating the ‘underlying factors’ and ‘salient dimensions’.

- External dimension (ExD)
- Salient dimension (SaD)
- External element (EE)
- External factor (EFa)
- External force (EFo)
- Underlying factor (UF)

### 3.9.12 Operational efficiency

The process of determining the underlying factors of salient dimensions in supply chain strategy formulation, should be focused on preserving core-activities and outsource non-core activities (Gilley and Rasheed, 2000). For example, third party logistic partnerships enable cost reduction combined with improvement in service and operational efficiency (Sheffi, 1990).

- Transport and logistics strategy (TLS)
- Transportation and logistics integration strategic elements (TLISE)
3.9.13 Level of integration

In this context, further investigation of a potential ‘fit’ between companies outsourcing intensities and vertical strategic integration could strengthen existing understanding of the problem (Gilley and Rasheed, 2000). Strategic alliances are also an essential component of supply chain strategy (Razzaque and Sheng, 1998). Since greater collective operational activities need to be advanced through supply chain alliances, then the strategic problem of integration grows into one of a degree (Frohlich and Westbrook, 2001). Without an overarching strategy it is unlikely that supply chain participants will achieve best performance (Frohlich and Westbrook, 2001), however, the right level and form should be identified to optimise performance (Jayaram and Tan, 2010).

- Outsourcing through abstention (OTA)
- Fit, intensity and integration (FOI)
- Integration as a method for integrating strategic choices (IMSC)

3.9.14 Strategic enterprise

The process of merging distinct operational areas into the supply chain operational area creates an urgency to integrate the information and physical flow into relationships that link these areas with supply chain partners (Bozarth et al., 2009). Pathak et al. (2007) designed the CASN framework, however, a framework development is required in the context of models such as case study and action research. The frameworks reviewed (Martínez-Olvera and Shunk, 2006, Martínez-Olvera, 2008, Perez-Franco et al., 2010, Narasimhan et al., 2008) measure and evaluate performance in the context of strategy reformulation. A framework is required that would evaluate and measure performance of integrating supply chain participants (Sukati et al., 2012), where performance depends on all supply chain participants (Lee and Billington, 1992) and requires measurement system for supply chain design (Beamon, 1998).

- Identification of best candidates (IBC)
- Networked organisation (NO)
- Trust and commitment (TC)
- Interdependence and organisational compatibility (IOC)
3.9.15 Greenfield project performance

Existing frameworks such as Kaplan and Norton (1996), which was expanded by Brewer and Speh (2000), are applicable to specific supply chain categories. These frameworks are not applied to evaluate strategy formulation where measuring performance in effect refers to forecasting performance. The existing supply chain performance measures are developed in a specific supply chain context (van Donk and van der Vaart, 2005) or for categorising existing performance measures (Shah and Singh, 2001). In this context, the most advanced performance measurement system identified is the SCOR model (SCC, 2001) because the model is applied to industry and has evolved through feedback from industry. The balanced scorecard framework (Kaplan and Norton, 1996) also represents an advanced approach for measuring performance, but disregarded measures, such as flexibility and feasibility. In an uncertain market demand and continuous new product development, flexibility and feasibility should also be included in the performance measures (Beamon, 1999).

- Supply chain performance measures and evaluation (SCPME)
- Greenfield project performance measures (GPM)

3.9.16 Categorising activities

Supply chain competences also lead to diverse performance advantages in various business environments (Closs and Mollenkopf, 2004), but the same practices and patterns cannot be applicable in every industry context to achieve superior performance (Vickery et al., 2003, Van der Vaart and van Donk, 2008, Nikulin et al., 2013). Factors that improve performance in the context of supply chain integration and performance have been categorised into attitudes, practices and patterns (Van der Vaart and van Donk, 2008). The relationship between these clusters remains elusive and the number of concepts, factors and measures, could be further validated through qualitative case study research.

Formulating supply chain strategies with a singular focus, such as integration and performance (Frohlich and Westbrook, 2001), represents limitations (Rosenzweig et al., 2003, Perez-Franco et al., 2010, Childerhouse and Towill, 2011), because various supply chain aspects should be considered in the design and formulation stage, and supply chain integration activities have a unique set of benefits (Swink et al., 2007).

- Greenfield project Formulation (GF)
3.9.17 Strategy implementation

Strategic integration represents an effective method for implementing strategic choices (He and Lai, 2012), however, further research is required to include the relationship of ‘change’ in culture and structure to integration. Nikulin et al. (2013) described an algorithm for selecting best supply chain integration strategy for scenarios when problems occur. However, the algorithm is limited on problem scenario measurement and ignores the vast list of measurements in existing literature. The soundness and the logic behind this approach could be applied as a tool to build upon a conceptual framework for supply chain strategy. Such a framework should embrace collaborative commerce and synchronisation of supply chain information flow, promoting flexibility and effectiveness (Kim, 2006, Frohlich and Westbrook, 2001, Vickery et al., 2003, Manthou et al., 2004, Al-Mudimigh et al., 2004).

3.9.18 Environmental dimensions

Supply chain formulation must anticipate product and product family (PF) in the design process, while supply chain architecture must anticipate the operating cost (BPOC) in the process of determining the best product (Lamothe et al., 2006). Product quality control can improve the overall performance of a supply chain (Liu and Hipel, 2012) and can be monitored through a hierarchical decision framework. Cost efficiency is the mostly pursued in the current climate (Lo and Power, 2010) challenging the Fisher (1997) method. The result invites a new insight for analysis.

The product development design must anticipate design for environment, design for disassembly (DE-DD) (Clendenin, 1997), and the context of ‘end of life management’ (Srivastava, 2007). In a formulation context, the reverse journey of empty containers could be optimised (Zsidisin and Siferd, 2001), specifically in terms of return of reusable units.
(Clendenin, 1997) and avoidance of disposal costs (Lee et al., 1997) aimed at reducing waste, saving on cost, and creating competitive advantages (Rao and Holt, 2005).

Supply chain strategy formulation should be focused on: (1) optimising the company strategy and service elements (Korpela et al., 2001b), and anticipating customer behaviour in uncertain demand scenarios (Bogataj and Bogataj, 2001); (2) the relationship between buyer and supplier (Van der Vaart and van Donk, 2008, Closs and Mollenkopf, 2004); (3) the supply chain functions must be based on the business model and the business model must be based on the targeted market (Martínez-Olvera and Shunk, 2006); (5) the supply chain integration strategy must be based on the market and product strategies (Narasimhan and Kim, 2002).

- Strategy Dimensions (StD)
- Business environment (BE)
- Postponement strategy and market demand (PS-MD)
- Market and distribution planning (MDP)

The critical summary of literature reviewed resulted in identifying and outlining in the bullet points the main themes necessary for generating a new theory on the subject area researched in the thesis. The literature review in this chapter is outlined in a summary table of issues discussed or highlighted in existing literature Table 3-1 (see Appendix A, Table A-1 for a more detailed description) and categorised in research areas that highlighted the research focus and enabled the process of identifying the gaps in existing literature on the subject area.

Table 3-1 links authors to themes and represents the categories of the reviewed literature into subjects. The emerging categories identified (in Table 3-1) summarised the gaps in the literature and are translated into a diagram in Figure 3-1 to enable the process of building conceptual diagrams of gaps in literature as the preliminary stages of building the research framework.
| ISSUES DISCUSSED or HIGHLIGHTED by the AUTHORS | Strategy formulation | Supply chain strategy formulation | Holistic supply chain strategy formulation | Supply chain strategy reformulation | Supply chain strategy absence | Supply chain formulation criteria | Supply chain evaluation criteria | Evaluate the salient dimensions | Relate external /salient dimensions | Supply chain as a conceptual system | Supply chain strategy formulated through activities | Tacit knowledge in strategy formulation | Integrated strategy formulation | Supply chain decomposition | Supply chain architecture | System architecture and integration design |
|-----------------------------------------------|----------------------|----------------------------------|------------------------------------------|----------------------------------|----------------------------|--------------------------------|--------------------------------|---------------------------------|---------------------------------|-------------------------------------|----------------------------------|----------------------------------|-----------------------------------|-------------------------------|--------------------------------|
| Al-Mudimigh et al. (2004)                     | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Bardi and Tracey (1991)                      | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Bartolomei et al. (2007)                     | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Bogataj and Bogataj (2001)                    | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Bourgeois (1980)                             | X                    |                                  | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Bowersox and Closs (1996)                    | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Bozarth et al. (2009)                        | X                    |                                  | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Brewer and Speh (2000)                       | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Bryceson and Slaughter (2010)                 | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Chen and Paulraj (2004)                       | X                    |                                  | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Childerhouse and Towill (2011)                | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Cigolini et al. (2004)                       | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Clendenin (1997)                             | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Closs and Mollenkop (2004)                    | X                    | X                                | X                                        | X                                | X                          | X                              | X                              | X                               |                                  | X                                   | X                                 | X                                 | X                                | X                             |
| Daugherty and Pittman (1995)                  | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Dess (1987)                                  | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Dotoli et al. (2005)                         | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Dubois et al. (2004)                         | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Ernst and Kamrad (2000)                       | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Fisher (1997)                                | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Frohlich and                                 | X                    | X                                | X                                        | X                                | X                          |                                 |                                 |                                 |                                                 | X                                   | X                                 | X                                 | X                                | X                             |
| Reference                      | 
|-------------------------------|---|
| Westbrook (2001)              | X X X |
| Fuller et al. (1993)          |     |
| Gavirneni and Tayur (1999)    |     |
| Gilley and Rasheed (2000)     |     |
| Hafeez et al. (1996)          | X X X X X X X X X X X X |
| Ivanov (2009)                 | X   |
| Jayaram and Tan (2010)        | X   |
| JB and Hilmer (1994)          | X   |
| Kaplan and Norton (1996)      |     |
| Kim (2006)                    | X X X X X |
| Korpela et al. (2001a)        | X X |
| Korpela et al. (2001b)        |     |
| Kouvelis (1999)               | X X X X |
| Lai (2012)                    | X X X X X X X X X X X X |
| Lamothe et al. (2006)         | X X |
| Lee et al. (1997)             | X   |
| Lerptattarapong (2002)        | X X X |
| Liu and Hipel (2012)          |     |
| Lo and Power (2010)           |     |
| Manthou et al. (2004)         | X X X X |
| Martínez-Olvera and Shunk (2006) |     |
| Mckone et al. (2009)          | X X X X |
| Melnyk et al. (2013)          | X   |
| Mentzer et al. (2001)         | X X X X X X X X |
| Miller and Friesen (1978)     |     |
| Narasimhan (1983)             | X X X X |
| Narasimhan et al. (2008)      | X X X X X X X X X X|
| Nikulin et al. (2013)         | X X X X X X X X X X | X X |
| Pathak et al. (2007)          |     |
| Perez-Franco et al. (2010)    | X X X X X X X X X X |
| Perona et al. (2001)          | X   |
| Petroni and Braglia (2000)    | X X X X |
| Pettigrew (1977)              |     |
| Platts et al. (1996)          |     |
| Prajogo and Olhager (2012)    | X X X |
| Pugh (1990)                   |     |
| Qi et al. (2011)              | X X X X X X X X X X |
| Qu et al. (2010)              | X   |
Table 3-1: Summary table highlighting identified gaps in the research area

The methods and methodological approaches discussed in the review are aimed at addressing various supply chain problems. These are critically appraised above, with specific observations against each approach, to identify limitations and areas for further research in the field of supply chain strategy. Observations against each approach are presented in Table 3-1 (and in more detail in Table A-1). The process of relating themes to authors and outlining the themes into summary tables, enabled this study to identify the themes least covered in existing literature and present them in the form of a diagram (Figure 3-1).
Figure 3-1: Conceptual diagram of gaps identified in the research subject area
The process of theory generation on the gaps outlined in (Figure 3-1) starts by deriving with a number of postulates that are applied in the research methodology.

First postulate: in greenfield formulation, to understand the companies’ real strategies a researcher must firstly be informed of their activities. Existing literature states that the core of strategies is in the activities and the methods they use in applying their activities differently to rival companies (Porter, 1996, Cigolini et al., 2004, Andrews, 1982, Baumard, 1999, Perez-Franco et al., 2010).

Second postulate: to understand how strategy is formulated, ‘tacit knowledge’ should be considered as instrumental in distinguishing between the description of strategies and the actual happenings. The importance of ‘tacit knowledge’ has been extensively mentioned in existing literature (Baumard, 1999, Harrison, 2005, Tsoukas, 2005, Perez-Franco et al., 2010). To extract ‘tacit knowledge’ a case study, open or semi structured interviews can be applied. Harrison (2005) stated that a case study, open or semi structured interviews are valid and the most useful method of obtaining the data of how managers apply new practices to the strategy, while a triangulating data gathering approach can be applied to capture different viewpoints.

Third postulate: supply chain strategy can be formulated as a conceptual system where the formulation is based on a conceptual diagram and a conceptual model that can be based on the ideas, plans and abstract concepts. The idea of designing a supply chain conceptual system for the purpose of formulating a supply chain strategy as a systematic model by applying inductive approach is compliant with existing literature for developing a supply chain framework by applying a grounded theory and action research to an inductive reasoning approach (Glaser and Strauss, 1967, Gummesson, 2000, Goulding, 2002, Charmaz, 2006, Perez-Franco et al., 2010).

Fourth postulate: the supply chain relevant sectors are sufficient for applying the findings to the phenomenon of interest in this research context (Cigolini et al., 2004, Perez-Franco et al., 2010).

Fifth postulate: formulation contains vision and goals that represent the formulation where the vision is the central idea of the formulated strategy (Perez-Franco et al., 2010) but the strategic goals are representative of the participants and the goals determine the central idea (Mentzer et al., 2001, Narasimhan et al., 2008). This postulate is based on findings that
companies are directing their efforts to accomplish the strategic vision by implementing the strategic goals but in the integration of multiple participants, the implementation of the strategic goals represents a set of individual central ideas; those are directing the efforts to accomplish the strategic vision.

Sixth postulate: the strategic vision relies on the strategic goals and the goals are foundations of the formulated strategic vision that is determined by the strategic goals (Inkpen and Choudhury, 1995), where the goals represent a set of ideas incorporated in the strategy that; supplement, assist and enable the strategic core (Martínez-Olvera and Shunk, 2006, Schnetzler et al., 2007, Martínez-Olvera, 2008, Perez-Franco et al., 2010).

3.10 Conclusion

This review of theories, models and methodologies on various aspects of supply chain strategy identified a number of potential supply chain strategy research topics. The wealth of research on closely related topics (supply chain architecture, design, development, reformulation, realignment, integration etc.) leaves a lack of detailed methodology for greenfield project supply chain strategy formulation. The review of multiple obstacles and difficulties identified a gap in existing literature concerning how a commercial organisation would commit to addressing these multiple obstacles in a greenfield context, with high volatility and risk, without a formulation framework that would enable commercial feasibility assessment and performance forecasting. The interdisciplinary aspects, the phenomenon of strategy abstention, the issues with adapting and aligning supply chain principles and the continuous competitive pressures from the business environment, created the rationale for investigating how the formulation of integrated supply chain strategy in a greenfield context, is related to the overall business strategies and supply chain performance of individual participants.

This chapter reviewed relevant literature to the topic of the thesis and explained the development of supply chain strategy as a discipline. Within that discipline the requirement to integrate and develop organisational competences to deliver value, including the main improvement techniques, methods and methodologies were described. The immediate discipline of supply chain strategy process formulation (3.3) and integration (3.8), including the logistics (3.6) and performance (3.7) aspects were discussed. The literature review
coverage resulted in the description of the research roadmap framework (3.9) to address the research aims and objectives in this thesis.

The summary table (Appendix A, Table A-1) represents the process in this thesis of categorising the literature reviewed into recognisable clusters. The categories were critically analysed and multiple research problems identified. The research framework (3.9) outlines approaches to overcome the identified research problems. Summary tables were developed to firstly highlight the research area (Table A-1) and secondly to highlight the gaps in the subject area (Table 3-1) Finally, conceptual diagrams were used to identify and clarify the gaps in existing literature (Figure 3-1) The following chapter describes the research methodology and provides justification for the research paradigm applied. The results from the critical appraisal will be considered in Chapter 4.
Chapter 4 Research methodology

4.1 Introduction

This chapter presents the research methodology employed for building and validating the conceptual framework. It includes justification for the methodology, details of the methodology ethical considerations for the research and chapter conclusions. The methodology described is consistent with Eisenhardt (1989) guidance on developing management theories. The data collection process is described and includes the units of analysis and the pilot study undertaken. Details are provided to address questions related to reliability and validity. The data checking processes are described including the recording techniques and data transformations which are followed by a discussion of the missing data and tacit knowledge found in the responses. Finally, the data analysis techniques applied are outlined, followed by a discussion as to why these techniques are selected.

4.1.1 Research framework

The summary table of research gaps in the subject area (Table 3-1) are transcribed into a concept diagram (Figure 3-1) before the findings from the reviewed literature are summarised into building blocks and drawn into diagram of research problems (Figure 4-1) and related to the identified gaps in existing literature (Figure 4-2)
Figure 4-1: Research framework
<table>
<thead>
<tr>
<th>Research framework key</th>
<th>Table 4-1: Research framework key</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Std: Strategy Dimensions</strong></td>
<td></td>
</tr>
<tr>
<td>BE: Business environment</td>
<td></td>
</tr>
<tr>
<td>ExD: External dimension</td>
<td></td>
</tr>
<tr>
<td>SaD: Salient dimension</td>
<td></td>
</tr>
<tr>
<td><strong>GF: Greenfield project</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Formulation</strong></td>
<td></td>
</tr>
<tr>
<td>SA: Strategy absence</td>
<td></td>
</tr>
<tr>
<td>CS: Corporate strategy</td>
<td></td>
</tr>
<tr>
<td>SCSA: Supply chain strategy articulation</td>
<td></td>
</tr>
<tr>
<td>PAO: Participants aims and objectives</td>
<td></td>
</tr>
<tr>
<td><strong>FE: Formulation Elements</strong></td>
<td></td>
</tr>
<tr>
<td>FCr: Formulation criteria</td>
<td></td>
</tr>
<tr>
<td>NO: Networked organisation</td>
<td></td>
</tr>
<tr>
<td>TC: Trust and commitment</td>
<td></td>
</tr>
<tr>
<td>IOC: Interdependence and organisational</td>
<td></td>
</tr>
<tr>
<td>compatibility</td>
<td></td>
</tr>
<tr>
<td>IBC: Identification of best candidates</td>
<td></td>
</tr>
<tr>
<td>CSCIOI: Conceptual supply chain inter-</td>
<td></td>
</tr>
<tr>
<td>organisational integration</td>
<td></td>
</tr>
<tr>
<td><strong>FCo: Formulation Concepts</strong></td>
<td></td>
</tr>
<tr>
<td>CE: Capabilities evaluation</td>
<td></td>
</tr>
<tr>
<td>EE: External element</td>
<td></td>
</tr>
<tr>
<td>EFa: External factor</td>
<td></td>
</tr>
<tr>
<td>EFo: External force</td>
<td></td>
</tr>
<tr>
<td>UF: Underlying factor</td>
<td></td>
</tr>
<tr>
<td><strong>FI: Formulation Implementation</strong></td>
<td></td>
</tr>
<tr>
<td>AA: Adapting and aligning</td>
<td></td>
</tr>
<tr>
<td>OASA: ontological approach for semantic</td>
<td></td>
</tr>
<tr>
<td>alignment</td>
<td></td>
</tr>
<tr>
<td><strong>DSCHT:</strong></td>
<td></td>
</tr>
<tr>
<td>Decomposing supply chain into hierarchical</td>
<td></td>
</tr>
<tr>
<td>three</td>
<td></td>
</tr>
<tr>
<td><strong>PR:</strong> process of getting from the present to</td>
<td></td>
</tr>
<tr>
<td>the required stage</td>
<td></td>
</tr>
<tr>
<td><strong>CSSCD:</strong> Conceptual system for supply chain</td>
<td></td>
</tr>
<tr>
<td>decomposition</td>
<td></td>
</tr>
<tr>
<td><strong>MF:</strong> Conceptual framework approach</td>
<td></td>
</tr>
<tr>
<td><strong>PSaD:</strong> Preliminary salient dimensions</td>
<td></td>
</tr>
<tr>
<td>PF: product and product family</td>
<td></td>
</tr>
<tr>
<td>BPOC: best product operating cost</td>
<td></td>
</tr>
<tr>
<td>DE-DD: design for environment and design for</td>
<td></td>
</tr>
<tr>
<td>disassembly</td>
<td></td>
</tr>
<tr>
<td>PS-MD: postponement strategy and market demand</td>
<td></td>
</tr>
<tr>
<td>MDP: market and distribution planning</td>
<td></td>
</tr>
<tr>
<td><strong>TLS: Transport and logistics strategy</strong></td>
<td></td>
</tr>
<tr>
<td>TLSE: transportation and logistics</td>
<td></td>
</tr>
<tr>
<td>integration</td>
<td></td>
</tr>
<tr>
<td>strategic elements</td>
<td></td>
</tr>
<tr>
<td>SCA: supply chain agility</td>
<td></td>
</tr>
<tr>
<td><strong>SCPME: Supply chain performance measures and evaluation</strong></td>
<td></td>
</tr>
<tr>
<td>GPM: Greenfield project performance measures</td>
<td></td>
</tr>
<tr>
<td><strong>SCI: Supply chain integration</strong></td>
<td></td>
</tr>
<tr>
<td>OTA: Outsourcing through abstention</td>
<td></td>
</tr>
<tr>
<td>FOI: fit, intensity and integration</td>
<td></td>
</tr>
<tr>
<td>CFE: Capture the essence and forecast the effect</td>
<td></td>
</tr>
<tr>
<td>of supply chain integration and performance</td>
<td></td>
</tr>
<tr>
<td>CGSI: Characterise Greenfield project</td>
<td></td>
</tr>
<tr>
<td>supply chain strategy and integration</td>
<td></td>
</tr>
<tr>
<td><strong>BCAO:</strong> Barriers to change and approaches to</td>
<td></td>
</tr>
<tr>
<td>overcome</td>
<td></td>
</tr>
<tr>
<td>IMSC: integration as a method for integrating</td>
<td></td>
</tr>
<tr>
<td>strategic choices</td>
<td></td>
</tr>
<tr>
<td>STPC: Separation in space, time, parts and</td>
<td></td>
</tr>
<tr>
<td>conditions</td>
<td></td>
</tr>
<tr>
<td>PC-VC: Process chain and virtual eChain</td>
<td></td>
</tr>
</tbody>
</table>
The gaps in literature (Table 3-1) were used to design the research framework for this study (Figure 4-1). The findings and are shown in Figure 4-2.

![Combined conceptual diagram of gaps in the subject area and research framework for identifying the aims, objectives and postulates of the research study](image)

**Figure 4-2:** Combined conceptual diagram of gaps in the subject area and research framework for identifying the aims, objectives and postulates of the research study

### 4.1.2 Summary of the analysis of option

There are various research approaches designed for specific research strategies. A general overview, description and distinction of various research paradigms and approaches are outlined in (Table 4-2) based on interpretations of existing literature (Saunders et al., 2011).
Table 4-2: Research paradigms and strategies (Saunders et al., 2011)

The philosophical aspects of the research paradigms considered in this study are categorized into positivism, post-positivism, constructivism and critical theory (Table 4-3). These can be distinguished through the differences in ontology, epistemology and methodology (Guba, 1990, Creswell, 2009).

<table>
<thead>
<tr>
<th>Ontology</th>
<th>Positivism</th>
<th>Post-positivism</th>
<th>Constructivism</th>
<th>Critical Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistemology</td>
<td>Realism</td>
<td>Critical Realism</td>
<td>Relativism</td>
<td>Critical Realism</td>
</tr>
<tr>
<td>Objective</td>
<td>Modified</td>
<td>Subjectivism</td>
<td>Subjectivism</td>
<td>Subjectivism</td>
</tr>
</tbody>
</table>
Dualism | Objectivism
---|---
Experimental and Manipulative | Modified Experimental and Manipulative | Hermeneutic and Dialectic | Dialogic and Transformative

Table 4-3: Research paradigms

There are also ethical, axiological, rhetorical, and aesthetic qualities associated with the research paradigms that further define them. However, the discussion of these distinctions is reserved to the methodological distinctions used in the thesis.

This study applied critical realism and asserted that the nature of reality is independent of human existence, thus the reality can be understood and verified through sensory perception and rational thought, ontology based on ideas of materialism and physical absolutes (Guba, 1990). The critical realism approach applied is similar to realism, but with built-in scepticism and self-awareness. This research relied on multiple sources to reduce distortions in the research, analysis and interpretations. The subjectivist epistemology was used in the research methodology and rejected the objectivist scepticism of knowledge correlation in the real world and considered understanding to be created through discursive interaction in human life (Creswell, 2009).

The methodology, used to some degree, reflects the modified experimental methodologies because of the incorporation of ideas of critical multiplism, the estimation of natural settings, the use of grounded theory, the incorporation of qualitative data and the establishment of discovery in the research process (Guba, 1990). Nevertheless, the transformative methodology used guided the research into understanding of human relations and potentials through didactic, dialogic inquiry resulting in social change (Guba, 1990).

The research methodology applied in the thesis is also related to the constructivism in the way that it applies case study and grounded theory to identify patterns of complexities to generate new ideas (Creswell, 2009). The similarity of this thesis with constructivism is that the aim is not to predict the real world, but to reconstruct the real world at a point in time that really exists, as a representation of a period of time in the minds of the constructors (Creswell, 2009). However, the logical emerging question is: to
what use is such understanding of the world if it makes little difference to those in need of it.

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Positivism</th>
<th>Post-positivism</th>
<th>Constructivism</th>
<th>Critical Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Experiments and Surveys</td>
<td>Experiments, Surveys, Observation studies</td>
<td>Phenomenology, Case Study, Ethnography, Grounded Theory</td>
<td>Action research</td>
</tr>
<tr>
<td></td>
<td>Measurements, Observation, Structured questionnaires and interviews</td>
<td>Measurements, Observations, Structured questionnaires and interviews</td>
<td>Open-ended questions, Collection of qualitative data, recordings of observations and impressions</td>
<td>Interviews, Measurements, Focus group interviews, Community, organisation and action</td>
</tr>
</tbody>
</table>

Table 4-4: Research paradigms methodologies and methods

The difference between the research approach in this thesis and constructivism, is that this research aims to develop ideologically oriented inquiry into the research topics that constructivism cannot address, such as creating a universal reality, in a subjective topic, while recognising that individuals perceive the world distorted by the frame of one’s own values, thus, the research belongs to the critical theory paradigm (outlined in Table 4-4). To avoid marginalising individual perceptions and eliminate personal bias, subjects are perceived as participants, and the research study as a collaborator that organises data around the common points of view. In the process, operationalisation and real life activities are brought to light and judgements are made in concerns of which features can be altered.

To achieve the outlined, a qualitative research methodology was chosen because of the strengths in addressing the chosen topic and the research area (outlined in Table 4-5).

| Qualitative – quantitative research methodology: the interactive continuum |
|--------------------------|--------------------------|
| Qualitative research     | Quantitative research    |
| Inductive form of reasoning: develop concepts, insights and understanding from patterns in the data | Deductive form of reasoning: assesses preconceived models, hypothesis and theories |
| Emic perspective of enquiry: derive meaning from participants perspective | Etic perspective: meaning determined by the researcher |
| Idiographic              | Nomothetic               |
| Reality is subjective    | Reality is objective     |
| Captures and discovers meanings | Tests hypothesis |
Concepts are represented as themes, motifs and categories

Attempts to understand phenomena

Observations determined by the settings and modified to enrich understanding

Data is represented as words and quotes from transcripts

Unique, flexible and evolving research design, cannot be exactly replicated

Data analysed by extracting themes and categories

The unit of analysis is holistic and focused on the relationship between elements, and contexts. The whole is more than the sum

Based on interpretations from: Neuman and Kreuger (2003), Denzin (2006)

<table>
<thead>
<tr>
<th>Study Dimensions</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose of the study</td>
<td>Theory building</td>
</tr>
<tr>
<td>Paradigm</td>
<td>Interpretivist, anti-positivist, critical theory</td>
</tr>
<tr>
<td>Type of investigation</td>
<td>Pattern seeking</td>
</tr>
<tr>
<td>Extent of researcher interference</td>
<td>Case study, action research</td>
</tr>
<tr>
<td>Study setting</td>
<td>Field study</td>
</tr>
<tr>
<td>Unit of analysis</td>
<td>Organisational level</td>
</tr>
<tr>
<td>Sampling design</td>
<td>Non-probability, snowball sampling</td>
</tr>
<tr>
<td>Time horizon</td>
<td>Snap-shot, cross sectional study</td>
</tr>
<tr>
<td>Data collection methods</td>
<td>Methodological and data triangulation</td>
</tr>
</tbody>
</table>

Table 4-5: Qualitative vs quantitative research methodologies continuum

4.1.3 Justification for the methodology

This section describes the research methodologies used in undertaking the theory building and validation, or more specifically, how the case study, action research and grounded theory methods can be applied to formulate a practical research strategy. Real life constraints on supply chain data access ability guided this study towards a theory building approach similar to Eisenhardt (1989). A description of the main study dimensions of this work can be seen in Table 4-6. The justification for the selection of the study descriptors presented in the Table 4-6 is borrowed from relevant literature on research methodology (Eisenhardt, 1989, Guba, 1990, Yin, 2003, Saunders et al., 2011, Creswell, 2009). The main research processes applied in this study therefore is consistent with case study, action research and grounded theory as recommended by the literature for theory building approach used in this thesis (Eisenhardt, 1989).
Table 4-6: Research methodology dimensions and descriptors

The merits of the chosen research approaches are discussed in great detail in this chapter.

4.1.4 The purpose of the study

The purpose of this thesis is to understand and explain the nature of the relationships that exist between business and supply chain strategies in a greenfield context, considering formulation and integration variables. The variables used in the thesis are identified from the literature review as the most needed in order to answer the research questions posed in section 1.7 above.

4.1.5 Type of investigation

Research philosophy represents the process applied for data gathering, using and analysing. Two major research philosophies are present in Western scientific research tradition, namely positivist (or scientific) and interpretivist (or anti-positivist). This study belongs to the interpretivist philosophy.

The first step of the investigation involved identifying the cause of the observed variation of strategy absence and the relationship with the variables considered: formulation and integration. However, obtaining permission from senior executives to manipulate the operating business and supply chain strategy of several companies in the same supply chain is highly unlikely. Therefore, case studies have been used to undertake actual research, while generalisability relevance has been constantly addressed with grounded theory approach to ensure validity in a complex and dynamic supply chain environment.
4.2 Theory triangulation

4.2.1 Grounded theory

The sociologists Barney G Glaser and Anselm L Strauss developed grounded theory in 1960, while working on the book ‘Awareness of Dying’ and exposed the details of the procedure in their subsequent book ‘The Discovery of Grounded Theory’ (Glaser and Strauss, 1967). Grounded theory represents a theory that is developed inductively from a mass of data and is the most commonly used analytic technique in qualitative analysis (Gibbs, 2008). To clarify the grounded theory approach, Glaser and Strauss (2009) stated that grounded theory is the study of a concept and not a descriptive study of a descriptive problem. However, while grounded theory in Glaser and Strauss (1967) represents an approach for theorising on how the world is represented, Charmaz (2006) perceived the approach as how the responders in the sample population perceived the world. Grounded theory design can also represent a systematic qualitative approach to generate theory that explains, on a conceptual level, a process, action or interaction on a substantive topic and is used for broad theory and explanation of a process (Creswell and Garrett, 2008).

4.2.1.1 Dominant grounded theory designs

There are three dominant grounded theory designs:

First is Glaser’s approach that claims that ‘all is data’ which contributes to a substantive area that can be used in the process, including data from scientific literature. The method is not limited to qualitative research, instead the method emphasises the conceptualisation abstract of time, space and people (Glaser, 2005). The Glaser approach represents a constant comparative data analysis method where the researcher moves back and forward in the data collection and gradually progresses from coding to conceptual categories and theory development. The advantage of this approach is that minor incidents in the coding can be compared and coded with previous incidents to generalise theoretical properties of the category.

Second is the Strauss and Corbin approach for ‘systematic design’ where the emphasis is placed on the use of data analysis stages of open, axial, and selective coding to develop
a logical paradigm and a visual picture of the theory generalised (Corbin and Strauss, 1990). The data analysis involves open coding, where data is divided into segments and analysed for cohesions that reflect categories or themes. After categorising the data, properties are evaluated to characterise individual categories. This process enables the reduction of the collected data to a smaller set of categories or themes that describe the phenomenon investigated.

Third is constructivist grounded theory and is based on pragmatism and relativist epistemology. The approach assumes that data and theories are not discovered but constructed by the researcher and the participants in the process of interaction in the field (Charmaz, 2006). This assumption is supported by the argument that data constructs are representative of the researcher and participants perspectives, interactions, positions, values and geographical locations and assumes multiple realities and multiple perspectives of these realities. In this approach, literature can be used in a data sensitive method to avoid forcing literature on the data (Thornberg, 2012).

4.2.1.2 Grounded theory approach in this thesis

The earliest grounded theory, building theory from case study, an approach found in Glaser and Strauss (1967) claimed that comparative analysis can be applied to generate middle-range substantive and formal theories. The lack of actionable advice and clarity in how the research can be successfully performed in Glaser and Strauss's (1967) is addressed by (Brytting, 1991) who has provided and successfully applied a comprehensive diagram for applying grounded theory to build theories. The study referred to Brytting (1991) diagram, in the research approach. Bryttig's (1991) suggested analysing secondary data to design preliminary theory through theoretical sampling and cross case analysis. The research methodology, followed by the development and theory testing of the method for formulating supply chain strategy, is applied in this study following the approach recommended by Brytting (1991) where;
Table 4-7: Theory building approach

Other studies have been consulted (Goulding, 2002), in the pursuit of detailed procedures on how to build and apply the grounded theory to formulate new methodology and in the process recommendations from existing literature have been followed to ensure design validity. As a result, grounded theory was conducted by applying multiple methods for data collection, marking the main points with a series of codes and grouping them into concepts, then formulating categories which served as the foundations of the theory. The process involved firstly identifying the process to study (1.5, 3.9 and Appendix A, Table A-1) secondly obtaining approval and access (Chapter 2), thirdly conducting theoretical sampling (4.5), fourthly coding the data using selective coding to develop the theory (Chapter 5, Chapter 7, Chapter 8 and Chapter 9) and finally validating the theory and writing the results in the thesis (Chapter 9).

The approach in this thesis is also closely compliant with Eisenhardt’s (1989) guidance for producing a ‘mid-range’ theory with case study research. In the Eisenhardt (1989) method the researcher develops a number of actual real life case studies for construction of the theory, where theoretical selection is applied to select the cases and after repeatedly applying cross-case analysis the ‘mid-range’ theory is developed. This study developed multiple company case-scenarios and the theory was developed after repeatedly applying cross-case-scenario analysis. The work of Eisenhardt (1989) has extensively been cited and reviewed as a clear and well-structured reference for designing academic theory from case study research.

Eisenhardt (1989) applied previous research studies from qualitative data analysis (Miles and Huberman, 1984b), case study research (Yin, 1981), and grounded theory (Glaser and Strauss, 1967), to create guidance on developing management theories with the development strategy involving eight phases: getting started, selecting cases, crafting instruments and protocols, entering the field, analysing data, shaping hypotheses,
enfolding the literature, and reaching closure. Eisenhardt’s (1989) guidance represents two corresponding similarities with this thesis: (1) analysing a cross company case study, the research commenced without detailed theory, but only with the initial research question, and (2) case study research is performed to aggregate findings to a single mid-range theory.

In a later study, Eisenhardt and Graebner (2007) highlighted the applicability of various distinguishing ways for building theory from cases, labelling the usual challenges, and recommending potential solutions for measuring and testing, through relating inductive and deductive theoretical propositions: ‘inductive and deductive logics are mirrors of one another, with inductive theory building from cases producing new theory from data and deductive theory testing completing the cycle by using data to test theory.’ (Ibid., p.25).

4.2.2 Case study research

Case study research represents an investigation without experimental control or manipulation of the phenomenon researched, and if the boundaries of the phenomenon and the context are not obvious, the boundaries can be defined after formulating the question (Benbasat et al., 1987). Meredith (1998) established that case study methods can be applied to areas of research where few studies have been performed previously. Such an option enables an investigation into existing methods and methodologies for addressing the greenfield project formulation problem. Furthermore, the case study research enables the use of secondary data from studies performed previously. The ability to research a case as an area of research where studies have been performed previously, creates ‘outstanding strengths’ (Meredith, 1998), which is instrumental in narrowing the scope of the strategy formulation problem in supply chain context. The process of how supply chain strategies are formulated in industry presents very little or almost no possibility for the researcher to control the events or influence the results. The lack of control over the events leads to uncertainty and creates a greater value in having the flexibility to apply multiple research methods, but not the obligation, depending on various formulation scenarios.
Formulating a supply chain strategy for greenfield projects, implicates complexity and uncertainties arising from investigating a concept in a real-world scenario. The relationship between the formulation of a supply chain and business strategy, in the context of greenfield project integration strategy, are not clearly evident. For such scenarios, the case study research provides flexibility in analysing various sources of data (Benbasat et al., 1987). Addressing these complexities, and uncertainties, requires approaching the supply chain formulation topic from a new perspective and abandoning the traditional practices that have been applied in existing supply chain literature to seek conceptual validity.

A case study approach enables ‘examining closely the hypothesised role of ‘causal mechanisms’ (George and Bennett, 2005). Investigation of the supply chain as a system of different parts, from the sum of activities, enables systematising the causal mechanisms in a manner that they create a particular type of outcome, such as overall strategy. George and Bennett (2005) claimed that a case study is as an occurrence of a course of activities, such as a phenomenon with scientific importance, that the researcher selects to investigate, with the objective of developing a theory or new understanding. The phenomenon of scientific interest selected in this study is the occurrence involved in determining the operational activities of individual participants, comprising the formulation and the relations between the activities and the participants. Through focusing on the activities this research examines and assesses how the introduction of one activity affects a conceivably complex configuration of equally independent activities from different entities as a direct result.

Gerring (2007) claimed that a researcher cannot develop a valid research question without a general awareness of all elements. Yin (Yin, 2003) supported this view by claiming that a case study research design must comprise of five elements; ‘study’s question, its proposition, its units of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings’. Yin (2003) also stated that these elements will successfully impose the assembling of an opening theory linked to the subject of the research study. In other words, regardless of whether the study is focused on developing or testing a theory, the preliminary design development stage must start before the data collection stage. The preparation in this research for theory development has taken a long time and the process followed recommendations for

When answering some research questions, the study has been able to apply secondary data, from previous research, to design a conceptual framework for the case study (Chapter 5). The framework involves tasks that need to be addressed in the process of developing a comprehensive greenfield project formulation framework. Secondary data refers to existing data collected for a different purpose and different researcher (Ritchie and Lewis, 2003). The secondary data is applied following existing literature recommendations to create savings in time, finances and work load but also to void duplication of research effort and investment (Given, 2008).

4.2.3 Action research

Action research aided this study in covering the research aspects while simultaneously filling in the gap between the activities investigated in the field and the researched topic. These are expected results from the action research method (Given, 2008). The main challenge in applying the action research method is the process of being involved in the action and reflecting on the action to design theory that is contributing to knowledge (Seuring, 2008). Given (2008) stated that action research with its exceptional access to insider knowledge, allows for the creation of practical knowledge that would lead the strategy of the participating institution and represents a process where the knowledge generated incorporates this exceptional but frequently ignored factor.

The study aims to form a bridge between the participant’s understanding and the generation of theoretical knowledge, while at the same time addressing the strategy absence problem. Forming such a bridge is only possible through action research (Thorpe and Holt, 2008, Given, 2008). The action research approach in this study is the collaborative enquiry branch (Heron, 1996) where the active participants are involved in the research decisions. The research process involves four stages (1) preliminary propositional understanding, (2) practical understanding through observing and recording the activities, (3) experimental understanding through observing individual activities and actions that depart from the original propositions, and (4) reflection phase with the group to re-frame original ideas.
4.3 Units of analysis

The units of analysis are mentioned in (Yin, 2003, p.28) as one of the five elements in case study research design. The data analysis considered and analysed most of the individual responses as individual data sources. The exception is the formulation criteria analysis where responses are grouped in superior candidates and formulation evaluation where responses are analysed through evaluation matrices.

4.4 Case study sample population

The common issue in action research is obtaining access to the information from involved participants. The relationship between the researcher and the supply chain companies, as the researched participants was considered of crucial importance in obtaining the primary and secondary data. The data collection, testing and validating stages of the research have taken longer than anticipated because of the multiple companies participating in the data collection process of formulating a supply chain strategy. Data collection through action research with a consortium of participants comprising a supply chain is demanding both in time and finances. Nevertheless, it represents one of the crucial steps for formulating and validating the methodology for supply chain strategy formulation.

4.4.1 Supply chain strategy architecture as a concept

Through discussions with the executive directors of the supply chain lead company it was confirmed that the elements, factors and forces present in the salient dimensions (Figure 6-15) are shaping their business strategy and business goals. Their business goals were also shaping their supply chain strategy. The preliminary interviews with the executive directors confirmed that their interests for integration in a formulation of a supply chain strategy were caused by their desire to achieve existing goals present in their business strategy.

More specifically, ‘to obtain access to markets’, for which they required a ‘low cost transport’, but through interviews it was also confirmed that the lead company (C1) had no intention to diversify their operations to rail or shipping modes of transports. Their
transportation was observed to involve road transport, even to distant locations and during the interview it was confirmed that this strategic goal could only be obtained through integrating with 3PLs. This aspect of their business strategy presented the need to integrate with the first supply chain formulation participant (C4).

The transportation aspect also required a distribution centre. While such a site was available with planning permission to upgrade the site; the landowner was reluctant to engage in building the distribution centre without a long term commercial contract. The landowner was interviewed and the main interest from aligning with the production company was the commercial aspect of using the brownfield site. The brownfield site was the only suitable location for the distribution centre with access to a rail terminal. The alternative site required rebuilding an old rail line, an extensive building work, and planning permission. The distribution centre aspect of the business strategy brought the second supply chain participant in the formulation (C5).

The lead company also required expert civil engineering skills to process and manufacture the raw product from the production and extracting line to the distribution centre. These operations were observed to be performed through outsourcing, where the interviews confirmed that the cost of outsourcing represents a great percentage of the cost of operations. The process represented outsourcing through ‘abstention’ and supply chain integration was perceived required for reducing the cost of converting the aggregate to the best product for operating cost (6.6) from the product family (6.4.4) and for reaching the required product utilisation rate (2.1.3). This represented the third participant in the formulation (C3).

The last aspect of the business strategy was to secure access to markets. Considering that the break-even point was calculated as 1 million tonnes and the profitable point was calculated as 2 million tonnes (2.1.3), the access to multiple markets in urban areas where demand was highest was considered a crucial requirement. To achieve this business goal, the quarry (producer) required a virtual quarry (retailer) capable of selling the product to multiple locations. Considering the cost and complexity of accessing multiple markets, the integration with an already established retailer was considered as the most valuable and deciding aspect of the formulation. This brought the fifth participant to the formulation (C2).
Considering the outlined, the commercial or strategic aspects of the business strategy are perceived in this study as the main drive for companies commencing on integration in the context of a formulation of a supply chain strategy, or at least these are the drives for the executive directors and the operational level managers. Only when the commercial or strategic objectives are secured, then the supply chain strategy formulation process can start and each participant is focused on achieving the separate goals of their business strategy. This creates the supply chain formulation paradox (1.4), confirmed in Chapter 3 as present in many supply chains.

4.4.2 Representativeness of the sample population

In the process of ensuring coverage of the sample data the investigation focused on representatives. The main concern addressed in the theory building was the diversity of the sample population. The theory building process is not focused on representing a large population; instead, the main concern is the display of variability that is present in the larger population. To address this concern, the investigation continued into the richness of the cross industry section and the sample population representativeness, to determine whether the sample is sufficient to build a commendable theory.

The diversity of the sample population, represented in the supply chain participants, is analysed with reference to the 'Industry Classification Benchmark' to determine the industry representativeness in the sample data from the industries within which the supply chain strategies were operating. The relevant industry elements are extracted though consulting company experts then discussed with multiple academic experts and presented in a conceptual diagram. This step is based on expert opinions and is performed to ensure identification of the explicit and implicit industry involvement in the supply chain formulation. The main goal was to determine whether the findings behind the sample data collected from the sample population displayed sufficient diversity and whether diversity is heavily influenced by the industry to which the company belongs.

In the process, the investigation classified industries into explicit, explicit/implicit and implicit according to their visibility in the supply chain involvement. The following classification involved: industry, super-sector, sector and sub-sector of operations. To
ensure supply chain representativeness in these sectors, the extracted data sample is analysed to ensure that the industry is represented in the sample population categories.

The process determined the relationships between the multiple industry categories represented in the supply chain and enabled the conceptual design to bring the focus to describing these relationships. The process of classifying the industry elements according to the ‘explicit’ ‘explicit/implicit’ and ‘implicit’ operations represented in the categories: industry, super-sector, sector and sub-sector is presented in Table 4-8.

**Table 4-8: Case study sample population diversity**

If the diversity displayed in the sample data findings was established as segmented into company or industry boundaries, the sample data could have been considered as being heavily influenced. In that case, further sampling could have been required to further develop the strategy formulation method. However, the industry diversity displayed in
Table 4-8 confirms that the aggregated sample data does not belong to a company or industry. This eliminates the industry dominating factor of company biasing from the formulation methods.

The conclusion arising from these findings is that the sampling process should not be focused on looking at the representativeness of sectors other than those related to a specific formulation. Following this finding, the method did not attempt to confirm validity across the whole industry. The supply chain relevant sectors investigated are considered sufficient for the formulation represented in the context of this study. The field testing in this study did not attempt to apply the findings across the whole industry as the industries classified in the Table 4-8 were considered as sufficient for generating theory on the phenomenon of interest in the context of this research.

### 4.4.3 Culture, assets and capabilities

Having confirmed the sample population diversity through the industry sectors represented in the sample of participants, the study was faced with the obstacle of identifying and analysing the supply chain culture, assets and capabilities of the selected sample population. The process of identifying and analysing the culture, assets and capabilities started with interviewing a number of company directors from across the UK and US including directors of multinational companies, as represented in the sample population. To ensure that all relevant supply chain relevant culture, assets and capabilities data was collected from the sample population; methodological triangulation was applied in the form of: a) document analysis, participant observations, direct observations and interviews, with particular focus on extracting tacit knowledge through analysis of the operational activities; b), data triangulation: time, space and persons. The process also represented the initial stages of ensuring compatibility and eliminating conflict of interest between participants in the formulation process. The process of designing and applying the methodological and data triangulation is recorded and documented for the benefit of future researchers on this topic.
4.4.4 Time horizon

The case study research was performed as an on-going process starting in 2009 and finishing in 2013. Action research on a full time basis was performed between August 2010 and March 2011, supported by short day or week action research between 2010 and 2013.

4.5 Anticipated outcome of the case study

Supply chain integration in the scenario investigated, requires a formulation of integrated business and supply chain strategy of multiple small and medium size companies operating in multiple industry sectors. The theory design process for formulating an integrated supply chain strategy applies the case study and action research to identify and resolve obstacles which prevent its formation. The first stage involves identifying and agreeing a memorandum of understanding with all the companies that would comprise the supply chain strategy. The second stage involves defining the strategic goals and integrating strategic areas in their operational activities towards supporting the pre-defined set of strategic goals.

The operational integration is assembled through a systematic approach. The model is aimed at visualising the operations related to integration through (1) diversification of production process towards products suitable for various usages by investigating the product family, (2) diversification from road to multimodal transport of the product, from point of origin to point of consumption, aimed at reducing cost of distribution, (3) storage of the product to ensure availability in urban centres where demand is highest, and (4) investigating the relationship between reversed logistics and the supply chain strategy, aimed at reducing cost and increasing competitiveness.

To build and validate the method, qualitative interviewing approach is applied and supported with group discussions with industry participants and academic experts in the process of strategy formulation.

To address the research problem and to generalise the findings to be advanced for similar research on this topic, the study firstly identifies the implicit and explicit industries in the supply chain strategy to ensure sufficient diversity in the sample
population for theory generation. Secondly, the case study applies study content analysis to the secondary data using directive analysis as a comparison technique (5.2) and conventional analysis to the primary data collected through open ended questions (5.3) and summative analysis to generate preliminary theory (Chapter 5).

Thirdly, action research is applied to gather primary data to reveal additional capabilities of the participants through their operational activities. The data collected is applied to conceptual diagrams that are later assembled into a conceptual framework for formulating supply chain strategy. The conceptual framework places the strategy into a working order as a feasible solution to a business idea. The integration process is presented to academic and industry experts in the field to confirm validity.

Case study research is performed to gather primary data from industry participants resulting in identifying the supply chain integration in culture, assets, capabilities and technology as the concept solution to supply chain obstacles. The formulation process is aimed at providing flexibility in the company’s business strategies and to formulate a new supply chain strategy. The formulated supply chain strategy enhances and complements the business strategies of each individual company and represents an integral part of their business design.

The proposed framework in this study is aimed at defining the process of understanding how different parts in formulating a new supply chain influence one another when combined together. It is anticipated that supply chain strategy formulation would enable the business strategy to perceive and respond to unpredictable scenarios prior to making any significant investments. The process of assembling a supply chain strategy is aimed at designing an approach for problem solving when individual problems of the strategy cannot be solved, but can be solved if placed as a part of a larger system.

The formulation should tailor a set of high performance business objectives that evaluate and assess if these objectives are consistent and reinforcing, and would complement the operating model of individual companies in creating operational advantages. The formulation in this study, analyses how the collaborations between
companies provide flexibility in addressing external factors that are out of the company control through focusing on the salient dimensions.

The formulation design considers all likely aspects that impact the formulation process and integrate into a whole, as a system. This methodology design advocates the idea that to provide an actionable solution to a business idea, firstly one must understand the goals of that business idea. Secondly, the methodology must enable the participants to visualise the action through systematically assembly a strategy that would support the operational activities.

4.6 Outline of the single case study research approach

The aim of the thesis is to address the architecture and design of greenfield project integration strategy formulation.

The following research concepts are present in the thesis.

1. Architecture of a greenfield project integration strategy
   a. Articulation of the external dimensions, elements, forces and factors out of the control of the business and supply chain strategy
   b. Critical analysis of the factors and problems emerging from external dimensions, elements, forces and factors.

2. Conceptual framework
   a. Architecture for evaluating salient dimensions in relation to the external elements, forces and factors.
   b. Critical analysis of the problems emerging from the salient dimensions in relation to the external elements, forces and factors.
   c. Determining the importance of dimensions, elements, forces and factors in relation to strategy formulation
   d. Designing a method for systematic prioritising of activities towards formulation and integration areas.
e. Designing hierarchical concept maps for identifying and organising individual operational activities towards integrated supply chain strategy architecture.

3. Designing evaluation criteria for formulation of integrated business and supply chain strategy.

   a. Investigate how conflict of interests can be identified and eliminated in the formulation of a greenfield project integration supply chain strategy
   b. Designing conceptual diagrams to visualise individual companies business goals in a supply chain strategy
   c. Designing conceptual diagrams to visualise individual participants business and supply chain activities
   d. Designing conceptual maps of the participant’s activities and relating the activities to the predetermined supply chain strategic areas

4. Evaluation of how product nature and product family affect supply chain strategy architecture and design.

   a. Evaluation of the relationship between product family and greenfield project supply chain strategy design
   b. Investigation of the relationship between product and operating costs and evaluation of the effect on supply chain strategy architecture

4.7 Research framework and the case study

This literature review in Chapter 3 identified the existing tools and mechanisms and presented the background in building a conceptual framework for supply chain strategy formulation. The case study method combined with action research was determined as the best suited method for validation in the context outlined, while the grounded theory in the context of the thesis is directed at theory building.

4.7.1 The case study as method for building theory

The objective of the case study is to investigate how the changes in business environment are forcing companies to rethink their business models and their supply
chain strategies. The supply chain lead company in this study is selected through convenience sampling. For the remaining participants, non-probability sampling and purposive sampling is used.

The purposive sampling is based on the understanding of the research area and the available opinion-maker within the research area. From convenience sampling only experts in the slate mining industry, mining supply chain were approached and participated in the interviews. From non-probability one Vice President and 3 chief executives participated in the research, while the last company choose to nominate participants who are professionals in the supply chain field. Through purposive sampling the number of participants is increased significantly to include managerial and supervisory level participants (4.4)

Therefore, the supply chain strategy field work is implemented in a consortium of companies participating in the research study. The research methodology approach outlined earlier in this chapter serves as the foundations in the theory building process for supply chain strategy formulation. The formulation refers to identifying the strategy vision and goals and investigating how can be integrated in the supply chain operations. In designing the research parameters, focus is placed on formulating a supply chain strategy with vision and goals that are representative of the supply chain participants.

The supply chain strategy formulation required integrating the supply chain operations with logistics, transportation and engineering companies, followed by identifying the required formulation elements: assets, capabilities, working culture and know-how. The study approached the participants to collect field data on how integration and formulation would resolve the strategy obstacles presented. The field work addressed mostly the distribution, more specifically the logistics and transportation process, in the supply chain strategy. Nevertheless, apart from the logistics aspect for delivering the product, the formulation addressed activities related to: operations, market and product, among other aspects related to the supply chain strategy.

Through action research the study engaged multiple alternatives for change in the lead company business, supply chain strategy is needed. The change requirement is based on the fact that the Welsh roofing slate is far more expensive than alternative low
cost Spanish or Chinese roofing slate. Therefore, the slate industry must adapt to the needs of the 21st century and diversity its product, process and logistics to increase its profit margin. This process of diversifying involved selling slate aggregate which is a mining by-product with consistent and sustainable supply within North Wales. The process of diversifying required a supply chain strategy architecture and design in greenfield project and integration context that would anticipate: product family in the supply chain strategy, transportation and logistics aspect of the supply chain strategy, performance of the supply chain strategy and integration of multiple participants in the supply chain strategy.

4.8 Defining the research to the context of the case study

In the preliminary stages of refining the research topic, external and salient dimensions are analysed to visualise the main obstacles for utilising the by-product that remained from the industrial days in North Wales. The case study method is applied to gather and analyse secondary data sources, resulting in defining the lack of infrastructure and market as the main two obstacles for commercialising the by-product. The infrastructure and market obstacles are out of a small and medium size company's control. Due to the infrastructure and market being elements beyond direct control, the investigation applied content and discourse analysis to redefine the research questions and goals. Multiple interviews and group discussions with experts in the field followed, aimed at identifying a method to address these elements. Resulting from these discussions, the lack of integration in the business and supply chain strategy is identified as the obstacle within the control of the small and middle sized companies, which could lead to resolving the obstacles out of their control. Therefore, the process of scoping, narrowing and defining the aim and objectives in the research question, identified the formulation of integrated business and the supply chain strategy as the main obstacle in the process of commercialising the mining by-product.

This clearly demanded a degree of flexibility in the supply chain strategy. Such flexibility can be achieved through supply chain strategy integration. The literature review in Chapter 3 confirmed the need for integrating to provide flexibility in the supply chain strategy affects most companies with limited resources. This arises from
the lack of technology, assets and capabilities that multinational corporations possess. These challenges, followed by ever stricter regulatory policy changes such as carbon reduction, require continuous re-evaluation of the operating models for most small and medium size companies. In addition, the marketplace is continuously affected by globalisation, development of free market and competition from lower labour cost countries, creating rationale for small and medium size companies to re-examine their current supply chain strategies seeking to identify areas for improvement.

4.9 Design concepts for strategy formulation

Tracey et al. (1999) investigated strategy formulation through linear structural equation analysis and proposed that investment in communication mechanisms for the strategy formulation participant’s results in improved competitive capabilities and performance, while, Menda and Dilts (1997) linked ‘multifunctional’ viewpoints on manufacturing strategy formulation to design a conceptual process model. The process provided infrastructure in a form of a framework for reinforcing ‘concept understanding’ and the case study method was applied (interviews, observations and secondary data) to validate the findings. The weakness aspect, detected in the method, is that questions related to business and operational strategy were asked in the same interviews. This could have confused the responders because there is a high degree of informality in the strategy formulation process (Platts et al., 1996).

Karl-Erik (2001), explored the practical implications of an epistemological approach to strategy formulation from a resource based perspective and claimed that value grows when knowledge transfer or conversion takes place. Other recent studies confirmed the positive effect of strategy formulation in relation to performance by reviewing the positive effect of rational planning and negative effect of logical incrementalism and absence of strategy process (Andrews et al., 2009).

These studies focused on investigating strategy as a form of management process, conceptualised as a system of choices, patterns or decisions. In the context of strategy formulation these are combined with: visibility (Inkpen and Choudhury, 1995, Fisher, 1997, Fisher, 2003), acceptance (Saad et al., 2002), participation (Menda and Dilts, 1997,
Karl-Erik, 2001, Zhou and Chen, 2001, Qureshi et al., 2009), communication (Tracey et al., 1999), formality (Andrews et al., 2009), adaptability (Sakka et al., 2011, Saad et al., 2002), integration (Bozarth et al., 2009), effectiveness (Fisher, 2003, Fisher, 1997) flexibility (Narasimhan and Das, 1999, Beamon, 1999, Kim, 2006) and responsiveness (Fisher, 1997) all elements that are valuable in turning the formulation focus towards operationalisation.

4.9.1 Strategy absence and systematic innovation

Earlier studies distanced from the established norms (Inkpen and Choudhury, 1995) and investigated the phenomenon where ‘a strategy is expected to exist but does not’ (Ibid., p.315) and claimed that ‘absence’ of strategy does not necessarily mean absence of ‘core capabilities’, but is simply a form of realignment because of business environments and industry pressures, where ‘the process of expanding, modifying, and redirecting core capabilities is congruent with the notion of strategy absence.’ (Ibid., p.322). These conclusions invite further research in the field of strategy ‘absence’ through studying the visible patterns and the ‘interplay between the planned and the improvised... the deliberate and the accidental.’ (Ibid., p.322).

More recently, an innovative method has been developed by Sheu and Lee (2011) proposing a process for ‘systematic innovation’. Despite the process not being tested in the context of strategy, it’s relevance to business process, opportunity, and cross industry application resembles similarities with the context. The systematic innovation represents a series of stages that connect a business process from ‘opportunity identification to technology details to cross-industry application exploitation of newly developed technology/tools/products.’ (Ibid., p.848). The process provides a systematic method as an alternative to brain-storming and it would be interesting to see how the process can be applied for organising or ‘distilling’ innovation to strategy, specifically in a concept of strategy ‘absence’. However, its usefulness could be constrained to a degree depending on the level of ‘absence’.

The concept of innovation brings dynamics to companies and environments, but relies on ‘feedback mechanism’ between operating environments and technical development and is increasingly generated by relationships between companies (Saad et al., 2002).
High degree of ‘absence’ effectively disables development of the ‘feedback mechanism’ and creates a challenge for applying ‘systematic innovation’. These factors should be considered in strategy architecture.

This section derives a conclusion that strategy formulation represents a process of accepting the reality and acting upon that reality. The process should involve designing patterns of choices and evaluating the outcome of these choices. The remaining challenges in the formulation topic (Mckone et al., 2009) require research that separates the topics of strategy and operations (Menda and Dilts, 1997, Platts et al., 1996). Strategy formulation can be conceptualised as a system of choices, patterns or decisions, but literature would benefit from addressing the phenomenon of strategy ‘absence’ (SA) (Inkpen and Choudhury, 1995). This can be addressed by reaching a consensus on strategic objectives and through avoiding prescriptive and descriptive approaches to address the operationalisation aspects of formulation (Platts et al., 1996) and requires evaluation variables and communication mechanisms that enable conceptual understanding.

4.9.1 Supply chain strategy concept theory

To eliminate confusion regarding the process of conceptualising a supply chain strategy, a short introduction is provided to outline what is perceived as conceptual theory. Conceptual theory is used to analyse and distinguish between critical and less critical attributes and to differentiate one phenomenon over another and ‘the concept “theory” is not a concept that is typically “tested” as other concepts might be’, concept theory is used to ‘identify theoretical statements: statements describing relationships between two or more concepts, statements explaining the relationships between two or more concepts, or statements predicting the relationships between two or more concepts.’ (Pedersen and Burton, 2009).

The lack of clearly defined concept analysis framework does bring an element of vagueness to the method. Strunz (2012) investigated the conceptual vagueness by analysing arguments from philosophy of science and claimed that the results can be ‘twofold’. Namely, conceptual vagueness is seen by some as precondition for empirical science, but by others as a technique for creative and pragmatic problem solving. In
support of this claim, a conceptual framework is developed that separates descriptive, evaluative, and transformative aspects, into ‘trans disciplinary’ types of research: system, target, and transformation, resulting into empirical, normative, and pragmatic types of knowledge. The framework clarifies the arguments and assists in avoiding confusion regarding the type of knowledge generated by conceptual models.

Therefore, conceptualising a supply chain strategy, represents a real life phenomenon with multiple variables and conceptual theory can be applied in this context to (1) evaluate statements from supply chain decision makers, (2) statements from operational level employees can be applied to identify relationships or predict relationships between concepts. Furthermore, conceptual vagueness can be eliminated by designing a conceptual framework that prevents confusion on the type of knowledge generated.

4.10 Categorising the data

The first stage of data categorising consisted of identifying and validating the core strategy goals in a form of single statements. The statements are presented in a conceptual diagram prior to assessing their impact on integration and formulation. The same method is applied to multiple units of analysis and embedded designs to include main and smaller units on dissimilar levels with the objective of observing for consistent patterns of evidence across units, but within the case objectives of integration and formulation. This approach is compliant with the case study research approach for developing preliminary theory (Yin, 2003). The data analysis progressed towards theory development (Eisenhardt, 1989) in the form of a conceptual supply chain strategy formulation methodology.

The stages of designing the research methodology involved:

- OASA relating statements from the data collection with the research questions in 1.7 and the topics presented in 3.9 to generate conceptual diagrams.
- CGSI through relating the conceptual diagrams with individual participants’ business strategies.
- IMSC designing conceptual diagrams to validate the relationship between individual strategies and the integrated formulations.
AA relating the vision and goals with supply chain operational activities to design the formulation criteria through applying the evaluation criteria.

DSCHT to validate the conceptual framework through the supply chain activities to confirm the presented solution to the research problem.

Following the data collection stage, the research methodology commends a more intense process compliant with Glaser and Strauss (1967) of linking the accumulated data through categorising into codes extracted from the text, grouping them into themes and concepts and formulating categories, in the pursuit for designing research methodology for greenfield project supply chain strategy formulation. In that context the data collected through methodological and data triangulation is applied to the research questions; combined with applying the theory triangulation involving of more than one theoretical scheme, as suggested in existing literature (Denzin, 1978, O'Donoghue and Punch, 2003).

After categorising the data, the research methodology design in this thesis proposes matching the pieces of information with rival patterns derived from previous studies. The process involved comparing the data with tools and mechanisms from the most closely related methodologies (Schnetzler et al., 2007, Perez-Franco et al., 2010) to the concept of greenfield project strategy formulation. These mechanisms, in this study, have been found to address individual obstacles present in formulation, but do not address the concept of greenfield project formulation. The process of comparing the mechanisms is applied firstly to the lead company business and supply chain operations and secondly to the consortium participants in the context of formulating the supply chain strategy. This approach represents a process for validating that the theory generation principles represent foundations for supply chain strategy theory generation that contributes to existing knowledge.

The Perez-Franco et al. (2010) evaluation and reformulation methodology has been referred to in more detail because it represents established and detailed methodology for evaluating (Figure 4-3) and reformulating (Figure 4-4) an existing supply chain strategy of a company. The differences between this established methodology and the greenfield project methodology are described in this thesis in great detail.
The early attempts to apply the reformulation methodology to a formulation problem resulted in distorted concepts and diagrams. However, some of the tools found in this methodology served as grounding for the new method for formulating a greenfield project integrated supply chain strategy for small and medium sized companies.

![Conceptual model for supply chain strategy evaluation](image)

**Figure 4-3: Conceptual model for supply chain strategy evaluation**

![Supply chain strategy decomposed in categories](image)

**Figure 4-4: Supply chain strategy decomposed in categories**

4.10.1 Measurements of variables

The variables used in the research study emerged from the critical summary of existing literature, outlined in a summary table (Table 3-1) and conceptual diagrams (Figure 3-1 and Figure 4-2), that derived with research framework (Figure 4-1) and can be identified from the individual questions asked (questions examples Table 4-9, Table 4-10, Table 89)
To obtain the industry representativeness and the nature of the organisations in the single case study sample population, a number of descriptor variables were asked at the beginning of the interviews.

Questions 1 to 7 were related to the first postulate. Questions 1 to 7 were focused on setting the scene of the single case study by seeking information on the: main industry, type of industry activities, the locations, facilities dispersion, level in the organisation (directorial, managerial, supervisory), etc. Questions 1 (main industry) was seeking nominal variable, while questions 2 to 7 were seeking information that frequently changes caused by the nature business activities, and were interval-scaled as continuous.

**Example questions – 1 to 7**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Please describe the main industry your company/role is involved in?</td>
</tr>
<tr>
<td>2.</td>
<td>Please describe your current role?</td>
</tr>
<tr>
<td>3.</td>
<td>Please describe what do you do in your current role?</td>
</tr>
<tr>
<td>4.</td>
<td>How many years have you been involved in your current department/role?</td>
</tr>
<tr>
<td>5.</td>
<td>What role of supply chain activities has your position involved you in?</td>
</tr>
<tr>
<td>6.</td>
<td>Do you have any responsibilities in supply chain activities?</td>
</tr>
<tr>
<td>7.</td>
<td>Who is your direct supervisor within the company?</td>
</tr>
</tbody>
</table>

**Table 4-9: Example questions 1-7**

The questions 7 to 21 were placement questions and were related mostly to the second postulate.

For each of these questions, when required, a definition of the term was provided to the responders and an appropriate diagram was presented, including the diagram of the research framework (Figure 4-1) This stage of the interview was focused on extracting the formulation concepts.

**Example questions – 7 to 21**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Do you feel any bottleneck within in the supply chain process?</td>
</tr>
<tr>
<td>8.</td>
<td>Do you have web based supply chain and inventory system?</td>
</tr>
<tr>
<td>9.</td>
<td>Do you have documented procedures to deal with supply chain partners?</td>
</tr>
<tr>
<td>10.</td>
<td>Do you have a mechanism for your suppliers and customers to lodge complaints?</td>
</tr>
<tr>
<td>11.</td>
<td>How fast do you resolve such complaints?</td>
</tr>
<tr>
<td>12.</td>
<td>Do you have supply chain value and performance assessment methods in place?</td>
</tr>
<tr>
<td>13.</td>
<td>Do you charge supply chain participants during aftersales service?</td>
</tr>
<tr>
<td>14.</td>
<td>Do you share your risks with your supply chain participants?</td>
</tr>
<tr>
<td>15.</td>
<td>Do your objectives match with your suppliers capabilities?</td>
</tr>
</tbody>
</table>
Do your objectives match with your customer requirements?  
Do you have ‘state of the art’ arrangements for online communication and sales?  
What is the decision making process in your company?  
Do you have customer database? and service supplier’s database?  
Do you receive any governmental subsidies for using the waste material?  
How do you share your knowledge between your supply chain and the general public?

Table 4-10: Example questions 7-21

These questions were supported with exception backed questions, aimed at extracting and eliciting views of the emerging problems and potential solutions that have not been noticed. Some examples of such questions are included in Table 4-11 below.

<table>
<thead>
<tr>
<th>Example questions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have there been any occurrences when the problem did not happen?</td>
<td></td>
</tr>
<tr>
<td>2. Can you think of a time when you didn’t have the problem?</td>
<td></td>
</tr>
<tr>
<td>3. What was different about the occurrences when the problem didn’t occur?</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-11: Exception finding questions

Questions 21 to 30 represented open questions on the operationalisation of the supply chain formulation criteria and were related to the fifth postulate.

<table>
<thead>
<tr>
<th>Example questions – 21 to 30</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21. What is your level of involvement in designing the business strategy within the company you are employed at?</td>
<td></td>
</tr>
<tr>
<td>22. Could you describe the main duties of your role with the company?</td>
<td></td>
</tr>
<tr>
<td>23 What are the tasks that preoccupy your working time?</td>
<td></td>
</tr>
<tr>
<td>24. Which positions, under which departments, are under your direct supervision?</td>
<td></td>
</tr>
<tr>
<td>25. What are the main functions of the listed positions?</td>
<td></td>
</tr>
<tr>
<td>26. How is this (activity) executed?</td>
<td></td>
</tr>
<tr>
<td>27. How do you make sure this is executed in the correct way?</td>
<td></td>
</tr>
<tr>
<td>28. What is the reasoning for performing this activity?</td>
<td></td>
</tr>
<tr>
<td>29. What results were accomplished with the performance of this activity?</td>
<td></td>
</tr>
<tr>
<td>30. Previously you stated something that is of interest to this research study, you stated that... would you be able to comment further on this subject?... can you provide a few examples?</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-12: Example questions 21-30

These questions were accompanied with:

a) Preferred future questions, aimed at taking the investigation out of the past and into the future.
b) Coping questions, aimed at helping the study participants identify resources that have been ignored or forgotten, mostly in cases where the change seems impossible and beyond the participant’s control.

c) Alternative perspective questions, aimed at enabling the participants perceiving the problem through a different set of viewpoints and in the process allowing the participants to shift their point of view.

Some examples of such questions are included in Table 4-13 below.

<table>
<thead>
<tr>
<th>Example of preferred future, coping and alternative perspective questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred future questions examples</td>
</tr>
<tr>
<td>1. How would you know if this problem was improved?</td>
</tr>
<tr>
<td>2. What would you be doing if this problem was resolved?</td>
</tr>
<tr>
<td>Coping questions</td>
</tr>
<tr>
<td>3. How are you managing to cope with all this?</td>
</tr>
<tr>
<td>4. With all that has been happening in your company, I am wondering how have you managed your everyday responsibilities?</td>
</tr>
<tr>
<td>5. Alternative perspective questions</td>
</tr>
<tr>
<td>If I was to ask you or your colleagues what they think you would be doing if the problem was a little bit better, what would the answer be?</td>
</tr>
<tr>
<td>6. What would your supply chain partners think if you were feeling a bit more confident about this greenfield project?</td>
</tr>
</tbody>
</table>

Table 4-13: Additional questioning methods

Questions 31 to 40 were related to the sixth postulate and represented semi open questions on the operationalisation level of integration in the supply chain logistics and other related operational processes and independent variables. Semi-structured questions facilitate comparative research as different respondents answer the same common questions, although there was scope to probe and explore the specific responses provided by individuals. The flexibility of a semi-structured interview allowed for the interview to develop in unique ways for each respondent. This allowed each interviewee to relate the issues to their own ‘acceptance of the world’ and their own values and beliefs, and to use their own language and to organize these around their own ideological frameworks or knowledge (Wengraf, 2001).

The questions derived from the critical summary of the literature reviewed (see section 3.9) involved a number of comments to clarify individual questions to eliminate
misunderstanding and ambiguity. In the later stages of interviewing, multiple diagrams were created and presented to the responders to enable visualisation of the context in which the questions were asked.

The semi-structured questions were carefully designed to reflect each of the themes in the research’s conceptual framework (Figure 4-1) and its elements (Figure 3-1 and Figure 4-2) with the research aim and objectives (1.7). There were three main interviewing groups selected as respondents to understand company’s overall supply chain strategies and to measure and compare the supply chain with the business strategy.

**Example questions – 31 to 40**

<table>
<thead>
<tr>
<th>Question</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. What is your business strategy with respect to the supply chain strategy?</td>
<td></td>
</tr>
<tr>
<td>32. How do you facilitate feedback and communication mechanisms between the business and supply chain strategies?</td>
<td></td>
</tr>
<tr>
<td>33. What would you consider the greatest opportunity for the supply chain strategy?</td>
<td></td>
</tr>
<tr>
<td>34. What aspect of the supply chain strategy fits closest to the business strategy of your company?</td>
<td></td>
</tr>
<tr>
<td>35. What would you be able to sell through, or within, the supply chain strategy?</td>
<td></td>
</tr>
<tr>
<td>36. Can you define your end customer?</td>
<td></td>
</tr>
<tr>
<td>37. Is your customer internal or external to the supply chain strategy, or both?</td>
<td></td>
</tr>
<tr>
<td>38. What are the customer requirements?</td>
<td></td>
</tr>
<tr>
<td>39. How would you satisfy the customer requirements?</td>
<td></td>
</tr>
<tr>
<td>40.</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-14: Example questions 31-40

These questions were accompanied with elaborative questions, reflective questions that summarise earlier statements, and interpretative questions to reflect on an implied answer. A few examples of structuring such questions are included in Table 4-15 below.

**Examples of elaborative, reflective and interpretative questions**

<table>
<thead>
<tr>
<th>Elaborative questions</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Could you give me another example of how this problem was resolved?</td>
</tr>
<tr>
<td>2.</td>
<td>Would you expand on you did to record and document the process in more detail?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reflective questions</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Participant: Once the operation was executed, I continued with another operation..</td>
</tr>
<tr>
<td>3.</td>
<td>Interviewer: You continued with similar operations and activities in other regions?</td>
</tr>
<tr>
<td>4.</td>
<td>Participant: In the previous supply chain strategy plan, we identified sufficient market in East Midlands ...</td>
</tr>
<tr>
<td>4.</td>
<td>Interviewer: You identified sufficient market for the waste product?</td>
</tr>
</tbody>
</table>
5.5.5.6.

Interpretative questions

Participant: Once the project was completed I continued with another operation in...
5.

Interviewer: Could it be that the two projects are operationally similar between regions?
6.

Participant: In the previous supply chain strategy plan, we identified sufficient market in East Midlands ...

Interviewer: Was that because you had previous relationships with customers in that region?

Table 4-15: Elaborative, reflective and interpretative questions

Questions 41 to 48 represented focused questions on the operationalisation of the supply chain logistics aspect and were mostly related to: (a) third postulate, and (b) fourth postulate. Questions 41 to 48 covered aspects such as: virtual quarries, reversed logistics and empty containers, environmental implications, brownfield sites, aggregate levy, etc. The evaluation criteria were applied in the questions at this stage in combination with evaluation matrices.

Example questions – 41 to 48

41. On a scale from one to ten, where ten is the most feasible method and one is least feasible, how feasible is the possibility of creation of a network of virtual quarries?

42. On a scale from one to ten, where ten is the most supportive method and one is least supportive, how supportive are the environmental regulations towards the supply chain strategy?

43. On a scale from one to ten, where ten is the most compatible method and one is least compatible, how compatible is the aggregate levy with the supply chain strategy?

44. On a scale from one to ten, where ten is the most economically valuable (parsimonious) method and one is least parsimonious, how parsimonious is the utilisation of emerging brownfield sites?

45. On a scale from one to ten, where ten is the most sufficient method and one is least sufficient, how sufficient is the removal of 1mt (and 2mt respectively) of waste aggregate from mining operations’?

46. On a scale from one to ten, where ten is the most visible method and one is least visible, how visible is the conceptual summary diagram and map presented?

47. On a scale from one to ten, where ten is the most executable method and one is least executable, how executable is the transportation and logistics aspect of 1mt/2mt of waste aggregate through the Conwy Valley Rail Tunnel (considering the RA6 as opposed to the required RA10)?

48. On a scale from one to ten, where ten is the most synergic method and one is least synergic, how synergic is the process of integration with 3PLs (and 4PLs respectively)

Table 4-16: Example questions 41-48
These questions have taken a very short time to answer, however, they were left until last because it was noticed on the first few interviews that the earlier questions enabled the responders to get more familiar with the context of greenfield project formulation, and they were able to provide a more valuable response. The fast pace of the focused questions also served as a wrap up of the interview. These questions were aimed at determining opinions and feelings from individual employees, but also to identify resources, brainstorm solutions, set goals and increase the discussion between the supply chain participants.

In relation to qualitative interviews and number of interviews conducted, this study followed recommendations from Miles and Huberman (1984a) who recommend a sample size guided by the answers the researcher receives. The rule of thumb recommended is that once the answers from new responders become repetitive there is no need for continuing further interviews.

To address the topic of how the interview questions relate to the aim and objectives of the study and to ensure that the questions are suitable to draw appropriate conclusions, a number of pilot interviews were conducted prior to the actual interviews, in order to assess whether the translated questions were appropriate and could be understood easily. The assessment of the translation process of the summary table, the conceptual diagrams of gaps in existing literature and the conceptual framework, into interview research questions, was carried out with pilot interviews involving 15 colleagues of the researcher at: Aberystwyth University, University of Wales Institute Cardiff (at present Cardiff Metropolitan University), Glyndwr university, Westminster University, Newcastle University, Durham University, and Massachusetts University of Technology. The assessment of the translation process was carried out in order to assess whether the translation retained the original intended meaning. Approximately equal proportions of colleagues were involved from the departments of management, transportation and logistics and the department of engineering. Their comments led to slight amendments in the wording of some questions so that they were more comprehensible for respondents.

Pilot interviews were conducted prior to the actual interviews in order to assess whether the translated questions were appropriate and could be understood easily.
Pilots also helped the researcher to assess if the length of interview and sequence of questions were appropriate. Long interviews can cause respondent fatigue, and an inappropriate order of questions could cause respondent confusion. Therefore, following the pilot interviews with academic colleagues, a pilot interview was performed in an industry setting with the executive director from the transportation company, followed by a second pilot interview with the manager of the transportation company and the final pilot interview was performed with an officer in the transportation company. Besides the regular questions, the three industry respondents were asked to provide comments on the questions after the interviews. A few questions were adjusted after these pilots, with more appropriate wording being developed.

4.10.2 External evaluation participants

The evaluation process of the conceptual framework for greenfield project formulation is enabled through firstly developing the evaluation criteria. In this context, a number of existing performance measures and metrics are adapted for evaluating formulation (described in 4.9 and contextualised in 4.10.6) These measures and metrics have been applied at multiple stages during the research study, resembling the starting point for linking the aggregate data collected to build the designed conceptual diagrams into a preliminary conceptual system. Considering that supply chain strategy is defined as ‘patterns of decisions’ (Perez-Franco et al., 2010, Narasimhan et al., 2008), to design a formulation conceptual framework, the ‘patterns of decisions’ have been divided into four conceptual formulation criteria: formulation areas of decision, formulation principles, formulation imperatives and formulation choices. In the process of validating the formulation criteria, the methodology applied a process of selecting a superior candidate, following the principles from controlled convergence (Pugh, 1990) and advice from Perez-Franco et al. (2010) for adapting the design method to the context of this study. The process included industry representatives, academic experts and multiple participants external (Table 4-17) to the supply chain at various repetitions. The external participants are selected through convenience sampling, with exceptions of participants from institution 2 and institution 7.
<table>
<thead>
<tr>
<th>Sample set of participants: INEPN</th>
<th>Sample set of participating institutions: IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Participants</td>
<td>Institution 1</td>
</tr>
<tr>
<td>6 Participants</td>
<td>Institution 2</td>
</tr>
<tr>
<td>2 Participants</td>
<td>Institution 3</td>
</tr>
<tr>
<td>2 Participants</td>
<td>Institution 4</td>
</tr>
<tr>
<td>1 Participant</td>
<td>Institution 5</td>
</tr>
<tr>
<td>1 Participant</td>
<td>Institution 6</td>
</tr>
<tr>
<td>2 Participants</td>
<td>Institution 7</td>
</tr>
<tr>
<td><strong>Sample set of participants: EXnEPN</strong></td>
<td><strong>Sample set of participating experts: EXN</strong></td>
</tr>
<tr>
<td>1 Participant</td>
<td>NGO</td>
</tr>
<tr>
<td>1 Participant</td>
<td>Previous logistics provider</td>
</tr>
</tbody>
</table>

Table 4-17: External participant

4.10.3 Vertical and horizontal evaluation

The evaluation criteria can be applied through evaluation matrices in vertical or horizontal process (Perez-Franco et al., 2010). To address the formulation problem, the horizontal evaluation was the preferred choice because the data collection process presented more areas of interest than the vertical assembly could evaluate easily and with clarity, especially during field work. The horizontal assembly refers to positioning operational activity in each space before focusing to the next area, enabling the integration process to eliminate and avoid conflicts from the multiple areas of interest.

The field data collection stage in this study found that the operational level participants preferred the vertical assembly method that deals with individual formulation areas. This was perceived as easier to grasp and a quicker alternative that would deal with the conflicts within the areas before moving to the next area. However, formulation involves multiple companies that operate in diverse industries which created robust conflicts across formulation areas and makes the horizontal evaluation the only applicable method. This process eliminated confusion and prevented individual participants from requesting that non-related operational activity is placed in the formulation. After the first few discussions, the construction design was aimed at eliminating potential conflict between the formulation areas.
4.10.4 Field data

Interview scoping: The supply chain strategic vision prior to this research for the case study selected was defined as: ‘The Slate Aggregate by Rail’. The strategic vision was refined in the study and was explicitly stated initially in a document as ‘A slate industry that had evolved to meet the needs of the 21st century’. Narrowing enquiry was applied jointly with the industry participants so the supply chain strategic vision was redefined to be applicable to the business strategies of the consortium as: ‘Commercialise Blaenau Ffestiniog slate secondary aggregate by successfully competing in the existing market for aggregate materials and promoting secondary slate aggregate as a suitable product in new markets worldwide’.

The next step in the interviews was to determine whether the strategic goals are exclusive to the greenfield project formulation, or present individually or collectively in the business strategies of the consortium companies. Wide-ranging analysis was performed on the consortium business strategies in search for possible concept similarities. Categorical coding is applied to categorise the findings into: formulation concepts, formulation imperatives and formulation areas of decision.

Discourse analysis is applied to clarify how different categories are linked with the consortium companies’ individual supply chain strategic activities and the greenfield project strategy.

The process of choosing the relevant formulation areas of decision and formulation imperatives within the consortium companies consisted of outlining what aspect of the companies was to be studied in the research. Initially the relevant functions were determined; however the process remained open to adding new functions as and when raised during the interviews. Once the relevant formulation areas of decision were identified and outlined the case study method was applied for identifying the people that need to be interviewed within these specified areas.

Carefully consideration was applied to cover people from multiple levels in the consortium companies. The multiple levels consisted of:
• Level A interviewees that influence the business and supply chain strategy (directors);
• Level B interviewees that are supervised by level A; (managers) and contribute to the strategy formulation indirectly, and;
• Level C interviewees that are supervised by level B (supervisors and engineers) and contribute to the operational aspect of the strategy.

Therefore, the pool of people interviewed were representative of the directorial level, managing level, and the operational level supervisors and engineers of the supply chain consortium partners. Only part of the interviews were predetermined in the initial selection and the rest were chosen based on the development of the case study research, this process corresponds with existing literature (Patton, 2002). In the sampling guidelines it was aimed for at least 10 interviews with each participating company, totalling to 50 qualitative interviews, where one third would represent the level A while the remaining was from level B and level C. Some of the participants selected through purposive sampling were difficult to interview in person and these interviews have been arranged over the telephone. On two occasions, the participants selected in this category were preoccupied with their work load and unable participate. These participants were replaced through convenience and snowball sampling to secure the ratio of one third in each category. The ratio of one third in each category was considered as required to maintain the integrity of the sample size, the data collected and the resulting conclusions.

The interviews were focused predominately on the supply chain, more specifically on the distribution and operational capabilities aspects of the supply chain strategy. Other aspects related to BCAO: Barriers to change and approaches to overcome were also researched to represent areas such as: marketing; sales; and finance. However, these aspects were seen as secondary for the greenfield project formulation and the priority was placed on CGSI: Characterise greenfield supply chain strategy and integration strategy formulation for making the product available to the consumers. In that respect, the operational capabilities (CE: capabilities evaluation) related to distribution were considered as the main obstacle in the greenfield project formulation. The first sample of interviewed selection is performed in the process of structuring the business vision and goals and it is representative mostly of Level A interviewees the managing team of the consortium partners (Table 4-18)
Table 4-18: Selected participants

The nominal interview sample selections were expanded through purposive sampling (Table 4-19) to ensure coverage of different levels and groups of employees.

<table>
<thead>
<tr>
<th>Level A Directors and VP</th>
<th>Level B Managers</th>
<th>Level C Supervisors and Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C1Dn):</td>
<td>(C1Mn):</td>
<td>(C1En):</td>
</tr>
<tr>
<td>1.Executive Director</td>
<td>1.Sales Manager</td>
<td>1.Geotechnical chief engineer</td>
</tr>
<tr>
<td>3.Executive Director of SC</td>
<td>3.Supply Chain Manager</td>
<td>3. Operations Engineer</td>
</tr>
<tr>
<td>Director</td>
<td>7.Strategic Sourcing Manager</td>
<td>7. Customer Service Supervisor</td>
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<td>9. Finance Director</td>
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<p>| (C2Dn):                  | (C2Mn)           | (C2En)                            |
| 1.Executive Director     | 1.Sales Manager  | 1.Infrastructure chief engineer    |
| 3.Executive Director of SC | 3.Supply Chain Manager | 3. Operations Engineer |
| 5.Director of Operations | 5.Civil Engineering Manager | 5. Waste Management Engineer     |
| Director                 | 7.Strategic Sourcing Manager | 7. Customer Service Supervisor |
| 9. Finance Director      |                  | 10. Geotechnical chief engineers  |</p>
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<tr>
<th>(CsDN):</th>
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<tr>
<td>1.Executive</td>
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<td>1.Rail freight chief</td>
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<tr>
<td>Director</td>
<td>2.Marketing Manager</td>
<td>engineer</td>
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<td>2.Managing</td>
<td>3.Supply Chain Manager</td>
<td>2. Road freight chief</td>
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<tr>
<td>Director</td>
<td>4.Operations Manager</td>
<td>engineer</td>
</tr>
<tr>
<td>Director of</td>
<td>6.Finance Manager</td>
<td>4. Multimodal logistics</td>
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<tr>
<td>SC</td>
<td>7.Strategic Sourcing Manager</td>
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<td>Director</td>
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<td>Director of</td>
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<td>UK operations</td>
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<tr>
<th>(C4DN):</th>
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<tr>
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<td>1.Sales Manager</td>
<td>1.Rail freight chief</td>
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<tr>
<td>VP</td>
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<td>engineer</td>
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<td>Director</td>
<td>4.Operations Manager</td>
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<td>6.Finance Manager</td>
<td>4. Multimodal logistics</td>
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<td>SC</td>
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<td>Engineer</td>
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<td>6. Accounts Supervisor</td>
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<td>Terminals</td>
<td>Supervisor</td>
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<td>Director</td>
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<th>(CsDN):</th>
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<td>1.Executive</td>
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<td>Director</td>
<td>2.Marketing Manager</td>
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<td>2.Managing</td>
<td>3.Supply Chain Manager</td>
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<tr>
<td>Director</td>
<td>4.Operations Manager</td>
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<tr>
<td>3.Executive</td>
<td>5.Customer Service Manager</td>
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<td>Director of</td>
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<td>Operations</td>
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<td>Director</td>
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<tr>
<td>5.Director of</td>
<td>9.Operational Directors</td>
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<td>Operations</td>
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<tr>
<td>6.Customer</td>
<td>10.Manager of Wales</td>
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<tr>
<td>Service</td>
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<td>Director</td>
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**Table 4-19: Purposive sampling**

However, purposive sampling has proven difficult in some scenarios (ex. CsMnEn, Table 4-19) and in these scenarios, deviant case sampling was applied to secure sufficient coverage in the study sample population. In other cases, to speed up the research process, purposive sampling was combined with convenience and snowball sampling techniques.
The second list of selected participants included representatives of Level A, B and C interviewees. The expanded sample (Table 4-19) is designed and proposed for data collection and resulted in a significant increase in the initial sample population (Table 4-18) that can be identified in (Table 4-20) which includes the case study sample population of the interviews, group discussion participants and questionnaire responders. In designing the sample participants an attempt was made to maintain the initial sample balance previously determined. After a number of reviews of the participant sample a number of suggestions were added to the final list, starting from the first year and including some in the final year of the study.

Therefore, Level A does not represent over a third of the sample selection and there is a balanced representation of level B and level C interviewees. Clear representation of the requested sample participants from level A, B or C is demonstrated in (Table 4-20)

<table>
<thead>
<tr>
<th>Level A Director</th>
<th>Level B Manager</th>
<th>Level C Supervisor Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C1DN): 5 Participants</td>
<td>(C1MN): 8 Participants</td>
<td>(C1EN): 10 Participants</td>
</tr>
<tr>
<td>(C2DN): 4 Participants</td>
<td>(C2MN): 9 Participants</td>
<td>(C2EN): 10 Participants</td>
</tr>
<tr>
<td>(C3DN): 5 Participants</td>
<td>(C3MN): 10 Participants</td>
<td>(C3EN): 10 Participants</td>
</tr>
<tr>
<td>(C4DN): 4 Participants</td>
<td>(C4MN): 10 Participants</td>
<td>(C4EN): 15 Participants</td>
</tr>
<tr>
<td>(C5DN): 3 Participants</td>
<td>(C5MN): N/A</td>
<td>(C5EN): N/A</td>
</tr>
</tbody>
</table>

Table 4-20: Expanded study participants

The level C group is of crucial importance in concept generation through extracting the tacit knowledge behind the activities. This study recommends that if the research process is faced with an inability to perform the recommended interviewing process, to oversee the interviews out in the field. In the literature review of research methodology traditions, the study discovered that triangulating the data collection is the most suitable method in this context, to avoid hearing what the interviewer wants to hear and for collecting the actual instead of the desired goals. To avoid these difficulties, the data collection through interviews and questionnaires is targeted to different levels of employees: A. directorial, B. managerial, C. operational; supervisors and engineers. The
data collection process also applied other grounded theory methods, such as participants’ observations and direct observations to create a textual database for discovering and labelling variables into categories, concepts and properties.

4.10.5 Formulation criteria

The literature review established evaluation measures and metrics for supply chain strategy. These are applied to design evaluation methodology to evaluate supply chain formulation. The methodology aimed to advance the understanding of the relationships between these measures and metrics in the context of formulation. The measures are applied on a consortium of companies participating in the formulation of a supply chain strategy. The approach involved performing the first round repetitions individually with individual participants, the second round repetitions with small groups, and the third round of repetitions as one group involving supply chain participants, external experts and academic experts.

This method enabled this study to collect and evaluate the operational activities simultaneously, then apply individual operational activities to the formulation criteria. The flexibility given to individual participants in the process of collecting and evaluating field data resulted in a greater percentage of contribution than expected in a relatively shorter period of time than anticipated. The second stage applied in small groups enabled the research to reduce the number of operational activities while retaining the best ideas. This process also enabled individual participants to familiarise themselves with the overall formulation idea, as grounding for the collective discussion in the final round.

4.10.6 Formulation measures and metrics

These steps represent the starting point in the methodology design, where the formulation criteria are determined by identifying areas of the business strategy that provide insights for the supply chain strategy formulation. The second step is hierarchically linking the formulation criteria by referring to the evaluation criteria to formulate the supply chain strategy. The formulation criteria are validated by the evaluation criteria, aimed at ensuring validity of the formulation and to enable
generalising of the relationship between formulation and evaluation of a greenfield project supply chain strategy. The preliminary evaluation criteria is derived from existing literature (Perez-Franco et al., 2010), combined with reference to multiple additional studies (outlined below) to address specific issues that have emerged during this study.

The formulation process resulted in extensive evaluation criteria to ensure validity of the research methodology. The formulation and evaluation criteria are tested on an assembling conceptual supply chain strategy for the mining industry in North Wales.

The following evaluation criteria were applied to the formulation:

1. In relation to ‘feasibility’ (coded Fe), the formulation must ensure that every concept is feasible and the integrated consortium is capable of performing the formulation criteria. The evaluation criteria is focused on strategy absence (Andrews et al., 2009, Inkpen and Choudhury, 1995), and ‘accepting’ and ‘acting’ upon reality (Pettigrew, 1977).
   a. Evaluation clarification criterion: in relation to ‘feasibility’, this evaluation criterion is focused on determining ‘executability’ (coded as Ex), of all the articulated concepts. In the context of this ‘feasibility’ clarification criterion, all emerging concepts must be executable through the combined effort of the supply chain strategy companies. The clarification criterion is based on ‘responsiveness’ (Fisher, 1997).

2. In relation to ‘sufficiency’ (coded Sf), the formulation needs to consider concepts as objectives to be satisfied by the support received. Without sufficient coverage the supply chain strategy cannot be executed effectively in sustaining the ‘goals’ of the integrated companies. The evaluation criterion is focused on visibility (Inkpen and Choudhury, 1995, Fisher, 1997, Fisher, 2003).
   a. Evaluation clarification criterion: In relation to ‘sufficiency’, the evaluation criterion is focused on determining ‘coverage’ (coded Co) of the formulation criteria. The clarification criterion is designed to ensure the emerging concepts cover all the determined formulation areas as expressed in the integration process of the consortium companies and as identified through applying the action research and case study method.
In relation to **‘support’** (coded Su), individual formulation criteria must be targeted at providing support to at least one of the concepts with higher ranking in the conceptual framework. The evaluation criterion is focused on participation (Menda and Dilts, 1997, Karl-Erik, 2001, Zhou and Chen, 2001, Qureshi et al., 2009), communication (Tracey et al., 1999), formality (Andrews et al., 2009).

a. The evaluation criterion **‘support’** is reinforced with the clarification criterion **‘adapting and alignment’** (Coded AA), the formulation needs to be focused on adapting and aligning individual assets, capabilities and culture towards predetermined goal. This evaluation criterion is based on: acceptance (Saad et al., 2002), adaptability (Sakka et al., 2011, Saad et al., 2002).

4. In relation to **‘compatibility’** (coded Cm) the formulation criteria must harmoniously coexist with all other concepts. The evaluation criterion is focused on ‘flexibility’ (Narasimhan and Das, 1999, Beamon, 1999, Kim, 2006).

a. In relation to **‘compatibility’** the evaluation criterion is supported by clarification criterion **‘parsimony’** (Pa), the formulation should assess if a concept economically makes the best use of resources and therefore is the preferred concept for achieving the required action. This evaluation criterion is based on principles from economic value added (EVA) and ‘effectiveness’ (Fisher, 2003, Fisher, 1997).

b. A second clarification criterion to contextualise the evaluation criterion **‘compatibility’** is **‘synergies’** (Sy) This clarification criterion contextualises **‘compatibility’** by investigating the desirable concept of formulation and is aimed towards mutually positive, complimenting and reinforcing relationships between the formulation areas. The clarification criterion evaluates the strategy in the context of integration (Bozarth et al., 2009),

The evaluation and clarification criteria are designed to address the main weaknesses identified in existing literature in the context of supply chain strategy formulation. The criteria also represent elements that are valuable in turning the formulation focus towards operationalisation. The formulation process is performed by firstly approving the list of evaluation criteria, then applying the criteria to the activities the supply chain
strategy is focused on achieving. The concepts were generated through action research and compared against the evaluation criteria throughout the interviews and group discussions. This was performed by requesting experts in the field to evaluate activities for a given formulation area in the context of all formulation areas.

### 4.10.7 Evaluation design

The evaluation methodology design process applied the theoretical strengths and qualities of the evaluation matrices for improving the conceptual design. The evaluation methodology was grounded on the established methods that considered the supply chain as a conceptual system. The application of interrelated evaluation matrices as a supply chain strategy evaluation method has been applied in Perez-Franco (2010) who considered the supply chain strategy as a system. This enabled the design process to apply the evaluation matrix in a similar method. The evaluation methodology consists of a supply chain strategy formulation evaluation matrix that includes the evaluation criteria in the form of: a) headers explaining the evaluation criteria as measures of the evidences and b) headers containing the categories and concepts to be evaluated, along with individual cells acting as an assessment of the evidence in relation to the concepts.

The design process enabled the application of the accumulated knowledge to advance the combination of controlled convergence and evaluation matrices further in a simple method to visualise the complete supply chain strategy evaluation process. The contribution from this methodology is that the design is not personalised for an individual company business strategy or supply chain strategy formulation. Instead, the method is personalised to evaluate the integration of individual goals and concepts in a supply chain strategy formulation, which was the objective of this study. The methodology is applied for evaluating and verifying the validity of the complete simulation of the conceptual framework captured in this study. The evaluation matrices are used to test the supply chain strategy formulation with the supply chain participants to ensure its validity.
4.10.8 Validity

Content validity has been addressed through ensuring that the questions asked and the answers received can be scaled into a representation of the area and the context of the concepts being measured. Content validity was pursued in two methods: firstly, through a comprehensive literature review that was heavily focused on providing indicators of the tested concepts; secondly, a number of redundant questions were asked on the interviews that were tailored to the same concepts already investigated, to test for cross-correlations, pattern recognitions, and tacit knowledge.

Criterion validity was pursued through continuously measuring if the interviews and group discussions were focused towards producing results that the criterion is expected to predict. The formulation criteria were considered as the measuring criterion for adequately differentiating if the discussion was focused towards productive data results. Criterion validity was further established through analysing the data with the established evaluation criteria.

Construct validity is pursued to ensure that the formulation and evaluation criteria represents a valid criteria for observing and measuring the concept investigated. Construct validity is perceived in literature as evaluative judgement of the degree to which evidence and theoretical foundations support the appropriateness of the process of deriving logical conclusions from principles assumed to be correct and the action based on these judgements (Messick, 1998). Therefore, the preliminary theory served as a deliberately created construct to enable conceptualising on the formulation criteria through continuously applying grounded theory to new findings in the data collected to ensure that the results are contributing to theory design. Construct validity is considered in this study as essential in pursuing conceptual validity. As can be seen from the results, strong construct validity has been established in the criteria where correlation was expected.

4.10.9 Reliability

The thesis perceived validity as; is the study measuring the concept selected, while reliability is how accurately and consistently the concept are being measured. Reliability
of the measures applied is determined by how sound the concept is being measured. The reliability test performed in this study involved adapting evaluation matrices and aggregating individual answers into a simple average to present the full spectrum and a trimmed average to get robustness in reliability.

4.11 Conclusion

The research design in this study applied case study, action research and grounded theory to design research methodology for investigating the topic of formulating an integrated supply chain strategy. The research design is aimed at investigating the relationship between business and supply chain strategies by placing strategy as a concept that is divided into business and supply chain and is presented as a conceptual system, the process is compliant with existing literature (Hafeez et al., 1996). The perception of supply chain as a conceptual system is tested in multiple fields, most relevantly in the field of articulating, evaluating and reformulating a supply chain strategy (Perez-Franco et al., 2010). Previous methods found that the business strategy is the main force that forms and drives the supply chain strategy, while the supply chain strategy makes the business strategy happen. Following existing literature recommendations, the research approach in this study, places the business strategy on the top of the conceptual framework and represents the foundations for designing the methodology for formulating integrated supply chain strategy.

The research methodology design is field tested on the slate mining industry in North Wales. Through field testing the method, this study represents a quest for designing the right level of integration that enables the highest level of.

To develop the preliminary theoretical supply chain strategy formulation framework, the study applied qualitative content analysis to case study research. The aim was to create an explicit supply chain strategy that would capture the real world scenario researched, instead of the desired outcomes. It’s common in case study interviews that the answers are biased and based on what the interviewer wanted to hear or what the interviewee perceives as the desired scenario. To avoid this and to obtain the information concerning the real world capabilities, assets and culture in individual companies participating in the study, action research was applied and the study started looking at
the strategies from the operational choices and activities perspective. The process is supported with participant observations, direct observations, and secondary data analysis.

4.11.1 Ethics considerations

Diligent care has been undertaken for the duration of the study to ensure compliance with appropriate ethical standards. In attempts to influence individual participants to contribute to the research, no coercion or social pressure was applied. The research design placed careful consideration to avoiding emotional statements and no demeaning questions were asked. For the duration of the study, from the first interaction with all participants, including potential participants, the purpose of the research was defined during the interviews, group discussions and electronic communications, including the final data validation summary map and questionnaire. This approach was not altered for the duration of the research study.

The research study did not involve any form of experimentation with the participants or potential participants. In every form of contact with the participants, in-person, telephone, email, or other electronic form of communication, it was clearly stated that participation is optional. The participants were informed that the results will be used as part of the study data analysis and that some of the data will be published in the final thesis. Individual data has carefully been edited to exclude participants’ personal information and the commitment for keeping individual questionnaire responses confidential with the results only published in aggregate has been honoured. The study did not involve control groups and withholding data from such groups was not an issue. Finally, approval from the University of Wales Ethic Committee to undertake the study was requested and granted. The Ethic Committee drafted a contractual confidentiality agreement with the industry participants and the agreement was signed by the participants, the University and the researcher.

The following chapter describes the data collection and analysis process.
Chapter 5 Data collection and analysis

5.1 Introduction

The data collection in this chapter relies on multiple sources of evidence analysed in a triangulate fashion and on predetermined theoretical schemes that enable monitoring of the data collection and analysis in a methodological order. The researched topic presents a scenario including multiple variables of interest, therefore requiring multiple sources of evidence. To ensure understanding of all elements in the present scenario, initial understanding of the phenomenon was considered crucial to the case study research.

5.2 Secondary data

The data collection process started in a planned and consistent manner, the data was used to create interpretations focused on answering the research questions, which was later used to analyse and produce explanation of the formulation process. This process started initially with gathering and reviewing the secondary data sources to confirm the validity of the research questions. Analysis of historic documents resulted in identification of the facts needed to reconstruct the historical evolution of the practical problem in the selected case study. This included previous reports and statistical data on the subject. Three types of secondary data collection are applied at this stage, including; documents; archival records; and artefacts.

a) Data Source 1: Collection of reports on all aspects related to supply chain strategy including: engineering, infrastructure, transport and all other secondary data available on formulation related aspects that affect the supply chain strategy. Focus was placed on the dimensions and building blocks identified in the literature review (discussed in 3.9)

i. Secondary data collected from multiple sources to present a multidimensional profile of the supply chain activities in the context of the mining industry setting. This stage was required for identifying the factors that positively or negatively influence the supply chain strategy.
Specific focus was placed on the dimensions of environment (discussed in 3.7.1), industry (discussed in 3.4), and resource (discussed in 3.6).

ii. Secondary data collected on the factors that cause competitiveness of the slate mining industry. This was necessary to understand the relationship between formulation of a supply chain strategy, the salient dimensions (discussed in 3.5.3), underlying factors (discussed in 3.4.9), capabilities evaluation (discussed in 0) and the overall competitiveness of the business strategies of the participants involved.

iii. Secondary data collection on the availability and suitability of the supplied product and product family (discussed in 3.5), the strategic selection of best product operating cost (discussed in 3.4), market and distribution planning (discussed in 3.5.3) and specific focus was placed on the strategy absence phenomenon (discussed in 3.4) in the previous attempts for supply chain formulation.

This process of developing a preliminary theory in this study involved evaluating the research problem from a systematic perspective. In the initial stages, the study referred to systems theory (Bertalanffy, 1973) and action theory (Parsons et al., 2001) and perceived the ‘action’ as decisions, drives and ideals. This approach presented an obstacle of covering more theoretical propositions than a single study can cover and describes the first failure in developing the preliminary theory; the attempt to construct a theory covering all possible aspects of the research questions. This approach has been criticised by Merton (1968) who claimed that a researcher should focus on the measurable aspects of action. This recommendation was followed and the study focused on developing preliminary middle-range theory.
5.2.1 Secondary data review methods

Ritchie (2003) acknowledged six methods for secondary data analysis: description, comparative research, restudy, or follow-up study, reanalysis, research design and methodological advancement, verification, and teaching and learning. From the stated methods, the most applicable to this study is reanalysis of qualitative data, because it permits new interpretation, research questions, research perspectives, analytical methods and new tools to be implemented from the existing data. The initial case study approach for data analysis involved case description in the form of a case study descriptive framework for analysing and organising the data based on the description and the general characteristics related to the determined research questions. In the latter stages the data analysis analytical strategic approach was changed to relaying on theoretical propositions to focus the study on certain data and ignore other data. The preliminary process of theory generation started by pattern matching where expected outcomes were compared to determine if the results have produced alternative patterns. Rival explanations have been produced to investigate if the salient dimensions identified can be empirically categorised into patterns. The analysis relied on all the secondary data relevant to address the issues in the researched topic. The approach is compliant with Yin (2003) argument that objective setting and parameter establishment of a research study are of far greater importance in a case study than a big sample size.

Given (2008) claimed that the more detailed the existing research data is, the greater would be the potential for additional research investigation but, that ‘access may have been difficult to negotiate or data hard to collect.’ In a formulation the integration process involving multiple entities, which releases data kept confidential by individual entities, and the data becomes available for formulation. Following the same principle, without formulation it is unlikely that an individual entity could negotiate the data from other entities. Gummesson (2000) stated that any inquiry into the access and advances of secondary data is of certain significance in the business situation, particularly if the research anticipates mediation within the participating organisations. The significance is even greater if the organisations are anticipated to take action founded on the conclusions of the investigation, which is the objective of a greenfield project formulation.
5.2.2 Secondary data review

The first stage of the research combined all of the secondary data to explore all the available information related to the research questions, prior to proceeding with preliminary theory generation. This method is consistent with Glaser and Strauss (1967) who stated that the process of theory generation is a process of strategic handling of data which in the process provides conceptualisation for describing and explaining. The same study also claimed that a good theory must be adaptable to the researched goals, be applicable when applied and be easily understandable.

To support the argument concerning the validity of the designed conceptual method for analysing real world scenarios, the research methodology implemented intensive analysis of the product and product family impact of the supply chain strategy. The process is recorded and presented in a conceptual diagram. With this information built into the formulation process, the research methodology expanded to explore the formulation impact on costs, through investigating the activities, culture, capabilities and assets.

In that context the research designed a framework to assess impact of formulation on the competitive advantages of: land, location, natural resources and activities. To analyse the creation of competitive advantages arising from formulating integrated supply chain strategy, the methodology is focused on the technological collaboration and know-how of the supply chain participants. The research used existing data for secondary analysis of the support activities and the new technologies obtained through integration. The conceptual framework, through secondary data analysis, absorbed the improvement effect in the product, process and planning. This stage of the formulation process applied the value chain analysis to identify the main business processes and how their interaction and linkages can develop, produce, sell and distribute a product.

The intention of the research methodology is through applying theory triangulation to create a reliable and accurate interpretation on how the supply chain activities are related to the business strategy. The conceptual frameworks and diagrams are used to assemble a visual representation of the activities required to formulate a supply chain strategy. This is aimed at generalising the finding of the study to be used by other researchers on the formulation of a supply chain strategy problem.
The process of applying methodological data section triangulation and theory triangulation is adapted to create confidence in the accuracy of the findings (Denzin, 1978). To confirm accuracy of the theory triangulation this study applied the grounded theory and action research followed by the brief allocation of segregated sections of existing theories to strengthen validity of the conceptual model. The research methodology attempted to explain the complexity of the formulation phenomenon by studying it from more than one view point (Cohen et al., 2000). The methods applied in the formulation of a supply chain strategy were designed for continuously double-checking the data from multiple sources in search for constancies in the collected research data, as suggested in existing literature (O'Donoghue and Punch, 2003).

5.3 Primary data

The secondary data enabled this study to extract a preliminary business strategy and assisted in developing the context of the supply chain strategy integration and formulation. The initial data sample was applied to theory generation prior to adding new sources of data. A series of electronic communications were exchanged to validate the extracted vision and formulation areas with the supply chain lead company. This resulted in a preliminary theory clearly outlining the integration and formulation aspects. The secondary data collection stage was supported with primary data collection with the consortium of companies: interviews; direct observation; participant observation. These findings are the foundation for generating the pilot theory, to be followed by an additional data collection process for validating the generated theory on strategic integration in the formulation of greenfield project supply chain strategy. The primary data sources applied are:

5.3.1 Phase 1: Interviews

A series of open, semi-structured and focused interviews, selected through convenience, snowball and purposive sampling, which included directors, managers, supervisors and engineers of the five consortium companies on the topic of integration and formulation of a supply chain strategy. The interviews were based on multiple aspects related to the subject of their individual supply chain practices and strategies.
The interview times varied and were later analysed using qualitative content analysis. One weakness noticed in applying interviews for data collection was that it produces outcomes affected by what the participant considers required or what the participant thinks the interviewer wants to hear. This motivated interview design with focus on activities, aimed at gathering from participants feasible strategic concepts instead of the desired outcomes from the supply chain strategy. To ensure data validity, after an interview and prior to the following interview qualitative content analysis was applied as a strategy to prepare focused questions for the following interview and later as a method for data analysis. The qualitative content analysis enabled the data collection process to apply three different approaches: conventional, directed, and summative (Hsieh and Shannon, 2005). The main variances among these three approaches are: coding schemes, origins of codes, and threats to trustworthiness, which makes the data collection more detailed and unbiased.

a) Open and semi-open interviews with preselected participants of the individual business and supply chain strategy formulation process. The participants were directly involved in the formulation of the strategy. The interview was focused on identifying their strategic vision and goals in the context of formulation and integration.

b) Open and semi-open interviews with preselected participants of the managerial functions. This group was less involved in the strategy but not completely involved in the functional and operational activities. The interview was focused on identifying the areas of business and supply chain strategic activities and investigating how these areas are related to strategy formulation and integration.

c) Open and semi-open interviews with preselected representatives of the main operational functions involved in the formulation of the supply chain strategy to determine the functional and operational activities. The interview was focused on identifying activities and investigating how these activities can be performed in the formulation and integration strategy context.
5.3.2 Phase 2: Group discussions

Group discussions; open and semi-open with supply chain participants, numerous experts and other participants from associated organisations. The supply chain strategic aspects discussed were: formulating a supply chain, integration in the supply chain to reduce the cost of the product, the suitability of the mining by-product material for various usages and the market demand for the product.

5.3.3 Phase 3: Action research

The process of applying the described approach for data collection and analysis in the selected setting of integration and formulation presented a real world practical research where the presented research questions were disorganised and distorted. Action research is considered as the most appropriate approach for investigating supply chain problems in practical, real-world problems that are often disorganised and disordered (Seuring, 2008, Näslund, 2002). In the process the study engaged the consortium of companies through action research projects that included: an engineering company, a freight terminal and multimodal logistics company, a mining company, and a warehousing company. A significantly greater proportion of the action research was undertaken with the transportation and logistics participants. The transportation and logistics was selected as the main topic of the supply chain integration and formulation investigation and with the consortium approval the most detailed action research data collection stage is performed with the rail freight transport and logistics participants of the supply chain strategy. The action research consisted of an informed investigation of a real management issue within the participating companies, performed to gather data for the research study. The action research involved corresponding cycles of investigation, action design, piloting of new practices, assessment of outcomes, while applying grounded theory at all stages in the collection and analysis of data to ensure generation of knowledge.

This action research project consists of the following data collection:
a) Group discussions, open and semi-open with the consortium transportation and logistics decision makers on the impact of formulating a supply chain strategy to the market demand for the product. The value of this topic is discussed in the literature review (3.5.3) This resulted in systematic research design for assessing the impact of the formulation as follows:

1. Formulation of integrated supply chain strategy impact on lowering the cost of transport, with specific focus on: PF, TLISE and SCA.
2. Lowering the cost of transport through identifying the: BPOC, and investigating the effect from DE-DD.
3. Impact from lowering the cost of transport on maximising the market share through increase in demand for the product along with PS-MD and MDP.

b) Group discussions; open and semi-open with experts in the field of environmental studies and the consortium transportation and logistics decision makers related to the environmental impact from the formulation of a greenfield project supply chain strategy on the slate heaps. Specific focus was placed on the topics of design for environment and design for disassembly (discussed in 3.5.1)

5.3.4 Phase 4: Questionnaire

Questionnaires were sent to different groups within the supply chain participants. The questionnaires were focused on evaluating the benefits and trade-offs from integration and collaboration between the operational functions of the participants business and supply chain strategy. The data collection process is accompanied with continuous attempts to build and test theory and enrich existing literature. The aim of these attempts is focused on re-designing the setting for formulating an integrated greenfield project supply chain strategy framework that would link individual companies’ business strategies and their supply chain function towards a common goal.

The applicability of the evaluation criteria was confirmed through (1) multiple discussions with academic experts (2) content clarity is validated through presenting the
criteria to participants unfamiliar with the context of the study. These attempts are recorded in the next step of the research methodology.

5.4 Interview sample

5.4.1 Conduct open, semi open and focused interviews

a) Industry: the interviewing started by conducting interviews with the executive directors (Level A) of the consortium companies at the individual company’s location and continued to Level B and C employees again at the individual company’s locations. The location exception was the engineering company, where interviews have been conducted at the lead company location and in an academic environment followed by electronic and telephone interviews.

b) Potential supply chain partners: multiple interviews have been conducted with related parties from previous supply chain formulation attempts. These interviews provided strong primary data applied in designing the formulation evaluation criteria.

c) Supply chain related parties: in addition interviews were conducted with governmental organisations and non-governmental organisations (NGO’s), experts in the field external to the supply chain and potential customers for the products supplied.

To keep the interviewee engaged it was decided to keep the length of the interviews to no longer than one hour. However, some of the interviews lasted much longer, while other interviews had to be shortened to half an hour. In designing the interview process the aim for the interview to be in a private room and this step was considered valuable for obtaining open and trustworthy answers. However, some of the operational level participants were difficult to interview in such an environment and in the pursuit of validity and reliability, some of the interviews were performed out in the field of operations. Some of the interviews were recorded on audio and video with a confidentiality agreement; other interviews were recorded on paper.
5.4.2 Interview structure

The interviews were structured beforehand in the following manner: introduction 5 minutes, placement questions 5 minutes, pre-structured questions 15 minutes and open questions 30 minutes, semi-open questions 10 minutes and focused questions 5 minutes. The given times were only used as guidelines and if the interviews were rich for example in the open questions content, the timings were changed to allow for more time on the open questions. The context of the interviews was structured to ensure getting the most out of the case study interviews. The structure applied was as follows;

5.4.3 Introduction

The interview introduction included:

- Greeting the interviewee,
- Introducing the interviewer,
- Introducing the interviewee to the terms and conditions of the research study,
- Introducing the reason they have been selected to participate
- Explaining the time it will take for the interview to be completed.

An example draft taken from one of the interviews is presented in the text below:

‘Good morning Mr …. Just to introduce myself, my name is Petar Radanliev, from the University of Wales. Thanks for agreeing to participate in this research study, and thanks for allocating your time for this purpose. The aim of this interview is to ask you for information regarding the main practices of your position within the company.

This case study research interview is used towards the action research data collection for the PhD research study we are conducting with the consortium of companies. Please consider it as an open conversation, about your daily responsibilities. We are scheduled for one hour, are you ok with time?’

The introduction was used as part of the interviews to request the permission to record the interview and to answer any questions the interviewee would possibly have, such as questions regarding the confidentiality of the recordings. One example used in the interviews is the following:
‘The recordings from this interview and all the written or spoken information you provide today is considered confidential. When I accepted the contract to perform this research study I have signed a confidentiality agreement with the University and the lead company. Although I will be quoting sentences in my PhD report none of the quotes will be linked to any individuals that participate in the research interviews. The participation in the case study interviews is voluntary, and you can decline to answer any given research questions that you may find discomforting to answer, and you are in a position to terminate this interview at any stage. Considering this, is my request for permission to record this research interview acceptable? If you change your mind, you are in a position to revoke this at any stage of the interview. The voice recording of the interview will be stored in an encrypted digital file, stored in secured premises. All copies of the voice recordings will be deleted once our PhD research project is finalised. Do you have any questions?’

5.4.4 Placement questions

In the introduction stage 3 placement questions were asked. The first placement question was: ‘Could you describe your present role within the company?’ Surprisingly, despite the interviewees being previously selected the response regarding the job role was not always very understandable. In this scenario it was asked from the interviewee to extend the explanation to allow the interviewer to take more notes until the answer became clearer.

The second placement question was ‘who is your direct supervisor within the company?’. This allowed the design of a hierarchical structure which assisted the study in determining the representation of previously explained different level of interviewee representatives. The third placement question presented in the interviews was: ‘what is the level of involvement in designing of the business strategy within the company you are employed at’. This would further assist in determining the group level the interviewee should be placed at. Determining the level of the interviewee would assist in asking the correct question in the case study research. After completing the placement questions the interview continues with the next stage, which is open-questions.
5.4.5 Open questions

The main reason for asking open questions was to find out about the tacit aspect of the supply chain strategy of a given company. However, as explained in the text previously, the tacit supply chain strategy cannot be discovered by simply asking a question. Therefore, the open-questions were structured in a way that would relate to the interviewee’s job role, while attempting to gain the knowledge of the tacit supply chain strategy. Then, in the following stage, the semi-open questions start with enquiries about the interviewee job role and continue to drill deep to obtain data of the tacit supply tacit strategy of the companies.

In the literature review it was discovered that it must be considered that the interviewees involved in the design process of the supply chain strategy will have a different perception of the strategy than those that were not involved in this stage (Collier et al., 2004). Considering the latter, a different set of questions were designed for the different levels of interviewed participants. The interviewees that are involved in designing the supply chain strategy have one set of questions and the interviewees that are not involved in the design are presented with a separate set of questions. For example in a semi-open interview with an interviewee from level B or C the open-question would start with: ‘could you describe your main duties of your role with the company?’. While some interviewees would provide a straight forward answer, others requested clarification. The alternative question for level B or C would be ‘what are the tasks that preoccupy your working time?’.

When presenting semi-open questions to level B or C, staying factual and unbiased was easier to achieve. However, when interviewing level A it was crucial to stay factual in the data collection, because the level A interviewees would easily drift into the desired goals as opposite to the actual real-world activities of the strategy. Therefore, instead of asking the same questions as level B or C, the level A questions were related to the task performed by the level B or C managed by the interviewee of level A. To be able to identify the level B and level C that are managed by the level A we presented the question ‘which positions under which departments are under your direct supervision?’ the question was presented as if trying to determine the positions not the individuals. All the positions mentioned in the interviews were recorded and explored further by
asking the question ‘what are the main functions of the listed positions’. Before extending into the open questions, it must be emphasised that the open questions section is the most relevant to the data collection through case study interviews. At this stage it was crucial for the researcher to remain factual, as strong and grounded data can be collected from open questions that would be of great assistance in the analysis of the data collected. The following statement represents the process applied to extract the most relevant data.

In the process of attempting to shift the focus from the interviewee to the company and from the accomplished to tacit knowledge, the interview structure was kept focused on factual executed actions by asking the question ‘what’. While to obtain the factual data regarding the method of executing particular actions, validation questions were asked starting with ‘how’. However, it is not always easy to understand the ideas behind particular actions, in which case the questions were structured to start with ‘why’.

In the action research the ‘what, how and why’ questions have been predominated. Another case study method that was applied to open question interviews was aimed at determining how a desired action can be executed. The method applied was, every time interviewee was asked ‘what’ the next question that followed would be started with ‘how’. This case study method provided strong and grounded data of the factual execution. The researcher must consider the need for an open questions interview that would create a balance between strategy and activities. This is easier to perform if the interviewer discovers the interesting areas for the interviewee.

However, the interviewer must constantly be certain that the discussion is contributing to the data collection concerning the tacit methods the companies are executing in their factual strategies. If the interview distorts from this objective it would have to be shifted back by the interviewer to the main objective.

For example there were occasions when the case study interviews were turning more towards the direction of desired strategy. If this happens, it is the task of the researcher to turn the interview back to facts and how actions are executed within the companies. Some probe questions that have assisted the case study in changing the direction were: ‘how is this (activity) executed’ or ‘how do you make sure this is executed in the correct way’.
On the other hand if the interview is led into an operational level the researcher must guide the interview towards abstract questions. Examples applied in the case study included: ‘what is the reasoning for performing this activity’ or ‘what results were accomplished with the performance of this activity’.

During the interviews, it was considered that careful listening is one of the most important aspects for exploring further in the data collection process. One method of making sure that strongly grounded data is collected is taking notes of activities mentioned that are in the interest of the project and going back later to obtain further data on these activities. One example used in this case study research is: ‘previously you stated something in the interest of this research study, you stated that the logistics chain is of crucial importance for the continuation of the slate industry in Blaenau Ffestiniog: would you be able to comment further on this subject? Or: can you state a few examples’.

During the initial stages of the interviewing it was decided that the open question conversation must be allowed to extend for as long as it is required to get the momentum going. However, at some point the interviews developed into more structured interviews, mostly because towards the latter interviews it was found that the topics discussed have been excessively covered in previous interviews. This research concluded and recommends that when the interviewer starts to get this impression, it is the correct time to move onto semi-structured questions.

5.4.6 Semi-open questions

In the semi-open questions section of the interview it was found that is easy to revive an already existing discussion or to explore further a topic of interest mentioned in previous interviews, which is crucial in a case study research. In the interviewing questions, it was considered crucial to limit the information provided from previous interviewees regarding the same or a specific topic of interest. This must be considered for two reasons: first is data confidentiality and second to allow the interviewee to express his own point of view.

In this case study research it was found that it is recommendable to have a list of common semi-structured questions. This list was used to double check if all the common
questions related to the topic were asked. In the last stages of the interviews, it was found that many of the common questions have already been answered, in which case it was considered a time wise measure to avoid duplicating the questions.

Some examples of the common semi-structured questions applied in the interviews are: ‘What would you consider the greatest opportunity for the supply chain strategy’; ‘What do you consider the greatest challenge for the supply chain strategy’; ‘What aspect of the supply chain strategy fits mostly to the business strategy of your company’; ‘What would you be able to sell through or within the supply chain strategy’; ‘Can you define your end customer’ ‘Is your customer internal or external to the supply chain strategy, or both’; ‘What are the customer requirements’; ‘How would you satisfy the customer requirements’.

This is the detailed structure of the data collection interviews performed in this study. The last stage is closing the interview. In this stage the focus was on thanking the interviewee and requesting to stay in contact in case there was a need for further communication. The closing statement is followed by the question requesting further communication if needed, one example used is:

‘This finalises the case study research questions I structured for you, I would like to thank you for allocating time for this interview. I wanted to ask if it is ok that I contact you with additional questions after I have analysed and compared the data from all the interviews. This may not be required, but I wanted to ask in case a need arises, many thanks for your assistance’.

5.4.7 Data collection on the supply chain external elements

To address the barriers from external elements to the supply chain, the interviews explored the relationship between multiple external elements and the supply chain strategy formulation. The interviews were focused on exploring the environmental implications and requirements to validate the supply chain impact; the effects and its influence on sustainability of competitive commerce of the business strategy; and the relationships between individual business strategies and the formulation of integrated supply chain strategy.
Throughout the process; to capture the action, to apply the theoretical schemes and to remain instrumental in encouraging the overcoming of multiple obstacles related to a formulation, the data collection explored the relationships between strategy formulation and integration and transport and cost, the environmental implications and reversed logistics, and multiple other aspects related to formulating new supply chain strategies. Topics outlined in the research framework (3.9) that are extensively covered during the interviews were:

1. Environmental and cost benefits of reversed logistics:
   a. DE-DD and PS-MD: explored the potential operation of refilling the empty containers at the final destination point with domestic waste materials to be recycled back in the depot and/or production facilities.
   b. MDP: explored the potential for utilising brownfield sites created from removing the slate waste product from slate heaps.

2. Environmental and cost benefits of multimodal transport:
   a. TLISE integration with 3PL’s
   b. SCA rail transport vs. existing road mode of transport, freight terminal vs. depot, sea transport: Port of Mostyn.

3. Sustainable low cost transport:
   a. BCAO and IMSC reversed logistics impact on: transport cost, environment and a long-term competitive commerce.

The interviews also explored the potential for overcoming multiple existing barriers internal and external to the supply chain strategy. The focus was on how these barriers could be addressed or mitigated in the design of an integrated supply chain strategy. The barriers identified in the salient dimensions and addressed in the interviews to relate the primary data to the previous theoretical discussion were:

i. Lower the cost of transport through integrating with 3PL,
ii. Lower the cost of products through integrating with other supply chain related parties,
iii. Balance the competitive advantages created by integrated supply chains in other suppliers,;
iv. Create long-term competitive commerce.
5.5 Conclusion

This chapter has presented the research methodology and philosophy that has guided the research design, methodology and methods. The approaches used were greatly influenced by the interpretivist approach to understand the complexities in supply chain strategy formulation and of the responses to strategy formulation of the mining industry in North Wales. The use of qualitative research was considered appropriate in order to understand the social reality from the responders’ perspectives and to collect in-depth and rich data. The research used a case study approach and various qualitative methods: in-depth interviews, observations, and secondary data gathering. Semi structured in-depth interviews were the main method used to obtain data and these were structured using convenience, snowball and purposive sampling approaches. The main industry in the case study is the mining industry in North Wales. Two additional industrial groups were present in the case study companies: civil engineering, transportation and logistics. The interviews were conducted from February 2009 to January 2013.

The research methodology applied data collection triangulation to ensure a thorough and truthful investigation of the impact of the formulation of the supply chain strategy. The application of a case study, grounded theory and action research enabled flexibility in the design approach to sampling, because the initial sample set was not sufficiently predefined at the beginning of the research. To gather all the facts and information necessary for developing a viable formulation theoretical framework, the research applied qualitative secondary data collection and analysis. The secondary data was collected through documents, archival records, artefacts and direct observations to explain the current situation, while the primary data investigation process applied data triangulation: time, space and persons. Extensive interviews with a broad range of related parties were performed to develop understanding of the present situation. This resulted in multidimensional profile design for investigating and validating the research questions.

The total aggregated data is applied to design the research methodology by separating the data analysis between formulating business and supply chain strategy. The data analysis also followed closely existing literature recommendations for applying the grounded theory to open and categorical coding in action research (Goulding, 2002,
Charmaz, 2006) followed by discourse analysis (Eriksson et al, 2008), summary tables (Eisenhardt and Graebner, 2007) and conceptual maps (Miles and Huberman, 1984a). The research process started without previously determining the full scale of the formulation analysis, which allowed the investigation to keep an open mind for emerging outcomes. This process is recommended in existing literature (Goulding, 2002, Charmaz, 2006).

Following Yin’s (Yin, 2003) recommendation for eliminating ‘criticism and scepticism’ concerning the uniqueness or artifactual condition, the case study undertaken included a review of internal documents to formulate the theory by applying qualitative research methods (Gummesson, 2000, Eriksson et al, 2008). The benefit of the recommended research methods is the capability to analyse previous data and collect new data to produce a cross analysis of data and develop a preliminary theory. In developing the theory, consideration has been placed on the requirement to develop theoretical contribution to knowledge while working on actionable recommendations to a real-world problem within a relatively short time frame, considering the chosen approach. To address the wide ranging aspects of the research questions of the study, the research adapted all relevant existing methodologies for data analysis to better understand the nature of supply chain strategy formulation and integration and design a conceptual framework. From an implementation standpoint it is essential that prior to theory testing, the theory is assembled (Snow and Thomas, 1994), therefore, the process of strategy formulation was performed prior to validation. The process followed literature recommendations for applying generalisations based on individual instances as a process of theory-building (Eisenhardt, 1989, Eisenhardt and Graebner, 2007) and the present multiple business strategies of the participants are applied to pursue direction and contexts and to address the issue of ‘how’ the business strategy for this project is best formulated.

In this context, the investigation is focused on how strategy is formulated by reviewing data from a real world case study aimed at advancing the existing methodologies to cover the formulation aspect through qualitative data analysis and discourse analysis on the sample population of industrial sectors. The approach is compliant with previous literature (Eisenhardt and Graebner, 2007, Eisenhardt, 1989) and with the research objectives of this study.
The number of postulates that emerged as a result of setting the scene in Chapter 2 and the literature review Chapter 3 are simplified and presented in a diagram (Figure 5-1) to evaluate their effect to theory generation.

1. Postulate: in greenfield project formulation, to understand the companies’ real strategies the researcher must firstly be informed of their activities.

2. Postulate: to understand how strategy is formulated, ‘tacit knowledge’ should be considered as instrumental in distinguishing between the description of strategies and the actual happenings.

3. Postulate: supply chain strategy can be formulated as a conceptual system where the formulation is based on conceptual diagram and conceptual model that can be based on the ideas, plans and abstract concepts.

4. Postulate: the supply chain relevant sectors are sufficient for applying the findings to the phenomenon of interest in this research context.

5. Postulate: formulation contains vision and goals that represent the formulation where the vision is the central idea of the formulated strategy but the strategic goals are representative of the participants and the goals determine the central idea.

6. Postulate: the strategic vision relies on the strategic goals and the goals are the foundations of the formulated strategic vision that is determined by the strategic goals, where the goals represent a set of ideas incorporated in the strategy that; supplement, assist and enable the strategic core.

The postulates are applied for formulation and the method designed accordingly. The coding is provided in the list of abbreviations and described in more details in the thesis (8.2)
Figure 5-1: Postulates for greenfield project integration

The following chapter identifies the development of conceptual framework. The proposed framework is intended to explain the conceptual logic and direction of this study.
Chapter 6 Greenfield business and supply chain strategy formulation

6.1 Introduction

The aggregated data applied to formulate the preliminary theory in this chapter was collected from primary (Table 4-18) and secondary data sources (detailed in 5.2). The primary data source comprised interviews with employees from different levels and functions within the study participants, interviews with experts from companies operating in the area, governmental and non-governmental organisations and experts in the field of business and supply chain. The participants were selected through convenience, snowball and purposive sampling and supported with two group discussions. Feedback on the data validity was obtained from individual participants. While not all interview participants were present on the group discussion, the research design covered participants in equal proportion from each group for the group discussions to ensure consistency in the evaluation and strengthen the data validity.

Secondary data sources included internal and external documents obtained from the participating companies, governmental and non-governmental organisations. Existing literature relevant to the case study was also consulted. The secondary and primary data validity and reliability (4.10.8 and 4.10.9) is confirmed through group discussions with internal participants (Table 4-20) and external participants (Table 4-17). To develop preliminary theory, (1) content analysis was applied to preliminary evaluate the data (2) directive analysis was applied to analyse the secondary data in more detail, which is then combined with (3) conventional analysis of the opinions from the supply chain participants and related parties.

6.1.1 Setting the scene of the case investigated

Supply chain strategy formulation should initiate with the determination of the external and salient dimensions that are germane to the supply chain (Melnyk et al., 2013). Furthermore, the external factors that contribute or limit the potential for competitive success should serve as the basics for supply chain strategy formulation (Narasimhan et
Supply chain strategy is effectively a result from an evolved innovation in internal and external coordination (Saad et al., 2002). The causal loop and block diagrams can be applied as visualisation tools for interlinking multiple supply chain areas emerging from the external business dimensions (Lertpattarapong, 2002, Hafeez et al., 1996). Building upon the context of this study in Chapter 2, the literature review in Chapter 3 and the research framework (Figure 4-1) this study derives a new approach for investigating the external effect to supply chain strategy formulation. In Chapter 8 the study engages a more detailed investigation of the impact of the postulates (Figure 5-1) on supply chain strategy integration design (Figure 6-1).

**Figure 6-1: Investigating the impact from external and salient dimensions on supply chain strategy formulation**

The following chapter represents a detailed review of primary and secondary data sources on aspects that influence and affect the supply chain strategy, including elements, factors and forces in each dimension and the steps performed in analysing these factors to design the preliminary conceptual theory. To evaluate and define the impact on the external elements, driving forces and local factors specific to the mining industry supply chain strategy, the study commences with the historical background to set the scene of the case study.
6.1.2 Historic effect of external elements and driving factors

Following the historic evaluation of the external dimensions, the analysis continued with the determination of the historical background of the external element, forces and factors that impact the salient dimensions. Supply chain external elements, forces and factors are defined in this thesis as:

1) **Element**: essential part of abstract concept that cannot be interconverted.
2) **Force**: strength that attribute coercion of action at a distance.
3) **Factor**: circumstance, fact or influence that contributes to a result.

The effect of driving forces and local factors was investigated by Michael Porter (1980) to assess the influences on the industry and understand the context in which companies operate. More recently Melnyk et al. (2013) investigated the ‘influencers’ such as the business and political environment, the business model employed, the company’s desired outcomes, the supply chain life cycle and the ‘design decisions’ such as the social, behavioural, physical and structural design elements that define a supply chain. To determine the external elements, factors and forces that influences the business and supply chain. This study performed multiple interviews with experts in the field and produced the following results:

6.1.2.1 **Factor: substitute products;**

Despite all the efforts from environmental regulations, buyers are inclined towards primary aggregates as opposed to secondary aggregate (C1D2), (C2M9), and (C5D1) This is mainly because of the misperception that slate secondary aggregate is a substandard product that does not satisfy the industry secondary aggregate physical and chemical properties requirements (C1D2, E1,2,3),(C2M9),(C5D1) Slate aggregate is used for pipe bedding, drainage material, embankment fill, capping layers and, only over the past ten years, as Type 1 aggregate for unbound granular sub-bases (C1D2),(C2M9) Nevertheless, the slate by-product aggregate can be used as multiple other products (C1D2), (C2M9), (C5D1) The business strategy needs to anticipate that as promotion of the material intensifies, and demand for it increases, its high-quality properties will become known and valued within the construction industry (C1D2),(C5D1) The market, once it attains a
certain level, could ensure the long-term viability of the slate by-product industry (EX₁EP₁), (EX₂EP₁). However, a point of concern remains that there is a great deal of focus within the industry on crushing the material to fines, while experts in the field have recommended that ‘there might be intrinsic value in the large pieces that mainly constitute the tips, for a different market; not crushing them would also avoid large carbon expenditure’ (I₂EP₆).

6.1.2.2 Factor: competitive disadvantages;

The main competitive disadvantage identified is the shortage of access to lower cost transport for distribution of the product, rail or multimodal as opposed to road (C₄D₁M₄E₁). Lowering the cost of distribution, would maximise the benefits and minimise the impacts of mineral operations over their full life cycle (C₁D₁). Also, the brand identity of the slate by-product is currently regarded as waste and is commonly referred to as slate-waste, creating misperception and hence competitive disadvantages to entering new markets (C₁D₁), (C₅D₁), and (C₂M₉). The product needs to be rebranded in a manner so that it is no longer regarded as waste, but as a valuable commodity (C₁D₁), (C₅D₁), (C₂M₉). Some suggestions included: legacy stone and heritage stone (I₇EP₂). This specific competitive disadvantage can be addressed through the slate by-product heritage and legacy concepts, but also markets could be attracted by a product that would be considered very contemporary because of its sustainability credentials (I₇EP₂). Other suggestions for branding products in this category include: green stone, recycled stone (EX₂EP₁); or for specific projects: Millennium centre, Millennium stone; London Olympics; Olympic stone (EX₁EP₁). Such markets may be construction and road construction companies. These markets, once it attains a certain level, could ensure the long-term viability of the Welsh slate by-product industry (EX₁EP₁), (EX₂EP₁), (C₁D₁).

6.1.2.3 Element: supply chain service suppliers (supply chain participants);

The strength of the distribution channel is one of the instrumental elements in defining the power of suppliers (EX₂EP₁). In the case study investigated the strength of the distribution channel is what makes the business diversification possible (C₁D₂). In the context of bargaining power of the distribution service suppliers; the transport (C₄),
logistics (C₃) and engineering (C₂) service suppliers are part of the consortium companies (C₆) comprising the supply chain strategy. Through integrating in the supply chain strategy, they jointly depend on the supply chain being operational.

The mitigation effect from integrating with the supply chain service providers is the impact of inputs on cost, which comes through the sale of what is a by-product of mining. The impact of inputs on cost is anticipated to result in the unit-cost of roofing slate becoming more competitive at a time when the viability of the Welsh slate industry is being threatened by the fact that it’s traditional market (roofing slate) is having to compete with imported Chinese and Spanish roofing slates (C₁D₂).

### 6.1.2.4 Force: the customers (buyers)

The customer power (or the market) of outputs represents the sensitivity of buyers to price changes, which is high in the case scenario selected (I₂EPₙ), (I₄EP₁), (I₇EP₁) There is availability of substitute products, the primary aggregate and other secondary aggregates (C₁D₂), (C₃M₉) However, the fixed costs of production are minimal as the supply chain is working with a by-product from existing quarrying operations (C₁D₂)

The only fixed cost is the cost of transport from quarry to customer (C₁D₂) Therefore, the degree of customer dependency on the present supply chain channels is crucial in determining the sensitivity of buyers to price changes (I₂EPₙ), (I₄EP₁), (I₇EP₁) For example, if the consortium companies, through collaborative supply chain strategy, managed to lower the cost of distribution then this would create a competitive advantage. The aggregate product represents a low cost material and in terms of the market sensitivity, the cost of transport is a detrimental influencer to price changes and therefore, on the sensitivity of buyers (I₂EPₙ), (I₄EP₁), (I₇EP₁) The buyers’ price sensitivity could, in principle, provide the traditional product of the slate mining industry with the necessary competitive edge. However, the buyer volumes are also detrimental in this scenario. The buyer volume would need to reach 2mt annually to achieve this competitive edge (ARUP, 2001). The uniqueness of industry product creates impact on the bargaining power of customers (Porter, 1979), and the slate aggregate is a unique industry product (Figure 6-8) Furthermore, the buyer information availability is an influencing factor in the bargaining power of the customers (C₃M₉) and the customers’
information availability, regarding the specifications of the product, is low (C3M9),(C1D2)
The buyers’ lack of information and product specifications or differentiations is a
problem that needs to be addressed by the business strategy (C1D2)

### 6.1.2.5 Evaluation of findings

In the section above, the secondary and primary data collected was evaluated to identify
the external elements, factors, forces and to relate them to the business environment.
The external elements, factors and forces are the main drive in the process of identifying
the salient dimensions that represent the first stage in the supply chain architecture. The
concepts are built through applying content and discourse analysis for linking the
secondary and primary data collected to investigate the elements, factors and forces
that drive supply chain architecture for the mining industry and to interpret, and
conceptualise the findings.

This section evaluated the overall regional and industry influences and how these
findings can be applied to amending the business and supply chain strategies. The
findings lead to the conclusion that through applying distinctive business strategy and
integrated supply chain strategy the supply chain participants can expect to produce a
return. In that context, the findings can only serve to guide the theory building process
for evaluating the core competencies, business models and supply chain networks.

The objectives of the analysis in this section were to initiate the design of a framework
for business strategy development that anticipates the effect of the external dimensions.
The directive and conventional case study analysis derived a greenfield supply chain
architecture for outlining the external elements, forces and factors that determine the
competitive intensity and attractiveness of a specific industry. However, it must be
emphasised that a different business environment will differentiate in the external
factors and elements. Architecting a framework for world-wide analysis is virtually
impossible, because of the significant differences between business environments
(Miller and Friesen, 1978). Instead, the proposed framework represents an attempt to
generalise the findings from the case study into a supply chain architecture that
recognises that businesses and their supply chains are not lone islands. They are directly
influenced by the environments external to the supply chain and affect the supply chain because they operate in that business environment.

### 6.2 External dimensions, elements, factors and forces

The literature review in Chapter 3 established that the process of supply chain strategy formulation should start by investigating the external and salient dimensions (Melnyk et al., 2013, Nikulin et al., 2013). Therefore, the review and analysis of the external dimensions, elements, factors and forces out of the supply chain control, resulted with a sample of concepts (Figure 6-2) related to the context of business and supply chain strategy formulation. These are articulated with directive analysis (6.1.1, 2.1.1, 2.1.3 and 2.1.1) and conventional analysis (6.1.1) to investigate the impact they create on business and supply chain strategy and presented to the study participants in a causal loop (Figure 6-2)

![Diagram](image)

**Figure 6-2: Causal loop for evaluating the relationship between external dimensions, elements, factors and forces**
The causal loop is presented to the industry participants and the findings are confirmed as valid concepts that influence their business and supply chain strategies. Causal loop has been established in the literature review as valid tool for visualising complex internal and external concepts (Hafeez et al., 1996, Lertpattarapong, 2002). The findings are validated through three group discussions, first with (C1), (I1EPN), second with (C1), (I2EPN) and third with (C1), (I3EPN). The literature review in Chapter 3 (3.4.8) and the research methodology in Chapter 4 concluded that (4.9.1) conceptual vagueness can be eliminated through building a conceptual framework.

Therefore, the results of the summative analysis are presented and evaluated through two group discussions which interpret the data and evaluate the implications to supply chain strategy formulation. The process resulted in converting the causal loop diagram into a conceptual diagram (Figure 6-3) that clarifies further the relationship between the articulated concepts and initiates the process of building a conceptual framework. The conceptual diagram (Figure 6-3) relates the concepts from the causal loop (Figure 6-2) into a hierarchical order that clarifies the meaning in a simple and easy to visualise method. Furthermore, the conceptual diagram (Figure 6-3) relates elements, factors and forces into concept categories that simplify the meaning of the external problems that emerge from the external dimensions. The comparison of the causal loop (Figure 6-2) (Lertpattarapong, 2002) and the conceptual diagram (Figure 6-3) (Perez-Franco et al., 2010) methods are presented to the outlined industry participants and the conceptual diagram (Figure 6-3) method was clearly defined as the preferred method, mostly because of simplicity, visibility and clarity of the approach.
The process of evaluating and validating the findings through group discussions presented the preliminary greenfield architecture (Figure 6-4) The architecture is applied for evaluating the external dimensions, elements, factors and forces and their impact in formulating greenfield business and supply chain strategy in a given business environment and validated through two group discussions. The contribution to knowledge from the findings is outlined in a generic diagram (Figure 6-4)
The process for building the preliminary greenfield architecture applied directive and conventional content analysis and categorises concepts in a compliant process with existing grounded theory building approaches (Glaser and Strauss, 1967).

### 6.3 Salient dimensions emerging from the external architecture

The historical analysis research method (6.1.1) applied directive and conventional analysis to determine the effect of external elements, factors and forces is in the context of five salient dimensions: resource, transport, market demand, technology and environment. The salient dimensions emerged from reviewing existing literature related to the research subject area (Martínez-Olvera and Shunk, 2006, Schnetzler et al., 2007, Narasimhan et al., 2008, Martínez-Olvera, 2008, Perez-Franco et al., 2010, Melnyk et al., 2013), and the secondary data available on the single case study research investigated (ARUP, 2001, Parkman, 2001, DTZ, 2004, Atkins, 2006). Directive analysis was applied to the secondary data and the emerging categories and themes were classified in a
compliant process with existing grounded theory building approaches (Glaser and Strauss, 1967) and secondary data is analysed to design and build preliminary emerging theory (Brytting, 1991). The emerging understanding of the concept was supported with conventional analysis of primary data collected from the case study interviews with the study participants (outlined in 4.10), in a process compliant with guidance in existing literature for producing mid-range theories (Eisenhardt, 1989, Eisenhardt and Graebner, 2007).

The salient dimensions were analysed to investigate their impact on formulating business and supply chain strategy and grounded theory was applied to build the emerging concepts into categories (Figure 6-4) The number of salient dimensions emerging from the external dimensions exceeds the ones analysed in the thesis. Since this study is focused on business and supply chain strategy formulation, the factor analysis covers only the impact of salient dimensions relevant to the context of greenfield project formulation.

6.4 Resource dimension

The literature review (3.5) concluded that the level of product complexity must be considered in designing supply chains and argued that product architecture should be considered in the process of designing supply chain architecture. The strategy formulation investigated the relationship between supply chain design and product family, because strategy should be suitable for a given level of product complexity, and when the product complexity is changed, the supply chain design must be changed accordingly.

6.4.1 The mining by-product

The by-product represents a physical resource that exists in abundance in the mining industry and, until recently, was considered a waste product, as a product that simply exists and has no obvious purpose can only be conceptualised as waste (Figure 6-5) However, by reviewing the properties of the mining by-product the by-product family can reconceptualise this perception and the waste can be seen as a factor with an active force for commerce (Figure 6-6) The active force of the physical resource is claimed by
the slate mining industry to be strengthened by the by-product family element that enables usage of the waste for a number of purposes. Mainly as a recycled low cost aggregate, this is in the view of the slate industry, the driving factor for triggering the positive impact on the external dimensions.

The physical resource has been recognised in other studies as one of the factor conditions. For example, Porter (1998b) argued that specialised resources specific for an industry and its business imperatives can compensate for factor disadvantages. The physical resource germane to the supply chain strategy is the slate by-product which is perceived as a substandard, low quality waste material with its physical and chemical properties not being competitive with these of the primary aggregates (Figure 6-5) It is assumed that the slate aggregate particles are not strong, that it is not durable and will not compact. Through secondary data analysis, some of these perceptions are critically analysed. However, no primary data has been collected towards the topic of laboratory testing of physical and chemical properties of the product.

The directive analysis is focused on the available literature and secondary data on the performance of the slate by-product and the related aggregate material product family. To determine the best product operating cost (BPOC) while considering the design for environment and design for disassembly (DE-DD), the analysis inaugurates in the physical, chemical and mechanical properties of slate before expanding into a secondary data review of laboratory testing of slate aggregate.

6.4.2 Secondary data collection: case studies

The directive analysis reviewed secondary data from case studies of construction projects in North Wales, where the slate aggregate is used. The first case study analysed is the A55 coastal road and duelling of the A5 in Anglesey (WRAP, 2004), where slate aggregate was used as sub-base. The review of this case study confirmed that the slate by-product can be used as a standard sub-base material (Figure 6-5)
However, according to the quarry, the slate by-product has not been widely used for this purpose. The investigation continued with a number of telephone interviews with civil engineers to determine why the road building market is reluctant to use the slate aggregate and regard the material as sub-standard, flaky aggregate.

### 6.4.3 Properties of the slate by-product

The metamorphic rock in Wales has been present since the Palaeozoic age and is between 350 and 500 million years ago (Begg, 1995). There are three forms of slate in Wales which are Silurian, Ordovician and Cambrian (Table 6-1) (Thomas, 1956, Fieldhouse, 2006):
Prior to analysing in detail the slate mining by-product, in the interest of generalising the findings to other mining by-products, such as different types of mining by-product present with diverse physical and chemical properties. However, most hard based mining by-products are suitable for general or selected fill (Table 6-1) This argument creates the first attempt to generalise the product family classification of any hard mining by-product as a physical resource and therefore a factor that could create profit or reduce cost (Figure 6-6).

**Table 6-1: Physical resource present in slate mining industry**

| Slurian          | •Silurian is the most recent of the three slates to be formed.  
|                  | •Present in Llangollen, Glyn Ceiriog and Corwen  
|                  | •Least durable of the slates because it has had the least time under metamorphic conditions  
|                  | •Despite that Silurian slate has turned back into shale when left in slate heaps the industry has developed due to the easy access to major markets. |
| Ordovician       | •Present in Blaenau Ffestiniog and Corris  
|                  | •Is generally mined underground  
|                  | •Has a uniformly blue/grey colour throughout  
|                  | •This slate is easily processed using machines. |
| Cambrian         | •This is the oldest type of Slate  
|                  | •Present in the north around Bethesda, Llanberis and in the Nantlle Valley  
|                  | •Usualy with a purple colour, but this can vary  
|                  | •Cambrian Slates are mostly split, cut and finished by hand,  
|                  | •There has been some recent success with mechanisation. |
Figure 6-6: Relationship between profit and cost triggered by classification and application of the physical resource

This argument is supported by Woodward (2004) who investigated the performance of the Welsh slate aggregate and Goulden (1992) who reported that the slate has a high relative density, even higher than for most primary aggregates.

6.4.4 Product family

Dawson and Nunes (1993) identified that the weakness of the product is in the horizontal permeability of the slate aggregate that is much higher than vertical permeability. The findings of this weakness represented the first obstacle for the supply chain strategy. The preliminary discussions regarding the best product from the by-product family resulted with a strong interest in supplying slate aggregate for sea defences. Despite the case studies analysed that claim product suitability, the findings of the anisotropic and isotropic nature of the product, limits the product suitability for the sea defence market. Such market is still considered by the quarry executive director as worth investigating, however, the findings present a limiting potential as a sustainable market for the supply chain strategy.
Being from a reliable, regular source and being relatively inactive but durable means the slate aggregate can be used and perform well in many different contexts. However, the interview with (CzMs) identified that when slate travels out of North Wales it is being used by engineers with relatively little past experience of the aggregate. When tested using conventional methods, the impact may give a different impression of its compaction compared to a more conventional type of aggregate. This would suggest this is the main reason why civil engineers are reluctant to use most of the products present in the product family (Figure 6-7)

Figure 6-7: Impact of product properties to the relationship between profit and cost
6.4.5 Specific findings relating supply chain strategy with product family

Slate aggregate is concentrated in remote areas, with North Wales being by far the main producing area in the UK (Dawson et al, 1993). The critical analysis of Woodward (2004) and Goulden’s (1992) testing, concluded that testing methods may give a different impression of its compaction compared to a more conventional type of aggregate. These results impact the supply chain strategy because the testing determines the product supplied.

Secondary aggregate ‘can often be used instead of primary aggregate, for example as sub-ballast in road construction for which, as a totally inert material, it is particularly well-suited. Its use can help limit the demand on primary aggregate – itself a finite and more valuable resource.’ (C3M9)

The commercial value of the slate aggregate for the slate mining industry can be perceived from the following quote. ‘The industry is experiencing serious competition through the import of Spanish and Chinese slate, and it needs to diversify to ensure its continued viability as an industry. This can be done not only through continued production and promotion of traditional roofing slate, but by maximising the use of secondary aggregate which is a high-quality product in its own right, and the sale of which would not only signify the evolution of an industry to meet contemporary needs and thinking, but would maximise the commercial outcome of the whole quarrying process, and contribute to the long-term future of the slate industry in the region. Secondary aggregate represents 90% + of quarried material.’ (C1D1)

Slate secondary aggregate materials are produced to meet the requirements of a wide range of construction and civil engineering applications.
Figure 6-8: Product and product family categorised in relationship to potential utilisation of the physical resource


Considering that the slate aggregate is a by-product the question worth investigating in this context is identifying the (BPOC) from the product family and distribution processes to select. The product family is investigated only in the context of identifying the (BPOC)
and processes investigated are the supply chain activities that can be provided by the supply chain companies in terms of slate aggregate material, train rolling stocks, train containers, engineering machinery to take the product from quarry to the terminal and select the shipping and train routes that are most suitable for the supply chain companies. In Blaenau Ffestiniog there are only two modes of transport available, road or rail. The two modes each come with a number of options, including a multimodal transport with shipping from the Port of Mostyn (Figure 6-10)

The (BPOC) and processes stated above have individual production time and costs associated with them. Considering that there are multiple sections and processes, the study was faced with the task of identifying the sections and processes that could reduce the final cost of the supply chain. Some products, such as computing, have a product life span of one or two years. The slate aggregate product has an estimated long term product life cycle, because the demand for secondary aggregate is estimated to rise continuously in the future, while the supply in UK parameters is largely concentrated in North Wales. There are a number of potential products from slate aggregate product family (Figure 6-8)

An important component of this study is that the problems investigated in the research advance into a conceptual model that improves the decision creating process further than the attention of just production cost per product. In the context of this study, the production cost per product is investigated from the perspective of the final cost of the completed product, consisting of direct costs and allocated overhead. Direct costs in this context refers to costs that can be directly associated to the distribution of the slate aggregate, because the production cost is minimal in by-products.

Allocated overhead refers to costs compulsory for the product to get to the final stage but cannot be associated with an exact component of the production. In the case of North Wales slate industry the production cost per product is the prevailing measure in the design of a supply chain for a number of motives.

The first motive is that in the product development processes the slate aggregate product needs to reach a gross margin target before it is considered as sustainable for distribution.
The supply chain strategies specific to the mining products can be considered as the supply chain strategic collaboration, characterised by functionality that is of crucial importance in all the operations. The operation regardless of if it is related to raw material, the production, the assembly, or the transportation in each of these operations means the managers are faced with multiple options requiring specific activities. In this context, the research refers to the supply chain structure as an operation where each activity consists of an operational choice.

Figure 6-9: Example of the relationship between RD and BB’s

6.5 Transport dimension

Considering that the by-product has no cost associated with production, but also represents a low value product, the supply chain strategy must anticipate all additional costs. These costs are associated with transport and loading and are a crucial fixed cost
in deciding whether to consider the slate aggregate as a useful mineral or as waste slate. The transportation cost was identified as one of the main obstacles for the commercial exploitation of the waste product from the mining industry in the single case study investigated (ARUP, 2001, DTZ, 2004, Atkins, 2006, Parkman, 2001). Considering that the transportation cost is mentioned as the deciding factor in the secondary data reviewed (ARUP, 2001, DTZ, 2004, Atkins, 2006, Parkman, 2001), the single case study investigated if the phenomenon is present in other mining industries. From reviewing additional secondary data, the study identified that the transport cost compared to the cost of production is extremely high in all aggregates, from about 30% of the total for a delivery distance of 10 miles (15km), to 50% for 50 miles (80km) and pro rata above that (COMEU, 2000). These findings provided the justification for reaching the conclusion that the transportation cost represents one of the salient dimensions that influence the process of supply chain strategy formulation for the mining industries.

The largest resources of primary and secondary slate aggregate in the UK are based in North Wales (NWRAP, 2005), with most of the potential markets being based over 80km distance. Another option is transporting aggregates by rail if there is present infrastructure.

![Figure 6-10: Analysis of the potential freight transport modes](image)

<table>
<thead>
<tr>
<th>Preferred mode: Sea - Cargo ships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo ships are used for transporting aggregates in cases where aggregates are exported or when it is unworkable to move the aggregate by land.</td>
</tr>
<tr>
<td>Option: Port of Mostyn</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second best mode: Rail - Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>This option is applied when the final market is 100 miles or longer distance.</td>
</tr>
<tr>
<td>Trains can transport up to 400 tonnes of aggregate at a time</td>
</tr>
<tr>
<td>Trains are more reliable in terms of time</td>
</tr>
<tr>
<td>Option: Conwy Valley Line</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unsustainable mode: Road - Lorry</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 tonnes of aggregate in a single trip.</td>
</tr>
<tr>
<td>1 Mt = 124 trips per day</td>
</tr>
<tr>
<td>2 Mt = 249 trips per day</td>
</tr>
<tr>
<td>Environmentally and economically not viable option</td>
</tr>
<tr>
<td>Option currently applied: Road</td>
</tr>
</tbody>
</table>

Figure 6-10: Analysis of the potential freight transport modes
The transport cost factors will change with time and the consumers will start switching from using primary to secondary aggregates due to the aggregate levy applied on primary aggregates (DCLG, 2006). However, most customers will choose sources of aggregate predominantly on the bases of their distance rather than the material physical characteristics, because of the high cost for transporting aggregates (COMEU, 2000) This represents a salient dimension that is external to the supply chain strategy, but directly affects the strategy formulation (Figure 6-11)

Figure 6-11: Example of the relationship between TD and BB’s
6.6 Market demand dimension

6.6.1 Market demand for the by-product family

Ever since 1941, it has been documented that one possible use for slate aggregate is to produce expanded lightweight aggregate for use in concretes (Conley, 1942), creating a strong lightweight aggregate (Holm, 1993), but also the advantage of lightness which can be used in structures such as walls and roofs of buildings, suspension-bridge roadways and a number other usages where weight is an important factor (Conley, 1942). Furthermore, lightweight aggregates concrete blocks are ideal for structural buildings as they have good fire resistance properties (Dhir, 1996, Lindgard and Hammer, 1998), and have a comparable strength with normal or heavy weight aggregates (Fieldhouse, 2006).

Imaginably, these uses could attract a number of customers and consume an appreciable annual tonnage of slate aggregate from North Wales. However, it is worth mentioning that this study investigated the potential utilisation of the physical resource for this product on multiple interviews with geotechnical engineers and concluded that the cost of production is too high. The interviewing identified that an attempt was made in Blaenau Ffestiniog to commercialise this product, but the business has been closed.

Woodward et al (2004) established that slate aggregate fulfils the physical characteristic property requirements specified for unbound use in the UK road construction and that it is suitable for use in asphalt layers, while Sherwood’s (1994) study found that slate aggregate is a material with a high potential for usage in pavement foundation as Unbound Capping Layer and Unbound Sub-Base, and that the slate aggregate has some potential to be used as a Cement-Bound material (Sherwood, 1994).

The highest quality slate aggregate contributes to improvements in the stiffness of asphalt road-base, when compared with more commonly used aggregates (QPA, 2011). Mansur et al (2005) found that slate powder aggregate has a potential use in the manufacturing of ceramic pieces by applying the slip casting process (Mansur, 2006), while Campos et al (2004), in their study, documented that recovered slate aggregate is a suitable material for use in ceramic tiles, as the slate aggregate properties were within the range of these of conventional ceramic tiles (Campos et al et al., 2004).
Further tests were performed on the roads in North Wales where slate aggregate was used to firstly measure the performance after seven years in service (Goulden, 1992) and the reported degradation of the slate aggregate material was minor. Furthermore, it was also noted that the material remained stable during reconstruction of deficiencies caused by conventional aggregate (Dawson et al, 1993). Woodward et al (2004) presented different results than the conventional testing (Goulden, 1992, Dawson et al, 1993) and showed that slate performed identically to the best basalt in Northern Ireland where distortion of an unbound layer causes further distortions with overlying layers, slate aggregate could represent a better product for such usage.

The results are strengthened by the tests performed on the slate aggregate used as a sub-ballast for building roads in North Wales where the grading analysis of the slate aggregate material after seven years in service is reported in good condition or even better condition than expected from a conventional aggregate (Dawson et al, 1993). These findings confirm in the context of formulating a supply chain strategy for the mining industry, that the product family must be critically analysed to identify the best product and formulate the supply chain strategy accordingly.

6.6.2 Best product from the product family

According to Porter (1998b) companies can create a competitive advantage if the market buyers force the company to innovate faster and to create more forward-thinking products than those of competitors. Therefore, the market is one of the driving forces that create a great impact in the formulation of strategy. Directive analysis is applied to secondary data to determine the demand conditions.

The demand for secondary aggregate is increasing all around the UK (DCLG, 2006) The future aggregate demand is forecasted to low high scenarios of 0.4% and 2.16% with an average demand growth of 1.17% for aggregates in Scotland (WRAP, 2007). Further feasibility studies on sustainable use of resources have been undertaken for the West Midlands (WRAP, 2006) that resulted with projections of sustainable construction demand, market price and resource availability. Considering that the increasing demand is already established in previous studies, the demand conditions are only analysed in
relation to best product from the product family (Figure 6-8) in terms of supply chain strategy for utilising the by-product.

The supply chain strategy in terms of product innovation can be presented in a manner of forward thinking regarding the potential utilisation of the by-products. For example, ‘marketing secondary aggregate could mean that a by-product hitherto regarded as waste would no longer be regarded as waste, but as a valuable commodity’. This statement was further analysed and confirmed by the supply chain experts from the partner companies in a joint statement on a group discussion that:

‘It is anticipated that as promotion of the material intensifies, and demand for it increases and its high-quality properties become known and valued within the construction industry, that market – once it attains a certain level - could ensure the long-term viability of the slate industry.’ (EX1EP1)

Therefore, we presented the question ‘why is it not used, and how it is fit for purpose’ on multiple interviews at the quarry and group discussions with the consortium companies. Some of the quotes extracted from the group discussions with individual companies are presented as statements and listed to present their perception. The statements are confirmed with the consortium companies through group discussions to ensure that the quoted statements represent the view of the consortium:

‘Slate aggregate has been used whenever it has been viable to transport, for example on the A55, it was used on the sections of the road that was commercially viable to transport to and has been regarded as a success.’(C2M9)

‘It is not only fit for purpose but, in the view of some road construction companies’, slate aggregate is arguable a superior product for this purpose. However, the road construction industry is not familiar with it as a product and may be conservative about using it.’ (C5D1)

‘It is hoped that the diversification which this market would produce in the industry through the sale of what is a by-product of slate mining could result in the unit-cost of roofing slate becoming more competitive at a time when the viability of the Welsh slate industry is being threatened by the fact that its traditional market, roofing slate, is having to compete with imported Chinese and Spanish roofing slates.’ (C1D2)
However, statements are also recorded that present a viewpoint that the suitability of the product on its own is not sufficient for the product to be utilised appropriately.

‘The intrinsic superiority of Welsh roofing slate, as a product, does not alone deliver Welsh roofing slate the necessary competitive edge in the international market.’ (CsD1)

The salient factors from the market demand dimension relevant to the supply chain strategy are placed in the diagram and elaborated further in the analysis.

Figure 6-12: Example of the relationship between MDD and BB’s
6.7 Technology dimension

Supply chain formulation, for the mining industry in North Wales, creates a cluster presence of companies operating in similar areas of operation. This could, in effect, trigger intense rivalry in the home base and formulating a supply chain strategy that would eliminate conflict of interest is also important. Such strategy must also consider the context of creating pressure to innovate in order to increase competitiveness and upgrade technology, such as IT communications. That cost can be considered as investment in innovation, technological leapfrogging, employment and sustainable development. However, the fact that such costs can be high in some scenarios creates limitations on the quarry as individual company.

Integration in the supply chain strategy in this context does not represent an option and to develop the supply chain strategy for the secondary aggregate from North Wales requires integrating with 3PL’s and developing sustainable transport. Such strategic integration represented a unique greenfield supply chain strategy formulation. Regarding strategy formulation, Porter (1998b) stated that setting and managing the appropriate strategic goals is imperative for success. The process of formulating greenfield project strategy in this context requires examination of questions external to the supply chain, that directly influence the supply chain. Questions such as whether the secondary aggregate market could, in principle, provide the traditional product of the slate mining industry with the necessary competitive edge, and what level the market in secondary aggregate would have to reach to achieve this. The present inability to target or deliver to distant markets renders any significant evolution in the industry unlikely, if not impossible.

To ensure that the case study is specific to the topic of supply chain strategy rather than the broad study of the supply chain strategy dimensions and factors, this topic has been considered answerable through existing secondary data resources available to this study (Parkman, 2001, ARUP, 2001). However, opinions have been collected on the topic from interviews.
Figure 6-13: Example of the relationship between TrD and the BB’s
6.8 Environment dimension

The preliminary theory on supply chain architecture for greenfield project strategy investigates the chance events that are outside of control of the supply chain companies, but can create significant discontinuities for acquiring and losing competitive positions. The chance events identified are: surges of demand, environmental decisions, and discontinuities in input cost, infrastructure and technological discontinuities. The chance events create an environment associated to the new sources of advantage and supply chain companies should move most aggressively to utilise them. In this respect it was found that the environmental impact from the mining industries is quite significant but the environmental regulations are outside of the control of the companies. There are constant environmental decisions (6.8.1.1) aimed at creating a surge in demand for secondary aggregate. One of the key factors that affect decision makers when determining new manufacturing, industrial development and transportation is the need of reduction in environmental impact (UNFCCC, 2009). Example of such policy is the aggregate levy (6.8.1.1) aimed at encouraging recycling by referring to the benefits such as reduction of environmental impact and reduced cost.

6.8.1 Supply chain strategy and environmental impact from product family

The use of slate waste has been limited in quantity and in area, with approximately 0.5 million tonnes currently being used, representing a small percentage of the annual production, leaving untouched all the stockpiled material (Dawson et al, 1993). The environmental improvement of using the slate aggregate as an alternative to conventional aggregates involves prior resolution of other issues such as lower cost and lower carbon emissions transport in the supply chain, or what seems to be an improvement may have misleading results. The problem supply chain strategy is faced with in North Wales, is that trains often follow level gradients, and therefore take indirect routes, and quarries are transporting their products to the market using trucks and lorries and the extra pollution caused by transportation could be the same as the extraction of other materials elsewhere (Fieldhouse, 2006).
6.8.1.1 Aggregate levy

The literature review in Chapter 3 established that supply chain strategy formulation must anticipate environmental problems (3.5.1) In the context of strategy formulation for the mining industry the aggregate levy represents a supporting factor. The aggregate levy is aimed at reducing the amount of waste aggregate going to landfills and reducing the unwanted surplus amount of aggregate dug out of the ground (HMRC, 2002). The Aggregate Levy is an environmental tax on commercial exploitation of primary aggregate and is introduced to encourage usage of recycled and waste materials (HMRC, 2002). Companies around the UK are adding extra expenses by paying the aggregate levy for extracting aggregate, then sending large amounts of aggregate into landfill sites, paying for landfill tax, transport costs and damaging the environment (Fieldhouse, 2006), while the standard rate of landfill tax is gradually increasing (HMRC, 2010).

6.8.1.2 Damage to the environment from eating into the mountains

The detrimental effect on the environment caused by mining and quarrying for aggregate is an environmental area of concern. To protect the environment the obvious solution would be to stop the extraction of minerals from the ground. However, such option is unlikely to be implemented, considering the increasing demand for minerals. The process of extracting new slate requires quarrying between veins of other rock types and is performed with three main extraction methods:
Extraction of slate from the mining industry in the town of Blaenau Ffestiniog has always been predominately by underground mining mainly because the slate beds dip northwards at an angle of 35%, therefore there are no quarry face scars present as in other slate quarries (Anderton, 1982). What does North Wales have, as a result of the slate industry mining is slate waste on monumental scale created by the ratio of useful slate to waste material being more than one to ten (Anderton, 1982). The slate heaps are present in Blaenau Ffestiniog in such large quantities mainly because the beds of the pits are inclined at lower angles, which creates a large quantities of slate waste in the process of quarrying (Thomas, 1956).

Reducing the new extraction of minerals requires alternative supplies to ensure the continuity of development in infrastructure and to satisfy demands from the industry and customers. One possible solution is to use secondary recycled aggregates such as shale, clay, or slate which can be found in large quantities in mining towns in North Wales (Dawson et al, 1993, ARUP, 2001, ODPM, 2002, NWRAP, 2005, WRAP, 2010). Using the by-product which creates a large amount of waste material could reduce the damage caused to the countryside by reducing the amount of new aggregates and even clearing the waste heaps.

Table 6-2: Environmental damage from mining operations

Extraction of slate from the mining industry in the town of Blaenau Ffestiniog has always been predominately by underground mining mainly because the slate beds dip northwards at an angle of 35%, therefore there are no quarry face scars present as in other slate quarries (Anderton, 1982). What does North Wales have, as a result of the slate industry mining is slate waste on monumental scale created by the ratio of useful slate to waste material being more than one to ten (Anderton, 1982). The slate heaps are present in Blaenau Ffestiniog in such large quantities mainly because the beds of the pits are inclined at lower angles, which creates a large quantities of slate waste in the process of quarrying (Thomas, 1956).
6.8.1.3 Damage to the environment from slate heaps

The traditional mining and quarrying industries through the process of extraction produce large holes. The waste from the holes is thrown in the surrounding area creating the waste heaps. Many of the quarries dumped their slate waste aggregate over the nearest slope (Fieldhouse, 2006) creating slate heaps without any environmental considerations. The environmental consequences of this dumping by the slate industry have been considered harmful to the environment (Anderton, 1982). For example, the town of Blaenau Ffestiniog is surrounded but excluded from the Snowdonia National Park as the slate waste heaps create problem that will not disappear in a short time frame (Anderton, 1982).

The chemical and physical properties of the slate which makes it into a good roofing material also mean that the soil formation on the slate heaps is a very slow process (Anderton, 1982). Adding to this, the coarse angular material contains many voids, with the angle of rest being 40% to 45% making soil or water retention extremely difficult, resulting in virtually no natural re-vegetation being restored even after half a century (Anderton, 1982). Furthermore, Fieldhouse (2006) found that the physical and chemical characteristics of slate heaps impacts the environment because of factors such as ‘very coarse texture materials, extremely slow weathering rate, and minimal nutrient content’.

6.8.1.4 Secondary Aggregate vs. Primary Aggregate

The ecosystems surrounding the mining and quarrying communities will benefit from the reduced amount of expanding aggregate waste heaps and potentially improve and restore its original ecosystems that were destroyed by the waste aggregate heaps. The additional benefit to the industry is that a product that has been classified a waste can become a commodity, resulting in a reduced cost for material acquisition, taxes and levies. This creates a potential for a decrease in the input cost triggering a surge in demand and increasing the economic viability of the primary aggregate products that will contribute positively towards creating and maximising profits.

The corollary is that removal of slate waste creates brown field sites that might be used for further industrial development whether in the form of some diversification of the slate industry or a totally different industry.
For example, the Glan Y Don waste tip in Blaenau Ffestiniog was removed in 1975 creating an environmental remedy beneficial to the overshadowed houses and paved the way for a road expansion on the north side of the town (Anderton, 1982). In the process 570,000 million cubic meters of slate waste were removed and re-tipped at lower lying waterlogged areas of the valley at the cost of over half a million pounds (Anderton, 1982).

Figure 6-14: Example of the relationship between ED and BB’s

This case study research investigated how and whether, the slate secondary aggregate can be utilised in an economically profitable method. The study also investigated the downfalls of using slate secondary aggregate, and through secondary data analysis it is acknowledged that some of the slate heaps can create a dangerous and unstable environment for working. This, especially when working with large vehicles as there is a
fear that slate heaps can cause a ‘slate avalanche’ Fieldhouse (2006) Also, Campos et al (2004) identified that while working with very finely grained material products made of shale and slate, the dust inhalation can cause reason for concern. The alternative argument is that leaving the slate heaps also poses health and safety risks to the quarry workers and even to the local population. However, these factors must be considered before or during the supply chain strategy formulation. The risks and returns must be analysed in great detail before engaging into activity that would cause more damage than good.

6.9 Build dimensions and forces from conceptual diagrams in the conceptual framework

The secondary data review identified multiple elements, dimensions and factors that influence and affect the supply chain strategy formulation in a greenfield context, specific to the mining industry. Through semi-structured interviews and group discussion with the supply chain consortium participants, these dimensions, elements and factors are determined as representing the business environment for the mining industry in North Wales. To generalise the reference material in a visual method, a conceptual diagram is presented for further research into the applicability of the identified dimensions and factors.
Figure 6-15: Architecture for investigating the relationship between external and salient dimensions in greenfield project supply chain strategy formulation
6.9.1 Building greenfield project architecture in conceptual framework

Figure 6-16: Conceptual framework for greenfield project supply chain architecture
Figure 6-17: Framework key of the building blocks for the mining industry supply chain strategy architecture
6.9.2 Contribution to practice

The process of building the conceptual framework initiates with directive analysis and presents an argument that the slate aggregate characterises a specialised resource specific for the slate industry and its business imperatives, and that can compensate for other factor disadvantages in the industry. However, the conventional analysis presented doubts about suitability of the by-product for the industry preferred BPOC. The result from the analysis derives a conclusion that BPOC in the context of the mining industry, depends on very detailed analysis of the product properties, while in existing supply chains, companies are investigating the potential of their product families, in a greenfield context, failure to determine the BPOC could result in catastrophic results for the strategy formulation. Considering the value of BPOC for supply chain strategy, the study describes the process of applying directive, conventional and summative analyses to build the BPOC in the formulation process.

The directive analysis identified that North Wales slate by-product is suitable aggregate for use in road construction. The secondary data reviewed clearly shows that slate has properties comparable to high quality aggregate used in highway construction (6.4.5) There are examples of aggregates with much lower strength values than slate, but these aggregates are used and preferred in the market because of testing methods being material specific, and therefore give misleading results. Therefore, the performance of the product must be separated from the limitations of various test method, both in the laboratory and in the field with actual performance (Figure 6-7)

In the case study investigated, the supply chain strategy is not in a final stage; therefore, several costs are dependent on the operational choices. These choices will affect numerous supply chain design costs, such as the cost of by-product shifted which is representative of the direct variable cost of the product (Figure 6-10), determined by the number of tonnes shifted (2.1.3) Another variable is the needs to build the transport cost into the final cost of delivering the slate aggregate from quarry to the customer. To evaluate the validity of this argument, the research reviewed secondary data from internal reports to analyse and compare the product and transport cost of the slate aggregate.
6.9.3 Contribution to method

With regards to validity and reliability, the case study applied triangulation sampling design to represent different groups in the interviewing. Further validity checks were performed with the participants after the data was transcribed, as a method of respondent validation. The validity of the summative analysis is evaluated through two group discussions that included proportional number of participants from the groups interviewed. The measure of credibility applied is the participants’ confirmation that the results are found believable in the group discussions. However, the case study undertaken does not control the large number of variables, nor can the study guarantee with complete certainty that the most important factors are truly identified.

6.10 Conclusion

The greenfield architecture for supply chain strategy formulation in Chapter 1 contributed to knowledge with a conceptual framework that enables further research to identify, focus and relate the framework elements to different business environments. This chapter addressed Postulate 1 by deriving with a process of understanding, and placing into a framework the strategic activities. It then started building background theory for addressing Postulate 2 in distinguishing between descriptive and actual happenings.

In a scenario where the supply chain activities consist of a number of choices, there are a number of probable supply chain salient dimensions. These are evaluated with conventional analysis and supported with summative analysis. The analysis is aimed at identifying the elements, factors and forces within the salient dimensions of the supply chain operations in the slate industry in North Wales and generalise the findings to the mining industry.

Major contribution to theory in this chapter can be identified in addressing multiple gaps in Figure 4-2. The gaps addressed are Gap 1 to Gap 5. In addition, the chapter initiated the process of relating the architecture with integration, thus, partially addressed Gap 11. The major novelty in this chapter is the direction towards formulating holistic theory that anticipates external influencers, emerging from
specific environment and dimensions and relates these factors, forces and elements
with the business and supply chain strategies. In the following chapter (Chapter 7) the
findings derived from this chapter are applied for designing business strategy that
anticipates the effect from the external and salient dimensions (Figure 6-15; Figure
6-16 and Figure 6-17)

In the subsequent chapters, the study expands the greenfield architecture by applying
grounded theory, case study and action research to investigate the relationship
between the salient dimensions and greenfield business and supply chain strategies
and to build upon the conceptual framework.
Chapter 7 Greenfield project business strategy integration

7.1 Introduction

The theory development in this chapter embodies a process of building upon the conceptual framework in Chapter 1. The theory building process is representative of ideas and concepts conceived as an interrelated, interworking set of objectives that enable the development of systematic understanding of the topics outlined in section 1.7. The theory building is aimed at advancing the understanding of the effect from supply chain salient dimensions (Figure 6-15). The proposed approach derives from adapting the synthesised findings from Chapter 1 to extend and redefine the existing knowledge on the practice of supply chain strategy formulation. Through applying directive, conventional and summative analysis in Chapter 1, a number of critical problems emerge (Figure 6-16) closely related to the business strategy. The emerging critical problems are representative of the shortcomings in the business environment and are addressed further in this chapter.

The sample population in this chapter represents small and medium sized companies that are limited in their supply chain operational capabilities. Following the findings from Chapter 1, the lead company (C1) in the case study confirmed that they must abandon outsourcing activities and integrate their supply chain operations to achieve their business goals and deliver the preferred products to the market. The findings from Chapter 1 highlighted the importance of the business strategy in leading the supply chain towards addressing the salient dimensions (Figure 6-15) This chapter contributed to knowledge by investigating the question of how greenfield project business strategy can be formulated to integrate multiple supply chain participants in the supply chain strategy. This chapter applies interplay between a inductive and deductive grounded theory building approach to build upon the greenfield project supply chain architecture in Chapter 1 and contribute to knowledge to the topic of formulating integrated business and supply chain strategy.
7.1.1 Study participants

The research methodology design analyses the integration of multiple participants in the form of a consortium working towards a common goal. Through a memorandum of understanding, signed by the study participants, an agreement for integration was reached that eliminated the obstacle of obtaining access to primary and secondary data. Through these, the research obtained commitments from individual participants to contribute in the process of primary and secondary data collection. Furthermore, two of the participants were involved in a previous attempt to formulate a supply chain strategy. The research also gained easy access to these historic records. This has reduced the expected duration of the secondary data collection and enabled the focus of this case study towards primary data collection and analysis.

The integration eliminated the obstacle of obtaining access to primary and secondary data, however, the consortium design also created many obstacles in the data collection process. Multiple participants in a consortium bring diverse industry interests in the formulation of the business and the supply chain strategy. In the initial stages of the data collection, it started to become obvious that a comprehensive and systematically structured approach was required to address these obstacles.

The process of addressing the obstacles enabled this study to build upon the preliminary framework (Figure 6-16) and evaluate the relationship between the salient dimensions, the business strategy and the supply chain strategy, through:

a) Evaluating the relationship between the multiple participants and multiple business goals;

b) Integrating multiple business goals in the supply chain strategy,

c) Generating preliminary theory on the relationship between multiple industry goals in a greenfield project business and supply chain strategy formulation.

The data collection interviews in this chapter include: a) (1) 23 participants from the lead company; (2) 12 participants from the consortium companies; followed by b) 15 participants from (a) NGO’s operating in the area, (b) experts from other parties operating in the North Wales area, (c) the logistics provider during the slate industry golden days. Further details of the study participants are provided in Chapter 4.
The evidence collected from the participants is obtained with informed consent of the participants at the time of the data collection and with a commitment that their identities and their privacy will be protected. The methods for data collection and analysis applied in this chapter are partially manual and partially computerised and aimed purely at advancing the topic researched. The manual data collection methods included the interviews and two group discussions. The computerised data collection includes (1) electronic feedback requests of the transcriptions from the interviews, to validate the data as a method of respondent validation; (2) a questionnaire related to individual participants business goals. The theory development through case study data collection and analysis is supported and complimented with sufficient amounts of primary data gathered through action research to establish the validity and credibility of the research analysis and interpretations. The theory development is followed by in-depth group discussions related to validating the findings and to interpret its meaning related to the research questions. The process is supported with illustrative references designed in the research process.

7.2 Business strategy formulation

The formulation process in this study begins by requesting the lead company to define their overall business objective as a vision that can be applied to formulate the business strategy concept. Perez-Franco (2010) In their review of multiple case studies, Perez-Franco (2010) found that companies resort to one statement representing the central and important idea in the form of a ‘strategic core’ in their process of articulating the business strategy.

Their findings were applied as given by existing literature and the strategic core obtained was considered as representing an explicitly defined statement and quoted in exact wording to articulate the central idea (the vision) behind the business strategy. The executive directors defined and quoted the strategic vision as ‘a slate industry that had evolved to meet the needs of the 21st century’. This statement was also documented in the initial research plan and strategy for the research study. This initial business objective defined as a vision, explicitly stated by the quarry, presented a vision that is in fact blurred and very complex.
To clarify the idea behind the given vision, a series of open-ended interviews with group B and C were performed. The interviews were focused on obtaining valid data for analysis and if the interview was considered as not contributing towards quality data collection, focus was placed on the salient dimensions from Chapter 1. If the interviews were developing towards quality data collection, the salient dimensions were discussed only towards the end of the interviews. During the interviews it was confirmed that the idea contained in the statement triggers a number of closely related strategic objectives and social goals.

The data collected was transcribed and categorised with aim to investigate the relationship between the business objectives and the salient dimensions. The transcribed categories were analysed and evaluated through feedback requests from the interview participants. The aim of the analysis was to identify the ideas behind the statements using open and categorical coding. Table 7-1 outlines sample quotes illustrating the categories and subcategories identified that relate to the ideas behind the articulated strategy and the salient dimensions.

<table>
<thead>
<tr>
<th>Salient dimensions</th>
<th>Quotes</th>
</tr>
</thead>
</table>
| Resource dimension (RD) | **Product**  
2A) Differentiate through innovation  
1B) Introduce by-product materials to the markets  
1C) Bring new by-products to the market  
3B) Reduce cash to cash cycle  
9C) Match production to fluctuating demand |
| Transport dimension (TrD) | **Cost**  
2A) Develop new low cost supply chain  
2B) Lower the cost of transport from quarry to customer  
1A) Procure high value transport at low cost  
2C) Reduce cost of transport  
5C) Develop low cost responsive and effective rail transport  
9C) Infrastructure planning  
3B) ...lower distribution cost  
8C) Develop finance plan for the required infrastructure  
1C) Detailed cost appraisal  
7C) Resolve the logistic element of the supply chain |
<table>
<thead>
<tr>
<th>Dimension</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market demand</td>
<td>2A) Secure position in the aggregate material markets</td>
</tr>
<tr>
<td></td>
<td>3A) Rebalance the market power in aggregate materials</td>
</tr>
<tr>
<td></td>
<td>4B) Create trust and acceptance in new markets</td>
</tr>
<tr>
<td></td>
<td>9C) Screening defining and targeting individual markets</td>
</tr>
<tr>
<td></td>
<td>8C) Scope, identify and target new markets</td>
</tr>
<tr>
<td>Profit</td>
<td>3A) Obtain the highest market share possible</td>
</tr>
<tr>
<td>Solution</td>
<td>3C) ...branding innovation</td>
</tr>
<tr>
<td>Technology</td>
<td>2A) Develop technology... capability... infrastructure to increase competitiveness</td>
</tr>
<tr>
<td></td>
<td>5B) Create multiple virtual quarries in rail terminals</td>
</tr>
<tr>
<td></td>
<td>2B) Develop locations with virtual quarries</td>
</tr>
<tr>
<td></td>
<td>1A) Attain control over the supply chain</td>
</tr>
<tr>
<td></td>
<td>2C) Integrate with third party logistics to reduce the financial cost of delivery</td>
</tr>
<tr>
<td></td>
<td>9C) Optimise the supply chain</td>
</tr>
<tr>
<td></td>
<td>9C) Develop engineering and transportation infrastructure</td>
</tr>
<tr>
<td>Environmental</td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td>1A) Reduce environmental costs</td>
</tr>
<tr>
<td></td>
<td>3C) Reduce cost by increasing sales margin from selling recycled by-products</td>
</tr>
<tr>
<td></td>
<td>2B) Initial cost analysis to assess the potential to reduce cost</td>
</tr>
<tr>
<td></td>
<td>8C) Lower operational cost</td>
</tr>
<tr>
<td></td>
<td>9C) ...improve efficiency</td>
</tr>
</tbody>
</table>

Table 7-1: Sample categories and subcategories

To identify the precise aspects of these strategic objectives and to formulate the business strategy in a more visual method that could be understood and evaluated, it referred to additional text, provided by group A participants from (C1). The text was requested specifically to elaborate on the provided business vision and to define the goals of the strategic vision. In the process, content analysis was applied to scrutinise
the expanded elaboration of the statement. A section of the analysed text is provided in one paragraph in the form of a direct quote as obtained;

‘The promotion of secondary Ordovician aggregate as a product, whether as blocks for walling, or crushed for use as a high-quality inert material, particularly well-suited for use as sub-ballast, requires appropriate rail infrastructure. Because of its bulk and weight, it is not economically viable to send it by lorry-loads, neither would that be environmentally desirable or acceptable. For this reason, planning restrictions exist on how many lorry movements may be made from the quarries. These constraints have resulted in the industry not being in a position to tender for contracts – some of them potentially major ones, like the Olympic Stadium. The quarry is ideally situated to transport aggregate by rail, as it is situated close to the Conwy Valley Line and has a connecting tunnel to a location adjacent to the line. The line itself needs engineering works that would allow heavy industrial workings. These are achievable.’

The content of the text provided was further discussed with the participants categorised in group A and the potential strategic goals were acquired and associated to the strategic vision:

1. Diversify the processes and outputs in the quarry,
2. Develop a low cost transport,
3. Develop multimodal transportation,
4. Reduce the carbon emissions,
5. Develop in the area of sustainability,
6. Invest in technology, capability and infrastructure,
7. Increase the market share,
8. Secure longer term market for the product.

The extracted strategic goals were built into a conceptual diagram during the group discussion to visualise the results (Figure 7-1)
The extracted strategic goals in Figure 7-1 were discussed further with the group and similar goals were merged to keep the ideas not the wording. The goals to ‘reduce the carbon emissions’ and ‘develop in the area of sustainability’, were merged into ‘pursue environmental sustainability’. In the same process, the goals to ‘develop a low cost transport and ‘develop multimodal transportation’ were merged into ‘develop low cost transport’. While ‘increase the market share’ and ‘secure longer term market for the product’ were merged into ‘increase the market share and secure long term market’.

In the process of merging the goals, a number of internal documents were presented and reviewed, including graphical maps of the rail lines and a wealth of records from the previous formulation attempts, to ensure the formulation preserves and contains the idea behind the company vision. The following goals remained and the conceptual diagram is redesigned accordingly (Figure 7-2):

1. Diversify the processes and outputs in the quarry,
2. Develop low cost transport,
3. Pursue environmental sustainability,
4. Develop technology, capability and infrastructure,
5. Increase the market share and secure long term market,
6. Build strong brand for the by-product
It must be emphasised that the design process represents a crucial stage in a greenfield project formulation because it was found that the latter stages (Chapter 8 and Chapter 9) are strongly dependent on the soundness of the strategic vision and goals. The vision and goals represented concepts that lead the research in grouping different categories and themes that emerge in the process. To ensure validity of the vision and goals concept behind the formulation a number of steps are recommended. To prove the validity of the concept as an accurate representation of the business strategy, the conceptual diagrams were presented to directorial, managerial and operational level employees to:

1. Confirm and validate the concepts (1) individually and (2) through group discussions that would include the management team responsible for the company strategy.

2. Confirm and validate the soundness of the concepts through interviewing operational level employees. The second step is recommended to ensure that strategic vision is realistic in the context of company capabilities.
In the first step, the strategic goals were described as a complete conceptual representation of the vision behind the business strategy. Considering the importance of the business strategy as the central idea behind the supply chain strategy, to ensure validity, the second stage scrutinised whether the presented strategic vision is realistically achievable. The recommended process includes validating the vision and goals through the operations by referring to the operational level strategies and operational capabilities. The process was accompanied with a number of field-interviews with operational level employees, supported by group discussions, resulting in a conclusion that the strategic goals are implicitly representing the interests of the quarry business strategy.

However, direct field-observations served as an assessment of the essential operations to achieve the expressed vision and goals and disclosed diverse obstacles in assembling a formulation concept. Obstacles were caused largely by the interviews and field-observations identifying insufficient clarifications regarding the activities in the essential supply chain operations. The business strategy, as expressed represented a statement referring to a seemingly simple idea, but in fact the idea is very complex and represents a vision and several complex ideas. These ideas are categorised and built into a conceptual diagram (Figure 7-3), alternative categorisations (in Figure ) and detailed concept diagram map of the formulation (in Table F-1)
Figure 7-3: Categorising concepts and objectives in the subcategories

The concept diagram derived from applying content and discourse analysis to the text in the categories and subcategories (Table 7-1). The expressed business strategy is focused on objectives related to desired status or action to be achieved.

Multiple interviews with the sample of participants external to the company, outlined above, derived indications that the business strategy as expressed (Figure 7-3) represents a vision in the form of a social goal that could bring the revival of the declining slate mining industry in North Wales (Figure 7-4).
The interviews were followed by group discussions with the external participants and the findings indicated that in addition to the industry revival, the business strategy as presented could also trigger increased economic activity in the area and directly mitigate the external dimensions (6.1.1). While such a topic is beyond the scope of this study, the values in these findings in relation to the topic studied are presented in the reverse effect of greenfield project business integration. The interviews and group discussions resulted with emerging indications that the interaction between greenfield project business creation and the surrounding business environment are interrelated (Figure 7-4).

**Figure 7-4: Salient dimensions effect the external dimensions**

This vision provided by (C1) represents an accomplishment of a number of ambitious strategic action objectives (Figure 7-3). However, the vision objective can be accomplished only by achieving operational (imperative) action objectives (Figure 7-3). In the case of (C1): lower product price, environmental sustainability; or determination to achieve a goal; greater market share, have a low cost transport.

The field-observations and field-interviews with operational level employees were aimed at extracting the operational activities required for executing the stated vision
and goals. A detailed diagram of the findings can be found in (Table 9-16). The investigation failed to identify an actionable concept for achieving the vision and decomposing the business and supply chain strategy and resulted with a number of concepts that could not be performed by the company, such as:

a. Develop low cost responsive and effective rail transport  
b. Reduce cost of transport  
c. Secure position in the aggregate material markets

The outlined process determined that the business strategy is a true representation of the quarry’s perceived desired goals. However, the process of investigating the operational activities, created a great deal of uncertainties regarding whether the stated business strategy is a true representation of the quarry operational abilities. The strategic vision and goals can only be implemented through the operational capabilities and the lack of operational capabilities resulted in the stated vision and goals failing to produce a valid concept in previous formulation attempts. The quarry (C3) has not been able to implement their desired strategic vision and goals because of lack in assets, logistics capabilities, transportation infrastructure and know-how, but also because of culture. The culture of ‘go it alone’ is perceived in this study as the first required change for formulating a supply chain strategy. The quarry executive director acknowledged that the supply chain operations require integration with companies with abilities in transportation, logistics, engineering, distribution, storage and retailing. These were seen as the formulation areas of problems for utilising the mining by-product.

7.2.1 Relating the findings

The slate mining industry in North Wales has left a large quantity of by-product, but for a long period of time the quarry was unable to formulate a supply chain strategy for utilising the assets. The process of moving the by-product from the quarry to the market required that the quarry collaborate and integrate the operations with participants from other industries in formulating the supply chain strategy. Evidently, outsourcing is a valid alternative to integration, but eliminates the internalisation of the activities and outsourcing highly strategic activities can cause a ripple effect through the entire company.
While all companies purchase elements of their operations, substitution of core internal activities from external purchases can be seen as discontinuation of internal production or even ‘vertical disintegration’ (Gilley and Rasheed, 2000). In this case the outsourcing represented outsourcing through abstention, because it does not represent shifting existing activities to external suppliers, but represents outsourcing services that are not currently completed internally. The abstention was not a choice to reject internalisation, but a shortage in capital and experience and the only choice within the managerial and financial capabilities. However, the lead company (C1) was open to formulating supply chain strategy integrated with the supply chain participants and representative of a networked organisation. The supply chain operational integration was considered by the lead company (C1) as crucial to formulate the supply chain strategy.

The lack of integration between the logistics requirements and the transportation providers, combined with the lack of integration in the market distribution and the remaining supply chain strategy aspects was in the view of the (C1) management team the main obstacle in utilising the by-products from the mining industry. The integration of these functions is the key in formulating a supply chain strategy for utilising the by-products from the mining industry.

Some of the most difficult technical tasks specific to integrating these functions are the environmental implications, the demand uncertainties, the low profit margin and possibly the biggest obstacle, the weight and bulk of the product. These factors restricted and increased disproportionally the transportation cost comparing to the value of the by-products.

Formulating a supply chain strategy for the mining industry by applying the operational strategies of the industry participants would not give the desired results and the lack of strategic alignment would represent a form of outsourcing without combined vision and goals. The scepticism for such approach arises from arguments in the existing literature confirming that supply chain functional strategies are interlinked with the participating industries in the chain and require jointly coordinated action (Schnetzler et al., 2007, Martínez-Olvera and Shunk, 2006, Cigolini et al., 2004, Narasimhan et al., 2008, Ivanov, 2009).
The lack of strategic integration in \((C_1)\) is possibly caused by the supply chain strategy continuously being confused with other aspects of the core growth drivers, such as production, marketing and finance, such indications were identified in this study (Figure B-1, C-1). This is a common phenomenon and existing literature confirmed that the importance of production, finance and marketing are recognised as core drivers of success, however, the supply chain strategy operations are often confused with marketing or production (Narasimhan et al., 2008). Prior to presenting the next stage of the data analysis, to narrow the scope of what the study perceives as a greenfield project formulation, two further clarifications have been implemented in designing the operational concept:

a) The formulation is focused on identifying BCAO for delivering the products from production line to the market and CGSI.

b) The formulation is focused on investigating IMSC by focusing on the relationship between integration and strategic goals, and UF such as: lowering the delivery cost, reducing the product cost or FOI in terms of creating value through integration.

An extensive analysis of existing methodologies on the process of formulating a supply chain strategy identified (Perez-Franco et al., 2010, Martínez-Olvera and Shunk, 2006, Schnetzler et al., 2007) as the closest methods in existing literature. The findings in this chapter (7.2) challenge the existing understanding of business strategy integration and call for future research to the topic.

### 7.2.2 Greenfield project business strategy integration

To evaluate these findings further, sets of interviews were performed with four executive directors and one operations manager, designed to perform analyses of the participating companies’ individual business and supply chain strategies. The resulting findings confirmed that the strategic vision and goals of \((C_1)\) (Figure 7-1 and Figure 7-2) do not represent the vision and goals of the participants. An electronic questionnaire was designed and distributed along with the conceptual diagrams (Figure 7-1 and Figure 7-2) to confirm these findings further (Table 7-2).
Is the strategic core true representation of your company strategic interest? Placing the question in the context of a specific integration strategy formulation. Placement text applied: *Is the evolution of the slate mining industry in North Wales a true representation of the core strategic interest?*

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>True representation</td>
<td>3</td>
</tr>
<tr>
<td>To some extent true</td>
<td>2</td>
</tr>
<tr>
<td>Lead to the achievement</td>
<td>1</td>
</tr>
<tr>
<td>To some extent untrue</td>
<td>0</td>
</tr>
<tr>
<td>Completely false</td>
<td>-1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>True representation</td>
<td>3</td>
</tr>
<tr>
<td>To some extent true</td>
<td>2</td>
</tr>
<tr>
<td>Lead to the achievement</td>
<td>1</td>
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<td>Lead to the achievement</td>
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<tr>
<td>To some extent untrue</td>
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<tr>
<td>Completely false</td>
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Table 7-2: Responses from supply chain participants to integrated strategy vision

Three out of five participants stated that their business was not directly associated with the slate mining industry in North Wales prior to this formulation (Table 7-2). The fourth company had only interest in increasing the business potential of their warehouse located on a nearby brownfield site, regardless of whether it was used for the mining by-product or any other purpose. The warehouse was located on the most suitable location for building a distribution centre with a multi-freight terminal for loading the product, two crucial operational elements of the supply chain strategy.
To confirm that the stated documented strategic vision is not a true representation of the greenfield project strategy concept and to identify the individual participant goals; specific questions were built into the interviews related to the strategy formulation (8.2). This process is recommended to ensure the vision and goals are effective in linking the business and supply chain strategies, and are: 1. CE representative of the operational capabilities of the supply chain participants; 2. PAO representative of the strategic goals of the supply chain participants.

From the response collected through the interviews, the explicit message was that the vision behind the strategy was not representative of the supply chain participants and the stated strategy vision was determined as mainly being relevant to the vision of the lead company (C1). Therefore, it was not representative of a vision shared by the supply chain participants. However, the ideas behind the goals, was confirmed as an applicable representation of the interests of the multiple companies that create the supply chain. To validate these findings, the questionnaire (Table 7-2) was accompanied with additional questions (Table 7-3).
Do the strategic goals represent correctly your company business interest? Placing the question for confirming the context of the business goals in the specific integration strategy formulation. Placement text applied: Is the evolution of the slate mining industry in North Wales something that will lead to the achievement of your company business strategy? Or individual aspects of your business strategy?

<table>
<thead>
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<th>Column2</th>
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</tr>
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<td>Lead to the achievement</td>
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<td>Completely false</td>
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Table 7-3: Responses from supply chain participants on integrated business goals

These findings contributed to the process of characterising greenfield project business strategy integration and concluded that when multiple companies are integrated in formulating a greenfield project strategy, the vision and goals must be articulated in a method that the strategic vision is determined through the integrated goals and the goals should be representative of the integrated vision (Figure 7-5).
Figure 7-5: Integrated business strategy

To confirm and validate these findings, a number of additional questions were built into the interviews in Chapter 8 to investigate the relationship between the greenfield project goals and participants existing business strategies. This step was considered instrumental in confirming the vision and goals validity, but also, to identify how the participants’ goals can be grouped into categories that would serve as a link to the supply chain activities and enable the design of integration as a method for integrating strategic choices. Without identifying the individual goals, it would be impossible to ensure that the research is investigating the appropriate concepts, which is crucial for capturing the essence and forecasting the effect of supply chain integration.
7.3 Conclusion

This chapter derived a new understanding of the process of formulating greenfield project business strategy integration. The theory building process applied the case study research method and confirmed that there are critical problems present in professional practice in the context of this study (Chapter 2) and in terms of applying the supply chain principles identified in the literature review (Chapter 3) The process of addressing Postulate 2 and building upon Postulates 4 and 5, redefines the existing understanding of the problems conceiving the relationships between business and supply chain strategy. This chapter is related to Gaps 6, 7, 10 and 11 (Figure 4-2).

The field of business strategy is a well-studied topic. For example, Mintzberg et al. (1998), named ten models on strategy formulation. Nevertheless, there are still many disagreements between academics and managers on many important phases of business strategy. This chapter reviewed the segments of strategy formulation that have been somehow overlooked, such as how strategy is formulated on a greenfield project level involving integration of a number of companies that operate in diverse fields (Gap 10), specifically in the context of Postulate 4 and 5.

The study derived insights into the shortcomings of the methods present in existing literature. The findings from this chapter are applied as guidance for the theory building process in the following chapters. The chapter also outlined a new approach for progression into accepting reality in the strategy formulation process (related to Postulates 1, 2 and 3). The supply chain participants were selected based on that acceptance of reality and the need for integrating the business vision with other participants (related to Postulates 5 and 6).

This chapter brought new understanding of Postulates 4 and 5, and confirmed that corporate strategy represents a vision that serves as a central idea but it emerges from the business objectives and is articulated through evaluating the operational capabilities and the operational strategies. This differentiates the understanding from existing methods for architecting the relationships between the business and supply chain strategy. Existing methods discussed in Chapter 3 proposed a formulation of a business strategy representative of vision and goals that can only be evaluated as desired status or action objectives.
Such architecture signifies a vision that requires accomplishment of ambitious action objectives that can only be accomplished through the operational activities. Setting up ambitious action objectives without considering the assets, logistics capabilities, transportation infrastructure, know-how, and culture, will inevitably result with a formulation that contains a desired and unrealistic vision and action objectives. This conclusion was reached when the lack of operational capabilities created multiple areas of problems each requiring decisions on outsourcing or integration (Figure 7-3). The findings from this chapter (Chapter 7) represent a process of relating (Figure 7-4) the external and salient dimensions (Chapter 1) to the process of formulating (Figure 7-1 and Figure 7-2) integrated business strategy (Figure 7-5). The following chapter applies the findings derived from previous chapters to narrow the topic further to business and supply chain strategy integration (Chapter 8).

The findings derived from this chapter in terms of contribution to practice, lead to the conclusion that the greatest obstacle in formulating supply chain strategy for the mining industry is the cost of transportation and logistics. The integration with 3PLs and creating a networked organisation with the related industries is therefore a crucial aspect for transporting waste by-products from mining operations.
Chapter 8 Business and supply chain strategy integration

8.1 Introduction

This chapter builds upon the least covered aspects in previous chapters and is aimed at conceptualising the synthesised knowledge from Chapter 1 and Chapter 7 for the purposes of interpreting the emerging business and supply chain strategy formulation. The critical analysis and evaluation draw on a range of sources to validate the theory and start with identifying, defining and formulating the visions and goals of individual supply chain participants from implicit into an explicit form. The second step conceptualises the idea, through developing and evaluating the information and the emerging issues, to derive insights into the complex and abstract concept of greenfield project business and supply chain strategy formulation.

The architecture aspect in this chapter is primarily focused on developing original and new ideas, for the concept of articulating and evaluating individual business goals and integrating the goals with the supply chain participants. In this context, the framework is critically analysed and evaluated through case study research. The case study research derives a proposed conceptual system that serves as tools for extracting and relating individual strategic goals to integrated strategic goals. The process of investigating the predefined critical problems (1.7), applies content and discourse analysis for converting tacit into explicit knowledge. The emerging methods are designed through action research and field-tested through the outlined process of eliminating the obstacles presented in extracting tacit strategic interests. The critical evaluation was based on evidence based solutions, extracted through verbalism, or reworded and distilled through content and discourse analysis. The emerging concepts are presented in a concept summary map, outlined in an explicit form and evaluated with the study participants to obtain respondents validations.
The architecture of the conceptual framework is designed with the objective of integrating individual vision and goals into executable vision and action objectives through systematically analysing the strategy abstention and absence of operational capabilities to determine the right level of integration. The conceptual framework is focused on defining, conceptualising, and evaluating the relationship between business and supply chain strategy architecture through referring to: BCAO, CGSI, IMSC, UF, FOI, CEFE, CE, and PAO. The conceptual framework derives an approach for providing the desired results through focusing on IMSC, SD, IOC, and CSCIOI. In that context, the framework is aimed at extending the frontier of knowledge on the greenfield project supply chain strategy architecture, while at the same time the tools applied are generalised into tools that can be used by other researchers in the process of integrating strategy.

The theory building was supported with action research and was aimed at enabling a validation of the formulation through an investigation of multiple operational objectives in multiple private sector organisations. The integration aspect required a synchronised investigation and analysis of how several operational strategies can be performed simultaneously. To achieve this it was necessary to create a comprehensible and corresponding research strategy that would cover the interdisciplinary aspects of the researched topic. This is compliant with existing literature on factual theory generation (Hines, 2004).

The alternative of analysing individual functional strategies without extracting specific goals related to the supply chain collaborated performance, would hardly lead to accomplishment of the stated aim and objectives. Hines (2004) claimed that even within one company, there are a number of operational goals, requiring different operational strategies, which are not isolated entities.

8.2 Formulate the individual vision and goals of the participants in an explicit form

The emerging conceptual design is tested in the next stage by identifying individual supply chain participants’ goals and defining sentences that represent the interest of all the participants in the formulation. These statements were used to extract the goals and a new strategic vision representative of all the companies (coded as Cn).
The recommended process is of significant importance for investigating the interests of individual participants, because the aggregated set of goals (coded as $P_n$) from the sum of companies ($C_n$), enables individual formulation areas of integration to be identified. This presents the first theoretical recommendation: in integrated greenfield project formulation, the vision must represent the integrated goals of the supply chain group (coded as $IP_n$) instead of being representative of the individual interest of the lead company (coded as $C_1$). This emerging design process recommends that the goals are representative of the sum of companies ($C_n$). To achieve this, firstly the sum of strategic goals ($P_n$) of each individual company must be identified ($C$) and grouped together (coded into $C_n.P_n$) to ensure coverage of strategic goals (as shown in Figure 8-1).

![Diagram](image)

**Figure 8-1: Formulation method for integrating individual goals into greenfield project business strategy**

To identify individual strategic goals a number of data collection methods have been applied. The first source for collecting data related to individual strategies and strategic goals was internal and external documents. The wealth of internal and external documents presented the easiest method for data collection related to the topic researched. The business strategy and goals of ($C_1$) were analysed and the data was presented in the conceptual diagrams (Figure 7-1 and Figure 7-2).

### 8.2.1 Framework evaluation through case study with the second supply chain participant

The recommended process involves critically analysing the strategies of individual companies and progressively identifying and building their strategic goals. In this context, progressively building the goals, refers to the process of applying the evaluation
criteria (discussed in 4.10.2) to the process of critical analysis, to ensure the goals can be applied to the formulation criteria (discussed in 4.10.4).

The process continued with the engineering company being the second company (coded as C2) analysed. Their business strategy (coded as S) is recorded as ‘to be one of the UK’s leading civil engineering companies within their areas of expertise in developing highways, building infrastructure, providing waste management and remediation, devising coastal and flood protection, road construction and managing complex logistics for renewable energy.’

The analysis of the second company strategy (coded as C2S) presented a very straightforward statement, which presents the temptation to disregard the potential in terms of sufficiency for formulating strategy. It must be emphasised that it is not the words that are being analysed but the idea behind the quoted statement. The fact that the statement was quoted in the direct format, as derived during the data collection eliminates the perception that the statement represents oversimplification of their business strategy. The idea behind the simple statement in fact represents multiple ideas. The analysis of secondary data from internal documents continued until the goals related to the greenfield project formulation were identified. The extracted sentences are presented in exact wording prior to being narrowed down to the required context.

‘Maintain our enviable track record in infrastructure projects from major business park infrastructures and access roads to site preparation for new homes developers.’

‘Provide a variety of remediation services for land remediation, contaminated land and brownfield sites and maintain our reputation for being one of the leading qualified remediation contractors.’

‘Continue to remain at the forefront in engineering safe, cost-effective schemes for the construction and operation of landfill sites, including the entire associated infrastructure and recycling facilities’. 

‘Promote our specialist skills for handling competently the reclamation of brownfield sites, particularly former industrial sites that may be highly contaminated with dangerous substances.’
The process applied open and categorical coding to internal documents to investigate the relationship between the individual strategic goals and the integrated business strategy. The objective of the exercise was to narrow the idea behind the sentences to relate to integration.

- (C2P1) Secure a position as it covers one of the key markets
- (C2P2) Keep a close relationship with suppliers and customers
- (C2P3) Invest in engineering technology, capability and infrastructure,
- (C2P4) Provide a wealth of civil engineering expertise for the supply chain
- (C2P5) Provide waste management expertise for the supply chain
- (C2P6) Develop conceptual models for land remediation
- (C2P7) Capture substantial aftermarket service opportunities

The set of goals identified are first validated during the interviews with (C2M9) from (C2). Secondly the relevance of the identified pillars to the greenfield project formulation was validated through group discussion with group. A participants from the supply chain consortium (Cn) The new process is designed specifically in the context of this study for extraction, analysis, coding and categorising process (Figure 8-2).

8.2.2 Framework evaluation through case study with the third supply chain participant

The analysis of the terminal and logistics providing company (C3) presented a different example. It must be recognised that not all companies have defined their business strategies in equally straight forward identifiable statements. To generalise and further confirm the validity of the data collection a different approach was applied. The business strategy is recorded as an initial introductory statement, followed by a description of multiple strategies. The initial statement as documented on internal and external documents is: ‘establish partnerships with customers to provide cost-effective solutions and services to enhance their supply chains, consistently delivering value added logistics. The statement continued with the documented description behind the single statement. The description presented multiple strategic ideas that are quoted in direct format:

- ‘Remain at the forefront of the industry, offering innovative, cost effective solutions of the highest quality.’
- ‘Offer a fully integrated service comprising Road, Rail and Warehousing solutions throughout the UK and Europe.’
- ‘Provide the most efficient and effective service to our clients through our comprehensive network of strategically selected transport and warehousing depots’.
- ‘Commit to promoting, where viable and sustainable, the transfer of freight from road to rail.’

Having identified the (C3S), content and discourse analysis was also applied to the passages, combined with open and categorical coding, resulting in specific goals related to the greenfield project formulation.

- (C3P1) Provide the supply chain with our comprehensive network of depot and terminals;
- (C3P2) Invest in rail terminal technology, capability and infrastructure for the supply chain;
- (C3P3) Keep a close relationship with the supply chain consortium to increase freight flow across our terminals network;
- (C3P4) Open virtual quarries to be used by communities in close proximity to our terminals;
- (C3P5) Provide a fully integrated service comprising Road, Rail and Storage for Virtual Quarries throughout the UK and Europe;

The set of pillars identified were validated through the following process; firstly through group discussion with (C3) that included the executive director and the manager of the nearest terminal, secondly, through group discussions with the executive directors of the consortium (Cn) The process is outlined in Figure 8-2.

**Figure 8-2: Extracting and relating individual goals to integrated business goals**
8.2.3 Framework evaluation through case study with the fourth supply chain participant

The method for extracting the strategic pillars from the fourth company providing rail transportation, maintenance and transloading (coded as C4) was completely different from the previous methods. The Vice President, the Executive Director and the management team of (C4) was based in the US and the internal documents were all based in the head office. The method applied involved extracting reference goals from external documents and validating the goals when an opportunity was presented to meet with the Vice President, the Executive Director and the management team of (C4). Further validation of the passages was performed by interviewing all operational level managers based in the UK individually. The operational managers were able to confirm that (C4) operations are compatible with the identified goals.

The passages that described the strategy were collected through external sources and quoted in exact wording.

‘Continually explore expansion of our portfolio through development of rail freight business and property development.’

‘Increase the value to rail customers and the communities our rail lines serve, through improvements in services, facilities and equipment.’

‘Continually seek additional rail acquisitions.’

‘Promote our competitive portfolio of track maintenance, rail repair and transloading services.’

The passages were presented to the operational managers to identify the strategic goals relevant to (C4) the discussions resulted with a set number of goals. Before taking the extracted goals as actual representation of the (C4) strategy, the goals were presented and validated with the management team. The process resulted with 7 goals related to supply chain integration.

(C4P1) Invest in rail technology, capability and infrastructure
(C4P2) Provide rail freight logistics for the supply chain
(C4P3) Carry a wide variety of slate by-product and other products
(C4P4) Offer high value rail transport for the by-product at low cost
(C₄P₅) Develop responsive and effective supply chain rail transport
(C₄P₆) Provide track maintenance and repair services
(C₄P₇) Provide effective rail transloading for the by-product

The extraction process is outlined in Figure 8-2.

8.2.4 Framework evaluation through case study with the fifth supply chain participant

The method for identifying and extracting the strategic goals from the fifth company was completely different. The goals were identified in a clear form through a series of interviews and validated through group discussions. The managers of (C₅) preferred to keep their strategy implicit and preferred not revealed it because it could leave them open to competitors. Their strategic goals were generalised by the executive director and given as:

(C₅P₁) Increase productivity and profits
(C₅P₂) Rebalance market power and maximise the value of by-product sales to the existing market
(C₅P₃) Provide the consortium companies with site for building, necessary infrastructure for the supply chain
(C₅P₄) Develop a distinct brand identity and image for the by-product
(C₅P₅) Optimise the supply chain distribution concepts

The example from (C₅) represents the most straight forward process for extracting the strategic goals, because the goals are given. The process is outlined in Figure 8-3.

![Figure 8-3: Extracting and relating individual goals to integrated business goals – applied to (C₅)](image)

8.2.5 Analysis and evaluation of the theoretical framework

The theoretical framework for extracting strategic goals specific to the supply chain strategy outlined 5 different methods for identifying and extracting individually the tacit strategic goals from individual companies that need to be integrated into a formulation.
This study does not claim that the framework is all inclusive and the requirement to apply different approaches to different case studies confirms that all inclusive frameworks are not likely to produce the desired results. The resulting conclusion from applying the extraction process to five case studies is that the goals from CnS can be extracted on multiple methods. The focus should be placed on determining and validating the CnPn and narrow the goals to integration by validating the goals individually with Cn before validating the goals with the group of Cn to determine the integrated CnPn.

The 5 methods (Figure 6-14, Figure 7-2, Figure 8-2, and Figure 8-3) represent tools that can be used by other researchers to extract strategic goals that are left tacit in the process of integrating strategy. The tools are designed through action research and field-tested through the outlined process of eliminating the obstacles presented in extracting tacit strategic interests.

8.2.6 Conversion from tacit to explicit strategy

The process of extracting tacit strategy and presenting it in an explicit format presents a dilemma when involving multiple companies in the formulation of a greenfield project strategy. Without visualising the explicit and implicit aspects of individual strategies, it is impossible to extract the required strategic elements and concepts. However, some literature opposes the process of making strategy explicit, claiming that an explicit strategy promotes ‘rigidity and inertia’ (Mintzberg, 1990). The process of making strategy explicit is criticised for leaving the strategy open for criticisms and attack from competitors as they would know the strategy (Quinn, 1977). This mind-set was identified in (C5). However, other literature supports the process of making strategy explicit stating that articulating strategy is essential to simplify and integrate the strategy (Andrews, 1982, Love et al., 2002). This approach was accepted by (C1,2,3,4).

Therefore, the latter’s attitude of making the strategy explicit was accepted by the model considering that tacit strategic interests are required in an explicit form for the integration of the strategic goals to be considered representative of a supply chain consortium. The findings of this exercise resulted in some goals extracted through verbalism, and others reworded and distilled through content and discourse analysis, they are presented in the table in an explicit form. However, only the goals that the
researcher was allowed to present in an explicit form are discussed in the study and company confidential goals are carefully eliminated through generalising the content into context suitable for the participants. The list of strategic goals is presented in concept summary map (Table 8-1).

<table>
<thead>
<tr>
<th>Sum of Companies (C&lt;sub&gt;N&lt;/sub&gt;)</th>
<th>Sum of strategic goals (P&lt;sub&gt;N&lt;/sub&gt;)</th>
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</thead>
<tbody>
<tr>
<td>(C&lt;sub&gt;1&lt;/sub&gt;)</td>
<td>(C&lt;sub&gt;1&lt;/sub&gt;P&lt;sub&gt;1&lt;/sub&gt;) Diversify the processes and outputs in the quarry (C&lt;sub&gt;1&lt;/sub&gt;P&lt;sub&gt;2&lt;/sub&gt;) Develop low cost transport (C&lt;sub&gt;1&lt;/sub&gt;P&lt;sub&gt;3&lt;/sub&gt;) Pursue environmental sustainability (C&lt;sub&gt;1&lt;/sub&gt;P&lt;sub&gt;4&lt;/sub&gt;) Develop technology, capability and infrastructure (C&lt;sub&gt;1&lt;/sub&gt;P&lt;sub&gt;5&lt;/sub&gt;) Increase the market share and secure long term market (C&lt;sub&gt;1&lt;/sub&gt;P&lt;sub&gt;6&lt;/sub&gt;) Build strong brand for the by-product</td>
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<tr>
<td>(C&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>(C&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;1&lt;/sub&gt;) Secure a position as it covers one of the key markets (C&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;2&lt;/sub&gt;) Keep a close relationship with suppliers and customers (C&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;3&lt;/sub&gt;) Invest in engineering technology, capability and infrastructure (C&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;4&lt;/sub&gt;) Provide wealth of civil engineering expertise for the supply chain (C&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;5&lt;/sub&gt;) Provide waste management expertise for the supply chain (C&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;6&lt;/sub&gt;) Develop conceptual models for land remediation (C&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;7&lt;/sub&gt;) Capture substantial aftermarket service opportunities</td>
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<td>(C&lt;sub&gt;3&lt;/sub&gt;)</td>
<td>(C&lt;sub&gt;3&lt;/sub&gt;P&lt;sub&gt;1&lt;/sub&gt;) Provide the supply chain with our comprehensive network of depot and terminals (C&lt;sub&gt;3&lt;/sub&gt;P&lt;sub&gt;2&lt;/sub&gt;) Invest in rail terminal technology, capability and infrastructure for the supply chain (C&lt;sub&gt;3&lt;/sub&gt;P&lt;sub&gt;3&lt;/sub&gt;) Keep a close relationship with consortium to increase freight flow across our terminals network (C&lt;sub&gt;3&lt;/sub&gt;P&lt;sub&gt;4&lt;/sub&gt;) Open virtual quarries to be used by communities in close proximity to our terminals (C&lt;sub&gt;3&lt;/sub&gt;P&lt;sub&gt;5&lt;/sub&gt;) Provide fully integrated service comprising road, rail and storage for virtual quarries throughout the UK and Europe</td>
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<td>(C&lt;sub&gt;4&lt;/sub&gt;)</td>
<td>(C&lt;sub&gt;4&lt;/sub&gt;P&lt;sub&gt;1&lt;/sub&gt;) Invest in rail technology, capability and infrastructure (C&lt;sub&gt;4&lt;/sub&gt;P&lt;sub&gt;2&lt;/sub&gt;) Provide rail freight logistics for the supply chain (C&lt;sub&gt;4&lt;/sub&gt;P&lt;sub&gt;3&lt;/sub&gt;) Carry a wide variety of slate by-product and other products (C&lt;sub&gt;4&lt;/sub&gt;P&lt;sub&gt;4&lt;/sub&gt;) Offer high value rail transport for the by-product at low cost (C&lt;sub&gt;4&lt;/sub&gt;P&lt;sub&gt;5&lt;/sub&gt;) Develop responsive and effective supply chain rail transport (C&lt;sub&gt;4&lt;/sub&gt;P&lt;sub&gt;6&lt;/sub&gt;) Provide track maintenance and repair services (C&lt;sub&gt;4&lt;/sub&gt;P&lt;sub&gt;7&lt;/sub&gt;) Provide effective rail transloading for the by-product</td>
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</table>
| (C<sub>5</sub>)                | (C<sub>5</sub>P<sub>1</sub>) Increase productivity and profits (C<sub>5</sub>P<sub>2</sub>) Rebalance market power and maximise the value of by-product sales to the existing market (C<sub>5</sub>P<sub>3</sub>) Provide the consortium companies with site for building,
necessary infrastructure for the supply chain
(CsP₄) Develop a distinct brand identity and image for the by-product
(CsP₅) Optimise the supply chain distribution concepts

Table 8-1: Summary map of individual business goals (CsPₙ) articulated through case study from (CN)

The outlined process of inductive theory building is representative of experience based scientific conclusions that arise from singular observational statements into general theoretical statements. The process is grounded on empirical evidence in the theory building process. While the preliminary theory resulted in merely observing the facts and describing them in their manifestation, one would argue that manifesting the facts can hardly be called science.

The outlined process contributes by leaping from the visible into the invisible aspects of the integration and formulation question. The process starts by evaluating single quotes and leads to the essential elaboration of the phenomenon investigated. Regarding the approach applied, Eisenhardt and Graebner (2007) stated: ‘inductive and deductive logics are mirrors of one another, with inductive theory building from cases producing new theory from data and deductive theory testing completing the cycle by using data to test theory.’ (Ibid., p.25).

Figure 8-4: Conceptual framework for articulating, evaluating and integrating individual goals for greenfield project business and supply chain strategy formulation
8.3 Formulate the consortium vision and goals

The aggregate sample goals collected \((C_n.P_n)\) resulted in many of the goals being similar in context. For example:

\((C_{1P4})\) Develop technology, capability and infrastructure  
\((C_{2P3})\) Invest in engineering technology, capability and infrastructure  
\((C_{3P2})\) Invest in rail terminal technology, capability and infrastructure for the supply chain  
\((C_{4P1})\) Invest in rail technology, capability and infrastructure  
\((C_{5P3})\) Provide the consortium companies with a site for building and necessary infrastructure for the supply chain

From the process of grouping these concepts into summaries, emerges the concept validity of the salient dimensions. The goals stated above present a remarkable resemblance to the technology dimension (TD) identified through secondary data as a salient dimension. The outlined process of extracting goals from individual supply chain participants, resulted in more than a manageable number of goals required to formulate the business strategy as a concept of a greenfield project strategy. To eliminate duplicating ideas, a process of determining superior goals is recommended for merging the sample set into a manageable number of goals, that can be related to the salient dimensions and in the process provide validity of the salient dimensions.

The controlled convergence (Pugh, 1990) represents a time-tested engineering design tool, that can be applied in the context of reducing the number of concepts and to design a superior goals for strategy formulation (Perez-Franco et al., 2010). Considering that this step involved the Vice Presidents and Executive Directors, the traditional controlled convergence method (Pugh, 1990) has been considered as too slow and time demanding, because the sample group was preoccupied with the day to day running of their companies. Therefore, an alternative, faster approach based on recent literature recommendations (Perez-Franco et al., 2010) was developed that delivered the desired results. While in a different scenario, where the samples of executives are willing to commit a significant amount of time to the formulation, a different design approach could possibly serve better. However, as time limitations were confirmed by the full sample population of executives, the claim that the faster approach is also a preferred approach for such a sample population brings validity to the proposed method. The faster approach was proven valid for the formulation of a greenfield project strategy integrating multiple companies and is detailed further on in the thesis.
The faster approach was designed to include 3 rounds of expert opinions; the first round with individual executives, the second with sub-groups that included one executive, one manager, one representative from an NGO associated to the strategy formulation in the form of a voluntary consortium coordinator, and a third round with groups that included executive directors and operational managers. The process is illustrated in Figure 8-5.

The designed process is summarised as:

- CGSI through identifying integration goals from multiple companies
- Determine the FOI to eliminate conflicting individual goals in the integrated goals
- Determine the impact of IMSC through merging multiple goals similar in context into singular goals
- Determine validity of SD and UF as guiding force for strategy integration in greenfield context; through CEFE of supply chain integration and performance
- Investigating the relationship between TC, IOC, and IBC for CSCIOI aimed at creating networked organisation

By applying the building blocks to the evaluation process for narrowing the goals; applying the process through 3 rounds; involving the managers to bring the opinion of experts in the field; and the consortium coordinator to ensure that the goals can be integrated; the probability of specific groups establishing preferred goals according to their industry interests was eliminated. The methodological changes in the approach proposed are made to avoid the element of individual preference in the selection design that could have created a conflict of interest in the segmentation process.

a) First segmentation: individual executives validating the set of greenfield project goals. This step included requesting the executives to review the sample set and identify their preferred goals from the ‘reference’ goals. The second step involved validation of the relationship between the goals and the individual business strategy. The third step involved validating the integration elements to formulate business vision and goals. At this stage it was also requested that individual executives propose an additional goal or a set of goals aimed at ensuring coverage of the stated goals.

b) Second segmentation: the reference sets are presented to sub-groups of Executive Directors, and/or Vice Presidents, Managers representing experts in
the field and the consortium coordinator. Each group was requested to identify only the most relevant goals. This created a formulation attaining superior goals, where the expert opinion was used as a criterion that ensures validation of the superior goals and in the process detects duplicated concepts in the goals.

c) Third segmentation: the superior goals are evaluated through organising a group discussion at the lead company offices with a number of Executive Directors and operational managers from the supply chain participants.

![Diagram of goal formulation process]

**Figure 8-5: Formulating integration goals from the individual goals**

The method in Figure 8-5 is designed and applied to: a) validate the individual goals with experts in the field, b) obtain additional individual goals generated by experts to add to the sample sets, c) reduce the list and to hierarchically classify the goals required for formulating the integrated vision and goals to be assembled as concept.

In the process the following criteria was considered:

- It was agreed with the participants that the evaluation criteria (4.10.2) should serve as the measure for the formulation criteria (4.10.4) and the superior sample set of goals (IPₙ) should preserve the relationship with integration of the goals from (Cₙ,Pₙ) by referring to the SD and BB's to define integrated goals (IPₙ) vision (ISV) for the supply chain strategy.
• It was agreed with the group A and B participants that it was necessary for the (ISV) to be representative of the interests of all companies expressed in the (scCN.Pn) in the consortium, and for the individual goals (CN.Pn) to be integrated in the context of the greenfield project formulation goals (IPn)

• Through group discussions with individual companies, it was confirmed that the (ISV) should evolve to be representative of the individual and greenfield project strategic goals (IPn). The vision, which was identified as representative of the greenfield project vision and the individual goals of the participants, was confirmed as: ‘commencement of increased sales of secondary aggregate’, eliminating individual preferences and bringing the focus towards integration.

• The reference goals established from multiple analysing, including content and discourse analysis of the ideas behind the text in the sample data were validated on individual bases and on group discussions. The references were used to compare the synergy between the individual industry goals during the validation process (outlined in 10.3).

• The process resulted with formulating additional goals (IPn) through merging the existing goals (CN.Pn) to update the list, in the process the (BB’s) evaluation criteria are consistently referred to where the pre-established reference goals served as sample guidance for investigating the relationship between the (CN.Pn) and (SD) resulting with the (IPn).

• Several repetitions were performed, including one repetition with each participant (CN.Pn) to identify the best possible (IPn) goals where integration is considered to identify alternatives to the references.

8.4 Conversion of tacit into explicit greenfield project strategy

Applying the outlined method, enabled the process of validating the conversion of the tacit into an explicit strategy. A degree of complexity was detected in the initial attempts to formulate the strategic vision and goals, in the attempt to make the greenfield project integration strategy explicit. However, that was expected considering that the strategy was not formulated but given and involved integration of multiple participants representing multiple goals. The degree of complexity confirms that if strategy is left
tacit, there is a possibility of conflicting interests to emerge. For example, while the executive director of (C_1) wanted the greenfield project strategy to cover ‘world-wide markets’, the executive director of (C_3) wanted the greenfield project strategy to cover only the surrounding areas where the company terminals were based. Such conflicting areas could lead the formulation away from integration.

Existing literature elaborated on this phenomenon by stating that while supply chain represents a ‘networked organisation’ (Ivanov, 2009) and a ‘single entity’ (Mentzer et al., 2001) companies can be participants in many supply chains and ‘be a customer in one supply chain, a partner in another, a supplier in a third, and a competitor in still a fourth supply chain.’ (Ibid., p.19). Therefore, it was considered that making the strategy explicit would ensure accuracy in the following stage, when formulating the greenfield project supply chain strategy. Also the method for expressing the strategy evidently and observably, unfolds a visible method for other researchers in the problems presented in formulation of greenfield project integrated strategy.

The aim in making the strategy explicit was that without this, not only would a consortium of companies encounter a number of conflicting goals, but also, the formulation would not benefit from their knowledge and neither would they know how it could be valuable to other companies in the consortium. Despite that, an individual company could possess certain knowledge this is not obvious to the other companies. In certain cases it was discovered that the companies were not aware themselves of how useful a contribution their specific knowledge to the formulated strategy could be. This was caused mainly because their expertise is a tacit knowledge and as such is not easy to record and share.

8.5 **Relationship between greenfield project vision and goals**

Through the outlined process, the conflicting or duplicate goals were merged and integrated into superior candidate goals. The final list of goals is confirmed on subsequent group discussion. The method applied served as a narrowing enquiry to merge similar goals aimed at keeping the ideas not the wording. The interdisciplinary strategic interests of the consortium demanded a different set of goal objectives from these stated in the initial strategic goals. The process of jointly defining the goals was performed, because the formulation demanded working with a consortium of
participants, to achieve a common vision and a number of goals; where the common goals were formulated to represent the strategic vision. In this context, it is confirmed that the strategic vision must represent the interests of all the participant industries and the goals must be focused on achieving the vision.

The strategic goals from the preliminary formulation were used as a reference material for visualising why a formulation of a new and integrated set of goals is required. The preliminary formulation is presented and visualised as a conceptual diagram (Figure 7-1 and Figure 7-2) and the extent of changes to the strategy can be visualised by comparing these figures with Figure 8-6. The outlined process for greenfield project strategy formulation is aimed at visualising the problem, avoiding confusion and bringing the focus on the common goals. Defining the common goals in this study represented the main rationale for scheduling the group discussion between the consortium executives and managers and keeping the focus on determining the common goals was crucial considering previous failures in formulating the business strategy.

The process of formulating the new set of goals included: 1. designing a sample set of individual goals (Cn.Pn), 2. Creating a smaller sample set of greenfield project reference goals with the executives and experts in the field by performing a narrative enquiry to extract the ideas and relating them to the (SD), 3. Present the greenfield project sample to sub-groups of executives and experts by referring to the (BB's) to design an alternative sample set of goals to these given in the business strategy, 4. Validate the (IPn) goals and ensure coverage through group discussion.

This resulted in the strategic goals broadly defined by the group in a few sentences as:

1. 'Supply enough quarried by-product to match the current demand and fulfil the demand of potential new markets for recycled secondary aggregate' (MDD: Market demand dimension)
2. 'Make the best use of engineering and technology for transporting slate aggregate to markets by rail and sea' (TD: Technology dimension)
3. 'Achieve economic and environmental sustainability for the aggregate supply chain' (ED: environmental dimension)
4. 'Have a cost-effective transportation system to move the slate aggregate from the quarry to the point of sale' (TD: Transportation dimension)
5. ‘Maximise the volume of our sales of slate aggregate to the market’ (RD: resource dimension)

Through group discussions among the executives and managers of the consortium companies participating in the formulation, the managers reached the conclusion that what unites their companies is their mutual desire for the ‘increased sales of secondary aggregate’. The (IPn) sample set of goals is summarised into a new vision (ISV): ‘Commercialise Blaenau Ffestiniog’s slate secondary aggregate by successfully competing in the existing market for aggregate materials and promoting secondary slate aggregate as a suitable product in new markets worldwide’. This sentence represented the strategy core in the form of a jointly defined strategic vision.

The validated vision and pillars were built into a conceptual diagram (Figure 8-6) representing the greenfield project business strategy as validated by the consortium.

![Figure 8-6: Greenfield project business strategy formulated for the sample population in the case study](image-url)
8.6 Critical analysis of the theoretical framework

Through formulating the business strategy on a consortium level the formulation ensured integration on two levels:

1. Ensures integration and anticipation of complexities when multiple industries are involved,

2. Ensures that the greenfield project goals support, compliment and enable the integrated vision.

This represents the process applied for simplifying the idea behind the vision and goals that formulate the integrated business strategy. The next stage of the theory building advances into designing conceptual maps and diagrams to bring the focus to the operational tasks.

This stage is required to determine the relationship between the areas of activity of the formulated business strategy and the supply chain operations of the participants. The theory building design recommends categorising the operations into formulation areas of operation to detect the activities and ensure coverage in all supply chain operational areas. This process represents the evaluation and validation of the strategic vision and strategic goals through the operations. Considering that the strategic vision is the fundamental aspect of the greenfield project formulation and the strategic goals assist and enable the strategic vision in integrating the goals behind the vision, the theoretical framework development resulted with a number of conclusions:

1. Validating the integration relationship between vision and goals in business strategy is instrumental for linking accurately the strategy coverage with the supply chain activities.

2. From a perspective of multiple supply chain companies’ strategy validity, coverage of the greenfield project business strategy is crucial for accomplishing the strategic goals of individual participants.

3. The integration focusing process involves concentrating on strategic goals that are linked to the main activities, know-hows, challenges and distinct goals.

4. Therefore, the strategic vision depends on the success of the strategic goals applied jointly and individually.
The process of ensuring validity of the conceptual framework applied qualitative research techniques as recommended in existing literature (Easterby-Smith et al., 2002, Gummesson, 2000, Eriksson et al, 2008, Perez-Franco et al., 2010). Conceptual validity is further confirmed through open and categorical coding to analyse the qualitative data. This represents a time-tested complimenting method for grounded theory (Charmaz, 2006). Open coding provides a reliable representation of the data collected, while categorical coding subsequently recognises the profounder concepts in the data (Goulding, 2002).

The process of determining the profounder concepts in the data involved analysing the applicability of the stated strategic vision and goals to individual industry participants, instead of taking the given business strategy by the executives and managers as a true representation.

In this process, recommendations from existing literature were followed and discourse analysis is applied to evaluate and interpret the connotation behind the explicitly stated strategy. This process is recommended by Eriksson et al (2008), along with tables of evidence (Eisenhardt, 1989) and conceptual maps (Miles and Huberman, 1984a) to present graphical analysis.

To visualise the effect of these findings a new conceptual diagram is presented (Figure 8-7). The framework is amended accordingly and redesigned to ensure validity and to ensure that supply chain participants have clear objectives of what represents their required accomplishment in the formulation. This enabled presenting interdisciplinary integration concepts in a conceptual diagram involving multiple goals and confirming that strategic goals influence the strategic vision. The greenfield project business strategy as a formulation concept enabled the research to determine a method that links the interdisciplinary concept arising from involving multiple participants. Also this resulted in determining that the set of integrated strategic goals (IPN) influence the integrated strategic vision (ISV). In other words, the multiple goals determine the vision, while the vision must represent the goals if assembled as a conceptual model or the goals define the vision and the vision defines the goals and can be seen as a system of tasks.
Figure 8-7: Conceptual framework for formulation of greenfield project integration business and supply chain strategy

The case study and action research methods were applied to involve the consortium of supply chain companies into formulating explicit conceptual diagram for integrating multiple companies in the context of formulating a greenfield project strategy.

8.7 Conclusion

Development and validation of the conceptual framework (Chapter 1 and Chapter 7) was considered as a crucial task to derive new findings from the postulates presented in this study (3.9 and 5.5). This chapter advanced the understanding of the topic, through critical analysis of the least covered aspects in previous chapters and addressed Postulates 5 and 6. This chapter derived a new process and a new perception for integrating business strategy in greenfield project context, and thus, addressed Gap 10 and touched upon Gaps 8 and 9. The new process is based on extracting, evaluating and relating individual interests into integrated goals. This chapter interpreted the business strategy architecture (Figure 6-4, Figure 6-16 and Figure 7-5), and related the findings with supply chain strategy, whilst drawing on a range of sources to validate the theory.

The contribution to knowledge from this chapter is represented in evaluating information and issues to derive insights, into the relationship between business and
supply chain strategy formulation, in the context of greenfield project integration. This chapter articulated original and new ideas related to the process of identifying and evaluating individual business goals and integrating the goals with the supply chain participants. The contribution from this chapter is presented also as a new process for solving critical problems for integrating business and supply chain strategy.

This chapter derived conclusions through the case study and concluded that making strategy explicit is essential in the strategy integration process. The evidence based case study confirmed that this approach is accepted by (C1,2,3,4), while (Cs) preferred to keep their strategy implicit and not to be revealed, because it could leave them open to competitors. To address this obstacle, the articulation approach was restructured and documented, to serve as a tool for future research studies that are presented with this obstacle. The synthesis of the concepts and ideas, of the routine problems and issues related to architecting integrated greenfield project strategy, concluded that tacit strategic interests are required in an explicit form for the integration of the strategic goals to be considered representative of a supply chain consortium (based on Postulate 4).

The case study exercise resulted in some goals extracted through verbalism and others reworded and distilled through content and discourse analysis (Figure 8-2 and Figure 8-3) they are presented in the summary maps of individual goals (Table 8-1), outlined in an explicit form (Figure 8-5). The new process is anticipated to be useful for dealing with the complexity of the issue and making informed judgements, in a situation where absence of complete or consistent data or information is present. The outlined process in this chapter has been confirmed as valid by the study participants for eliminating the obstacles in extracting tacit strategic interests. The architecture of conceptual framework for articulating, evaluating and integrating individual goals for greenfield project business strategy formulation (Figure 8-6), concluded that the business objectives represent a vision that serves as a central idea that is best articulated through the integrated operational capabilities and the individual operational strategies (Figure 8-7). The framework is developed as a response to the research problem (1.7) and is designed to eliminate the issue in literature at present of architecting vision and goals that represent desired status or desired action objectives (Sections: 3.1.3, 3.3 and 3.4).
The conceptual framework can be applied to designing integrated vision and goals through critically reviewing the assets, logistics capabilities, transportation infrastructure, know-how, and culture. The conceptual framework systematically analyses and addresses the strategy abstention and absence of operational capabilities and evaluates the strategy formulation through determining the right level of integration. The conceptual framework, through the methods outlined, defines, conceptualises, and evaluates the relationship between business and supply chain strategy through focusing on BCAO, CGSI, IMSC, UF, FOI, CEFE, CE, and PAO (Figure 4-1 and Figure 4-2) all requiring coordinated efforts between the supply chain participants.

Principles from controlled convergence (Pugh, 1990) and engineering design recommendation (Perez-Franco et al., 2010) are used to design superior goals for strategy formulation, resulting in a remarkable concept resemblance with the SD, strengthening the emerging design validity. The conceptual framework developed an alternative, faster approach that delivered the desired results through focusing on IMSC, SD, IOC, and CSCIOI (Figure 4-1 and Figure 4-2). The conceptual framework extends the frontier of knowledge on strategy integration through case study research. This chapter advanced into designing strategic vision dependent on the strategic goals (Postulate 5,6), where the goals are guided by the SD and the BB’s. Finally, the tools applied to validate the conceptual framework are generalised into tools that can be used in other research studies to extract strategic goals that are left tacit in the process of integrating strategy.

The following chapter narrows the research topic specifically to supply chain strategy integration. The findings derived from all previous chapters are synthesised to generate theory on supply chain integration design. The following chapter documents in detail the relationship between greenfield project business and supply chain strategy.
Chapter 9 Supply chain strategy integration

9.1 Introduction

The theory development in this chapter, applies the findings from previous chapters to advance the understanding from the conceptual framework. The synthesised knowledge from the previous chapters (Chapter 1, 7 and 8), is applied for the purposes of interpreting the emerging areas of integration, between business and supply chain strategies. The case study research is applied with the industry participants, specifically for designing greenfield project integration strategy and documenting the findings for generalisation of knowledge. In the process, the theory development is not investigating the representativeness of other industries. Instead, the theory building is focused on the representativeness of the sample population investigated, as elaborated in section 4.4 and generalising the findings.

The critical analysis and evaluation are based on a range of sources to validate the theory. The process initiates with identifying, defining and formulating the areas of interest, which are also interchangeably referred to as areas of decisions and areas of problems. The overarching description of the interchanged terms used in the thesis is formulation areas. The process builds upon the findings from Chapter 8.

Formulation areas are extracted from individual supply chain participants and converted from implicit into an explicit form. The areas are then investigated to identify concepts that support the validity of the formulation areas. The concepts are categorised in areas of interest, decision or problems. The process of categorising the concepts develops into a conceptual system for identifying the relationship between individual participants’ strategic supply chain goals and the integrated formulation areas. The process of categorising individual supply chain strategic interest, decisions and problems into formulation areas, is aimed at defining the process of greenfield project integration strategy as a system of concepts containing formulation areas, formulation principles, segregated into sub-categories of formulation imperatives and formulation concepts.
9.2 Relationship between business and supply chain strategy

To investigate the relationship between the business and supply chain strategy, the (Cn.Pn) in Table 8-1 are segregated into formulation areas. For a greenfield project supply chain strategy to be formulated in the context of networked organisation, the supply chain participants need to combine and integrate their operational activities as a single entity. To achieve such integration, case study research is applied to identify the relationship between individual participants’ (Cn.Pn) and formulation areas. The formulation areas represent an attempt to define areas of integration that provide means for achieving the (Cn.Pn) and ensure the successful integration of the (ISV) and (Cn.Pn) through assembling the conceptual supply chain strategy as a system of concepts. The relationships between the goals and integration areas is evaluated through categorising the interests as formulation areas and strategic decisions related to integration as formulation principles that are later segregated into sub-categories of formulation imperatives.

The relationship between the formulation areas and principles is investigated in relation to integration. In the process, to support and validate the findings, case study research was applied combined with internal and external documents reviews. The resulting framework is generalised for conceptual formulation to present a valid method for further investigation of the relationships between business and supply chain strategy in the context of integration and greenfield project formulation. The process of segregating the goals into formulation areas required engaging with the supply chain participants to identify linkages between the individual companies’ interests. The process of segregating the (Cn.Pn) into formulation areas represented an opportunity for all the participants to imprint their goals in the formulation.

9.3 Categorising individual goals into formulation areas

The integrated individual goals represented in the (ISV) and (IPn) are built into concept diagrams (Figure 8-6) that summarise the context of greenfield project strategy formulation. The conceptual diagram represents explicitly and easily identifiable strategic vision and goals (Figure 8-7) and is confirmed through group discussions. The following stage involved categorising individual goals into concept formulation areas. The derived process is recommended to:
This design derived a set of structures of the individual companies’ relevant areas of integration and formulation, in the context of the decisions required for a greenfield project strategy formulation. The set of structures is focusing on designing individual areas and identifying linkages with the consortium companies. In the formulation stage the areas are related with conceptual elements to assemble greenfield project formulation. The process can be visualised in Figure 9-1.

Figure 9-1: Conceptual approach for greenfield project formulation

The suggested process starts with reviewing the main strategic areas of the consortium companies to investigate the elements required and are specifically applicable to the greenfield project formulation. Allocating the main strategic areas of the consortium partners and designing the constructions is relatively easy task. However, relating the conceptual elements to the strategy assembling is somewhat of daunting task, because it involves:

a) Identifying and targeting the strategic tasks to fit the needs of the consortium partners in a formulation that;

   a. Would assist in achieving the goals stated in their individual business strategies;
b. Would assist in achieving the goals stated in the integrated business strategy;

c. While at the same time investigating the relationship between individual areas and the common goals;

b) Resulting in a complete conceptual map of formulation areas, which would lead to achieving the integrated goals, stated in the integrated business strategy as described in Figure 9-2.

![Conceptual Map](image)

Figure 9-2: Conceptual summary map for visualising the relationship between individual vision and goals with integrated vision and goals and the areas that relate the business strategy with the supply chain strategy

In achieving the outlined and extracting the formulation areas, it is firstly described how the main strategic areas of (Cn) can be identified and evaluated in relationship to (Cn.Pn)

9.4 Categorise emerging concept

The following stage in the design process involved tapping into the operations to validate the formulation principles through investigating the operational assets, capabilities and choices. The design process at this stage is predominately focused on identifying the gaps in assets and capabilities that create obstacles in formulating the strategy. These gaps serve as rationale for integration. A series of 30 interviews were performed with group B and C participants (detailed in section 5.4) To extract the
operational obstacles, the interviews were focused on triangulating data collection methods (space, time and people).

Furthermore, the same questions were asked in 3 different formats to ensure consistency in the data collected. The most valuable opening question to identify the operational obstacles, was proven to be a direct format question: ‘In your personal opinion, what represents the greatest operational obstacle that has prevented the stated strategy vision and goals from happening’.

The passages are extracted as a narrative measured by the richness in description of the obstacles in the operational activities.

- Sample passage: ‘Transportation is crucial for supplying the waste aggregate from the quarry to the consumer. The cost of transport hugely affects the sale price. The cost of transport is not only affecting the quarry but also the construction industry and the market for aggregates. Savings can be achieved by exploiting the most cost effective transport route.’

- Sample passage: ‘Transporting secondary aggregate by road raises many questions such as restrictive driver hours regulations, high and unpredictable cost of fuel and increasingly busy roads. Heavy goods lorries are not suitable for some of the roads around the quarry and it is cheaper to ship aggregates in bulk loads.’

From these passages, the ‘transportation cost’ was extracted as the main obstacle in performing the operations. To narrow the actual problem, the second question of these sequences was aimed at investigating further the activities of the functions. Sample question: ‘From an operational point of view, please identify what is preventing the strategic goals from being realised’.

- Sample passage: ‘The price elasticity is crucial to respond to the continuous change in price and secure long term quantity demand. To determine the price elasticity, we must first determine the price different civil engineering companies are paying for aggregate at present. Secondly, we must determine the precise and accurate cost of delivering the slate aggregate from the quarry to the customer.’
From this passage a number of concepts were extracted: ‘determine product price elasticity’, ‘determine the precise and accurate cost of delivery’.

- Sample passage: ‘Arup was commissioned to answer this question. The report concluded that for the slate waste to become a source of secondary aggregates for major UK markets and to take its place as a sustainable mineral resource in the UK it is necessary to be transported by sustainable transport’.

From this passage the principle ‘develop sustainable transport’ was extracted.

- Sample passage: ‘The promotion of secondary aggregate as a product, whether as blocks for walling, or crushed for use as a high-quality inert material that is particularly well-suited for use as sub-ballast, requires appropriate rail infrastructure. Transporting the material by rail will have a significant impact on the price elasticity of demand.’

Building on the previously extracted principle, the concepts extracted from this passage were ‘develop rail transport’ and ‘increase price elasticity by road to rail shift’.

The design process applied indicated that inductive reasoning must be applied throughout the interviews to extract and gradually build the action objectives until all the action objectives are extracted. The design is detailed further in the text through sample passages to present the method.

- From the sample passage: ‘There is a strong misperception of the slate secondary aggregate being a sub-standard product. This misperception is present among civil engineers and other potential customers in England where this product represents a small percentage in the market for aggregated, simply because the cost of transport by road to the English market makes the product economically not viable. In Wales slate is present in abundant quantities and at convenient location for extraction; therefore, the cost of extracting slate is quite small compared to other minerals such as granite or marble. However, these costs depend on the quality of slate, extraction methods, and the amount discarded as slate waste.’

From this passage emerged the concepts: ‘eliminate market misperceptions’, ‘pursue road to multimodal shift’ and ‘keep the cost of extraction at minimum’
- Sample passage: ‘Millions of tons of aggregates are taken out of the ground in the UK, while vast amount stockpiles of slate aggregates are present in Blaenau Ffestiniog and have been sitting there for many years due to the lack of low cost rail transport. The demand for secondary aggregates in the UK is increasing but still represents a minor proportion of total aggregates used.’

- Sample passage: ‘The open market competitiveness created a serious impact on our business and caused a greater demand for utilising the waste product. Slowing demand for the roofing slate product is a result of a decreasing competitiveness in the market. If the quarry is unable to competently manage a continuous movement of the waste products, through diversifying in product or processes, then, the quarry is at a considerable risk of losing ground in today’s markets. The quarry must create higher product turnover that in effect will reduce the production costs without the demand for additional product development resources. The slow product turnover disables the quarry in reaching economies of scale in a specific product which would in return lower the cost of production.’

The principle operational action objective in this passage was extracted as ‘develop economy of scale’. The concepts extracted are: ‘utilise the waste product’, ‘manage continuous movement of the waste product’, ‘create higher product turnover’, and ‘reduce the production cost’. The operational action objectives started ambulating and an increasing number of concepts started becoming confusing to analyse. At this stage, the supply chain design decomposition process recommends grouping action objectives and concepts into hierarchical categories as shown in Figure 9-3.

Figure 9-3: Concept categories for supply chain strategy formulation
In the process of analysing the data, open and categorical coding was applied to the concepts presented in the statements and the results are demonstrated in categories and subcategories. The categories created are based on 4 steps; idea, focus, command, and activity.

### 9.4.1 Build the formulation criteria

The importance of the linkage between the vision and the supply chain activities that are left in a tacit form to the participants creates great obstacles for integrating in a greenfield project strategy. Knowledge of such activities is neither secretive nor confidential; nevertheless, it is commonly ignored. The main sources of secondary data included (a) internal documents: archival records, artefacts, and a collection of reports on aspects related to supply chain strategy including: engineering, infrastructure, transport and other internal reports related to the availability and suitability of the supplied product and other related aspects that affect the supply chain strategy, (b) external documents: (i) case studies published online on the participating companies web pages, (ii) case studies published online on the Welsh Assembly Government, Office of National Statistics and other related web pages.

The method used to analyse the collected data included (i) reanalysis of qualitative data to create new interpretations from the existing data, followed by (ii) comparative research of the data that was made available through the process of consortium integration. This type of secondary data was made available to the study participants through the supply chain integration and the documents were difficult for individual study participants to obtain from the other participants. The process is supported with data triangulation and to create confidence in the accuracy of the findings (Denzin, 1978). To confirm accuracy of the secondary data, the findings are studied from more than one view point (Cohen et al., 2000), designed for continuously double-checking the data from multiple sources in search for constancies in the collected research data (O'Donoghue and Punch, 2003).

To capture the linkages between the vision and activities, the analysed data is applied to design conceptual maps and conceptual diagrams aimed at clarifying and simplifying the process of validating the supply chain strategy formulation on the mining industry. Firstly, conceptual diagrams are developed through applying secondary data analysis,
collected from reviewing internal and external documents. The secondary data analysis is focused on the supply chain strategy and its contribution to the business strategy. The findings are represented below.

### 9.4.1.1 Formulation methodology

The supply chain in the quarry is focused on three key elements: strict quality control; identify a longer term customer in need of Welsh roofing slate and; work with the longer term customers (museums, historic buildings, environmental agencies) to develop a strong relationship with the customers. The quarry has limited production capacity because of the lack of technological investments over many years. The production cannot be increased without investment and the product price cannot be decreased, because the fixed costs cannot be lowered and the variable costs have been lowered to the minimum. The process of translating ideas into a conceptual diagram is expressed in Figure 9-4, Figure 9-5, Figure 9-6, and Figure 9-7.

![Diagram showing Welsh Slate Products, Limited Production, Limited Customers, Strict Quality Control, Work with one time buyers, Develop strong relationship with long-term customers.]

**Figure 9-4: Translating ideas in conceptual diagrams**

Content analysis and narrative enquiry was applied to advance the conceptual diagram. To describe the process of how data is analysed in the study, the secondary data analysis is combined with primary data analysis from interviews in the quarry. During the interviewing process, it was determined that strong perception exists within the quarry employees that the Welsh slate is of superior quality (100% of the participants responded that the Welsh roofing slate has the longest lifecycle of any slate).
superior quality and long lifecycle of the Welsh slate is perceived in the quarry as the reason for reduced demand for replacement. The main idea in the quarry’s present strategy is to ensure continuous movements of products from the quarry (supplier) to customer (end consumer) linking the supply chain to the value chain, while at the same time working to develop a sophisticated supply chain system where the already used product (by-product) would enter the supply chain and directly link the supply to the value chain creating value from by-product that is not used and currently represents waste. The quarry estimated the demand of the by-product is to be more frequent because it can be used for multiple purposes. This is illustrated in a supply and demand conceptual diagram Figure 9-5:

![Supply and Demand Diagram](image)

**Figure 9-5: Building concepts on the ideas in the conceptual diagrams**

Figure 9-4 and Figure 9-5 represent the process of content analysis and narrative enquiry in conceptual diagrams. The same process has been applied on all activities and functions to assess the potential for developing the strategy.

In Figure 9-6, the ideas on the top are of higher importance in the strategy than these on the bottom that are more tactical ideas, this has been described as ‘cascading strategy’
(Narasimhan et al., 2008). The ‘cascading strategy’ was applied to develop further the conceptual diagrams into larger concepts.

Figure 9-6: Build the diagrams in larger conceptual diagrams

The ‘hierarchical cascade’ of the ‘cascading strategy’ (Narasimhan et al., 2008) enables joining smaller conceptual diagrams into a larger conceptual diagram in a form of preliminary conceptual diagrams in Figure 9-4, Figure 9-5, Figure 9-6, to be expanded in the larger conceptual diagram Figure 9-7.
Figure 9-7: Progressively building diagrams into hierarchical decomposed design for strategy formulation

The conceptual diagrams are progressively built into a conceptual model. The first two levels that should be built above the categories visualised in the larger conceptual diagram Figure 9-7 should represent the strategic vision and goals (Figure 8-6), as these were earlier identified as crucial integration mechanisms of the conceptual model. The following two layers represent the formulation areas of decision and formulation principles (Figure 9-3), followed by practical concepts referred to as formulation imperatives and operational elements referred to as formulation concepts (Figure 9-6).

The conceptual model is designed to investigate the relationships between ideas and activities and visualise how the greenfield project strategy formulation flows from the business through the supply chain into the practical and operational element. The process is generalised in the following stage.
9.4.1.2 Strategy formulation (C1)

The process starts with the strategic areas of (C1). The analysis is based on extracting the idea behind the statements. The process applied open and categorical coding and includes the quotations to illustrate the process. The (C1:P1) ‘diversify the processes and outputs in the quarry,’ presented a few ideas in a single statement and can only be described as superficial statement. To extract the idea behind the superficial statement the executive manager at the quarry was requested to define what the idea is behind this statement. The following description passages were provided: ‘we need to increase our productivity and profits’, ‘we need to increase our efficiency’, ‘we need to reduce the cost of mining by acquiring new technology’, and ‘we need to diversify our logistics chain processes and outputs’. From the (C1:P1) description, a number of (AD) were extracted and categorically coded into:

<table>
<thead>
<tr>
<th>Company one (C1) strategic goal (P1):(C1:P1)</th>
<th>Areas of decision (AD1,2,3,4) for (P1ofC1) : (ADnP1:C1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C1:P1) Diversify the processes and outputs in the quarry</td>
<td>(AD1:P1:C1) Supply chain processes and outputs</td>
</tr>
<tr>
<td></td>
<td>(AD2 P1:C1) Productivity and profits</td>
</tr>
<tr>
<td></td>
<td>(AD3 P1:C1) Mining cost</td>
</tr>
<tr>
<td></td>
<td>(AD4 P1:C1) Efficiency</td>
</tr>
</tbody>
</table>

Table 9-1: Example 1 of areas extraction process for (C1)

The following example was far simpler: from (C1:P2) ‘develop low cost transport’, the ‘transport cost’ was extracted as an area of decision and coded as (AD5:C1)

<table>
<thead>
<tr>
<th>Company one (C1) strategic goal (P2):(C1:P2)</th>
<th>Areas of decision (ADn) for (P2of C1) : (ADnP2:C1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C1:P2) Develop low cost transport</td>
<td>(AD1:P2:C1) Transport cost</td>
</tr>
</tbody>
</table>

Table 9-2: Example 2 of areas extraction process for (C1)

The data analysis process continued until all concepts were identified, examples of the process are outlined. ‘(C1) promotes the need to recycle the by-product, mostly because of the difficulties associated with waste disposal, but also because of the continually decreasing availability of landfill sites across the UK caused by population growth and products shorter life time. There are a number of legislations, taxes, and levies aimed at reducing the environmental impact caused by the aggregate industries. These legislations, taxes, and levies are aimed to reduce the amount of aggregate that goes
into landfills and to encourage the development of sustainable method for waste aggregate management.’

This quote strengthens the context of (C1P3) and from the text, the (AD1P3C1) was extracted and confirmed. The quote was selected because it highlights the value of integration through the visible relationship between (AD1P3C1) and (AD1P5C2), (AD1P7C2)

Furthermore, the area (AD2P6C1) was extracted from the quote: ‘(C1) have been worked by the same company for over 150 years. The traditional industry has been based on mining, quarrying and splitting Ordovician Rock to form roofing slate. Produced individually by hand in over 25 different sizes, Welsh slate has roofed buildings all over the world. Its production brought the slate-mining town of Blaenau Ffestiniog into being.’ The quote is strongly supportive of (C1P6)

‘The slate industry, similarly to all traditional industries has been faced with difficult issues related to infrastructure, technology, and logistic capabilities and needs to evolve in order to survive and prosper in today’s free market economic climate.’ A number of areas have been extracted (AD1P4C1), (AD2P4C1), (AD3P4C1) and verified. The quote was also strongly supportive of (C1P4), and multiple areas present in (ADnPnCn) The outlined process was applied to (C1Pn) resulting in the complete list of categorised areas (ADnPnC1) Table 9-3.

<table>
<thead>
<tr>
<th>Company one (C1) sum of strategic goal (Pn): (C1Pn)</th>
<th>Sum of areas of decision (ADn) of the first company (C1) : (ADnPnC1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C1P1) Diversify the processes and outputs in the quarry</td>
<td>(AD1P1C1) Supply chain processes and outputs (AD2P1C1) Productivity and profits (AD3P1C1) Mining cost (AD4P1C1) Efficiency</td>
</tr>
<tr>
<td>(C1P2) Develop low cost transport</td>
<td>(AD1P2C1) Transport cost</td>
</tr>
<tr>
<td>(C1P3) Pursue environmental sustainability</td>
<td>(AD1P3C1) Impact on environment</td>
</tr>
<tr>
<td>(C1P4) Develop technology, capability and infrastructure</td>
<td>(AD1P4C1) Supply chain technology (AD2P4C1) Supply chain capability (AD3P4C1) Supply chain infrastructure</td>
</tr>
<tr>
<td>(C1P5) Increase the market share and secure long term market</td>
<td>(AD1P5C1) Supply chain market</td>
</tr>
<tr>
<td>(C1P6) Build strong brand for the by-product</td>
<td>(AD2P6C1) Supply chain brand</td>
</tr>
</tbody>
</table>

Table 9-3: Summary map of extracted supply chain areas for (C1)
The analysis continued with evaluating if the (ADnPnC1) are supportive of individual strategic goals (scC1Pn) and core strategies (C1sC). The analysis and evaluation was considered required to identify how the areas of the greenfield project formulation lead or assist in achieving the goals stated in the individual business strategy of (C1). To assist with the analysis, (C1) provided an extensive sample of internal data regarding present operations and their overall business. The most valuable data was obtained through applying the case study methods and performing interviews with employees from different groups (C1D,M,E). The relationship between the greenfield project formulation and the objectives of their business strategy were identified as: ‘Diversify to evolve the slate industry’ and was coded as (C1sC). The strategic pillars identified are also coded as:

1) Better match customer demand for value for money slate products (C1sCp1);
2) Reducing the cost margin of roofing slate by offsetting the cost of production with profits from sales of slate aggregate (C1sCp2);
3) Achieve lower cost of transport from quarry to the market by operating with a lean supply chain network (C1sCp3);
4) Pursue innovation in new materials from slate aggregate (C1sCp4);
5) Maximize the potential of slate aggregate to offset demand and supply in existing aggregate markets (C1sCp5)

These are illustrated in a conceptual diagram (Figure 9-8)

| Strategic Core (SC) of (C1): (scC1) | Strategic pillars (Pn) from (scC1): (scC1Pn) | Extraction and validation of (scC1Pn) and confirmation of linkages with (ADnPnC1):
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversify to evolve the slate industry’</td>
<td>Better match customer demand for value for money slate products (C1sCp2) Reduce the cost margin of roofing slate by offsetting the cost of production with profits from sales of slate aggregate’</td>
<td>Secondary data: Internal documents. Primary data: (C1D1,2,3,4,5,6,7,8,9), (C1M3,4,8), (C1E1,2,3,4,9),</td>
</tr>
<tr>
<td>Achieve lower cost of transport from quarry to the market by operating with a lean supply chain network’</td>
<td>(C1sCp3)</td>
<td></td>
</tr>
<tr>
<td>Pursue innovation in new materials from slate aggregate’</td>
<td>(C1sCp4)</td>
<td></td>
</tr>
<tr>
<td>Maximize the potential of slate aggregate to offset demand and supply in existing aggregate markets’</td>
<td>(C1sCp5)</td>
<td></td>
</tr>
</tbody>
</table>

Table 9-4: Summary map of extracted strategic pillars for (C1)
This design resulted in a set of constructions that can be used as a tool to extract an abstract of individual companies’ tacit operational integration leakages relevant in the context of formulation. The set of constructions enables evaluating if there is sufficient linkages between; the abstract individual (AD), the greenfield project (IPn) and the existing individual strategic goals (scCnPn). This phase is crucial for ensuring the greenfield project formulation leads or assists in achieving the goals stated in the (scCnPn) and individual (cNSC). Therefore, evaluating the linkages must come prior relating the as elements to the conceptual supply chain strategy. The evaluation integrated the primary data sets from Table 5.4.2 3 and Table 5.4.2 4 into Table 5.4.2 1 and Figure 4.4.1 3 with Table 5.4.2 3 and Table 5.4.2 4, the resulting framework is shown in Figure 5.4.2 7.
9.5 Formulation principles

The formulation process discovered that some of the areas could not be joined under a common heading but they were far too closely related to be separate areas. To resolve this issue without impacting the validity of the data, an additional category was designed and coded as formulation principles (FPn) that allowed us to maintain a manageable number of (ADn). The experience from the field-interviews advocates a recommended level of (ADn) and (FPn) regarding the silent areas. The recommended level is no more than 10 (ADn) and no more than 20 (FPn). In the cases analysed, the number was found as being sufficient; however, there would be cases where this number would be exceeded.

In the cases where these numbers are exceeded the researcher should review the data sets and take sensitive action to keep the (ADn) and (FPn) within the recommended
range. This helped in recording all the data in a simplified illustration and ensured compliance with the recommendations for simplicity made previously.

The need to link and merge the formulation areas to reduce the number of areas to a reasonable level is described in this section. It includes the process applied to analyse the notes from the field-interviews and merge the presented formulation areas and the activities. Therefore, the number of silent areas and activities is within the limits recommended in this research. However the field work with (C₁), resulted with this number exceeding well beyond the limits recommended. For example initially 20 silent areas were identified and over 50 activities. This was predominately because (C₁) has diversified from quarrying into the tourism business with the deep quarry pits and hydroelectricity production.

The same process mentioned with (C₁) was applied on linking the silent areas. The number was reduced with this process from 20 to 10 silent areas. Applying over 50 activities as a second layer exceeded the recommendation of the method stated previously. Therefore, to simplify the process (FP₁) were used after the silent areas. The (FP₁) acted in a way as sub-silent-areas. The sub-silent-areas were grouped with three activities. The grouping involved clustering the activities in clusters of three and naming the clusters. This process applied on the aggregated data sets from (C₁), was discovered to be applicable even on conceptual diagram that were within the recommended limits. This in effect enabled an illustration of the process without illustrating the new diagrams for (C₁).

9.5.1 Extracting the formulation principles

Following the integration in the business strategy through the formulation areas, the process of extracting and validating the formulation principles commenced. The value of the formulation principles elaborated briefly in Figure 5.4.2 9. The formulation principles represent the focus category in the 4 categories created: idea, focus, command, and activity. The process involved applying content and discourse analysis for extracting, evaluating and associating the formulation principles to the integration areas.
This process is suggested to investigate the relationship between the vision, goals, and the (SD) and (BB’s) through the formulation areas that represent the drive of the business strategy, and the formulation principles that serve as a link with the operations and enable evaluation of the required activities behind the vision.

The design process starts by reviewing the generated ideas from the participants in a form of statements that can be used to extract the formulation principles and associate them to the formulation areas. Some statements are extracted from the notes taken during or after the interviews, some from reviewing secondary data files, while other statements have been specifically requested and extracted from electronic lists provided by participants. The complete text analysed represents hundreds of pages and much of the secondary data analysed is not directly related to this context, therefore, it is not detailed in the study. However, examples of the relevant quotes, statements and text that are used to extract the formulation principles are provided in the data analysis. Some of the example statements are also provided to describe the process.

- From the statement: ‘(C1) has anticipated that if the supply chain is not operational, the high cost of transport will cause the aggregate material consumers to use other sources as a material.’ The principal action objective extracted from the statement was: ‘anticipate threats’.

- Sample: ‘The slate aggregate is economically not viable after 50 miles of road transport. Road transport is also environmentally unacceptable as the quarry is based in the heart of Snowdonia. Rail transport is needed to lower cost and environmental damage in order to pursue profitable markets in England, Scotland and Wales’. From this statement, two operational action objectives were extracted: ‘pursue profitable markets’ and ‘develop low cost transport’.

- Sample: ‘We have to design a supply chain to lower the cost of delivering the products from quarry to customer. ‘The operational action objective extracted from the statement was: ‘be effective in the market’.

The emerging design process applied open and categorical coding to progressively build the action objectives into diagrams.
Figure 9-10: Cataloguing emerging supply chain concepts into strategic categories

The process of applying inductive reasoning to extract the tacit action objectives and categorising them into formulation principles was applied to all the goals in the following method. From the statements:

- 'We have to be innovative in identifying new product from the mining by-product.' The principle action objective extracted from the statement was: Be innovative.
- 'We have to increase our variety of products from the waste aggregate.' The principle action objective extracted from the statement was: Offer variety.
- 'The Welsh slate is well known for its superior strength when compared to other slate materials. Slate aggregate has, on the other hand, been perceived as a substandard product. A portfolio of brand names needs to be developed to tackle this misperception.' The principle action objective extracted from the statement was: Develop brand name.

The principle action objectives were applied to progressively build the conceptual design containing the action objectives into concept diagrams.
The inductive reasoning process for extracting the tacit action objectives and progressively building the action objectives into conceptual diagrams continued until all the action objectives were extracted. The text below states the principles and the action objectives followed by the statement that was analysed to extract the action objective.

- **Principle action objective: Improve Efficiency, extracted from the statement:**
  
  'The slate industry has been in a decline for decades. Many quarries have been closed. We need to collaborate, allow sharing of knowledge and improve efficiency of the processes.'

- **Principle action objectives: Increase Sales and Reduce Costs, extracted from the statement:**
  
  'We need to increase sales of secondary aggregate which is classified as a waste if its location is Blaenau Ffestiniog. Selling the waste will reduce the costs of landfill tax and reduce on costs to comply with environmental agencies.'
- **Principle action objective: Control the supply chain**, extracted from the statement: 'We need a greater control of the logistic chain.' (by logistics chain it was referring to the supply chain)

- **Principle action objective: Invest in capabilities**, extracted from the statement: 'Significant investment is needed for upgrading the rail line from route availability 6 to route availability 10 to allow for large volumes of aggregate to be moved by rail. Significant investment is also needed for the rail freight terminal. Additionally, the quarry needs investment in technology to increase its production of roofing slate.'

- **Principle action objective: Assure availability**, extracted from the statement: 'The stock piled slate aggregate in Blaenau Ffestiniog is estimated at 700m tones, while the slate industry is in continuous production of aggregate.'

- **Principle action objective: Reduce asset costs**, extracted from the statement: 'By diversifying into selling the secondary slate aggregate by-products, the asset costs of production will be reduced as the product is already available in large quantities.'

- **Imperative action objective: Outsource non-core operations**, extracted from the statement: 'Some of our operations need to be outsourced because they represent non-core operations. We need to partner with different companies to cover these non-core operations.'

The extracted action objectives and concepts have been related and grouped into categories represented in the (C1Pn). By assembling the action objectives into categories, patterns started to emerge. The first pattern was that action objectives can be interconnected. This can easily be visualised in Figure 5.4.2 12, Figure 5.4.2 13, Figure 5.4.2 14.

The second emerging pattern was that concepts that cannot be classified as formulation principles started to emerge. For example outsourcing non-core operations was not a principle decision for integration and formulation. The action objective represented an imperative objective that need to be addressed with the supply chain participants.
The third pattern was that strategic goals can have closely associated principle action objectives. For example the action objective ‘reduce cost’ presents a closely associated action objective as ‘reduce asset cost’. These action objectives are structured hierarchically into the formulation areas to group related action objectives. However, a different emerging pattern is that some of the action objectives ex. ‘reduce cost’
required multiple strategic decisions, while ‘reduce asset cost’ required strategic
decisions solely focused on a specific cost. This caused the data analysis to seek
additional patterns that can be placed in concept categories. The recorded formulation
principles extracted from the quarry, were observed with experts in the field and it was
concluded that the statements are interrelated in the sense that the aim is achieving
certain objectives. The wording was studied further to create links between the aim and
objectives. Some objectives were aimed at achieving status such as ‘be effective in the
market’, while other statements are aimed at achieving actions such as ‘increase sales’.
From the data analysis it also became obvious that regardless of the objective being
focused on action or status they were explicitly present in the formulation areas as
concepts that require decisions. The difference in the action objectives was analysed
and represented in different categories.

Figure 9-13: Architecting the supply chain design through articulating the silent
areas

After reviewing the silent areas the list was updated to include all areas of integration
and the related formulation principles with appropriate wording that eliminated the
lower ranked concepts from the list and investigated further the relationship between
these concepts in the form of strategic hierarchical concept map (Table 9-5).
Table 9-5: Conceptual summary map of silent areas and principles

<table>
<thead>
<tr>
<th>Silent Area</th>
<th>Principle Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on environment</td>
<td>Pursue environmental sustainability</td>
</tr>
<tr>
<td>Supply chain technology</td>
<td>Acquire new technology</td>
</tr>
<tr>
<td>Supply chain capability</td>
<td>Invest in supply chain capabilities</td>
</tr>
<tr>
<td>Supply chain infrastructure</td>
<td>Maximise usage of existing supply chain infrastructure</td>
</tr>
<tr>
<td>Supply chain market</td>
<td>Be effective in the market</td>
</tr>
<tr>
<td>Supply chain technology</td>
<td>Increase sale volumes</td>
</tr>
<tr>
<td>Supply chain brand</td>
<td>Develop new supply chain brand</td>
</tr>
<tr>
<td>Supply chain economy of scale</td>
<td>Develop supply chain economy of scale</td>
</tr>
<tr>
<td>Demand planning</td>
<td>Plan by-product demand for long term advantages</td>
</tr>
<tr>
<td>Production costs</td>
<td>Minimise cost of sales</td>
</tr>
<tr>
<td></td>
<td>Reduce the by-product cost margin</td>
</tr>
<tr>
<td></td>
<td>Reduce asset cost</td>
</tr>
<tr>
<td>Supply chain potential</td>
<td>Maximise the potential supply and usage of the by-product</td>
</tr>
<tr>
<td>Supply chain volume</td>
<td>Increase sale volumes</td>
</tr>
<tr>
<td>Supply chain education and development</td>
<td>Educate and develop</td>
</tr>
<tr>
<td>Supply chain innovation</td>
<td>Innovation in new materials</td>
</tr>
</tbody>
</table>

9.5.2 Formulation of supply chain tasks and activities

The focus in this stage was placed on the new emerging categories described in Figure 9-10 and Table 9-1. The categories in Table 9-1 represented the areas of decision and principle actions required for the supply chain to operate. The (ISV) and (IPn) in the case scenario analysed are continuously being referred to by going backwards and forwards in the data collection and analysis because these factors serve as the driving force behind the supply chain strategy. The main idea identified in the (ISV) is sustainably and profitably using the slate by-product for the multiple purposes represented in the product family. Therefore, the driving force for formulating the supply chain strategy was to send the aggregate to the market as rail freight by multimodal transport, in the process, lowering the cost of transport to make the product more competitive. The following stages are continuously been analysed and evaluated to ensure the data analysis is leading towards productive analysis of relevant concept. The process of
identifying the final two categories has benefited to a great extent in terms of narrowing the researched goals by categorising the emerging categories into areas and principles.

### 9.5.3 Catalogue silent activities in salient dimensions

The process of cataloguing silent activities from salient dimensions required additional preparation, largely because it is a process of crucial importance in the context of confirming conceptual validity through case study research. This section represented validating the recorded areas and principles in the activities. To achieve this it was crucial to stay open minded about the responses and to write down the facts. The process of confirming validity was targeted at observing sufficient evidence and if that was not available in a certain area of activity, the activities were disregarded. Considering that the process of confirming validity is considered crucial in the research, this process is divided into five steps:

1. Investigate the salient dimensions: influencers, design decisions, building blocks.
2. Identifying silent categories of activity in the salient dimensions
3. Investigate the activities in each category
4. Investigate the support factors for each activity
5. Double-check for sufficient amount of evidence of supporting concepts
6. Summarise different undefined activities into hierarchy

In the first step, the interviews were focused on observing and identifying the categories of activities that were left silent. To confirm validity, it was crucial to determine the relevant categories of activity from the vast areas covered by the supply chain consortium companies. In this process the investigation was focused on identifying the consortium cross referencing areas by referring to the (SD) and (BB’s) aimed at bringing the focus on strategy integration. This was considered as crucial to integrate the consortium supply chain activities in the context of the vision and goals of the greenfield project strategy formulation. In the process of building conceptual theory, it was considered crucial to validate these activities of the consortium companies, which consisted of a complete supply chain that can be formulated into a greenfield project supply chain strategy. In the scenario the formulation is scoped on the supply chain participants and covers the distribution of the product and services of a supply chain
strategy from production line (C₁) to the retailer (C₂). The main focus on service in the context of integration is the transport and logistics aspect of a supply chain solution.

The supply chain integration was considered the greatest interest to the greenfield project formulation because the main problem for (C₁) was ‘how to make the supply chain from quarry to customer more cost efficient’, ‘how do we become as efficient as other quarries despite the lack of capabilities of lower cost rail/shipping transport’, ‘how to make the slate aggregate by-product affordable for distant customers, considering the 50 miles limit of road transport for economic and environmental efficiency’. The supply chain logistics problems stated above suggest that the tacit activities of the supply chain strategy for (C₁) are focused on becoming more efficient in delivering the product to the market with lower costs and lower carbon emissions. After selecting these as crucial formulation imperatives, they were recorded and coded in imperative statements (Table 9-6)

| Formulation Imperatives (FIᵢ) |  |
|-------------------------------|  |
| (FI₁C₁) Make the supply chain from quarry to customer more cost efficient |  |
| (FI₂C₁) Become as efficient as other quarries |  |
| (FI₃C₁) Make the slate aggregate by-product affordable for distant customers |  |

Table 9-6: Progressively building imperative concepts to validate the principle categories

The second step addressed the concern that in consortium integration, even if the researcher is an employee of one company, the researcher is always external to the remaining companies. Therefore, the researcher has a little knowledge or understanding of the silent areas that are left tacit in the vision and goals. In this study, the researcher was external to all participating companies. The first task after identifying the silent areas was to investigate the activities in each formulation area. This task was performed by answering the ‘how’ questions with asking questions beginning with ‘what’. For example: ‘What evidence do we have that constructing the logistics chain of five companies comprising the supply chain will actually lower the cost of transport, make the supply chain more efficient and make the companies more competitive’.

To find the answer to this question, the method suggested in this study represents looking at the concrete examples of activities stated in the interviews. Concrete examples are used to prove the validity of any silent areas. The data collected through
interviews provided several examples of executed activities in the area mentioned in the question. One example is \((C_3 D_1)\): ‘\((C_3)\) can provide one solution for \((C_1)\) by making the slate aggregate product readily available for consumers in the urban areas where the demand for aggregate is highest. To open virtual quarries on a national level where the slate aggregate by-product would be readily available for customers would cost millions for the quarry and would require staff recruitment, management and running cost for these stores. \((C_2)\) will enable the benefits of all this for \((C_1)\) with a 21\textsuperscript{st} century state of the art multimodal transport and a large number of rail terminals across the UK that can be used as virtual quarries. \((C_2)\) will ensure that the orders of additional slate aggregate material are on time for the consortium partners to be able to deliver the product to the virtual quarry. Virtual quarries will ensure that \((C_1)\) has at any point in time available product in multiple destinations across the UK without even hiring extra staff to manage the orders. Creating virtual quarries would also save one or two working days for their operations and sales team and the orders will be processed in better times from the terminal managers directly.’

From this text it was recorded that the consortium would enable \((C_1)\) to ‘gain access to the market and customers on multiple locations’ across the UK the consortium would also ‘provide access to a chain of terminals’ across the UK and ability to sell the slate aggregate product to the customers as and when needed. The recorded formulation imperative (Table 9-7) of these activities is: ‘become more efficient and competitive’.

<table>
<thead>
<tr>
<th>((F_1 C_3))</th>
<th>((F_2 C_3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>((F_1 C_3)) Become more efficient and competitive</td>
<td>((F_2 F_1 C_3)) Gain access to the market and customers on multiple locations</td>
</tr>
<tr>
<td>((F_2 C_3)) Provide access to a chain of terminals</td>
<td></td>
</tr>
</tbody>
</table>

Table 9-7: Progressively building the conceptual tasks to validate the imperative concepts

This process in effect refers to probing the interviewee regarding the silent activities. The probing enabled the assembling of the silent areas with elements from activities of individual companies. The assembling through probing is applied in the progressing of the latter stage of assembling a conceptual model. The initial testing of the assembly method on the undefined areas, in the second stage is presented as applied in the field-
interviews with (C₃) to provide logistic and market solutions for the greenfield project supply chain strategy.

In the third stage, the support factors for each executed action are investigated. This stage of the investigation is probing into the tacit knowledge which is not clearly expressed prior to the probing. Therefore, the process of validating the collected data must be placed in consideration constantly. To ensure this consideration is constant, all the executed activities that were recorded were also grounded in actual practices of the consortium companies. For example the investigation probed a number of interviewees that were unaware of the statements made in previous interviews to validate the support factors for the (FI₁C₃) activity stated above ‘become more efficient and competitive’. It was found that a large number of the interviewees made statements in support of the importance of this activity to the supply chain.

Some statement examples are: (C₁E₁):‘the remoteness of Blaenau Ffestiniog and the distance from the market makes the slate aggregate less competitive than other aggregates’ or (C₁D₁):‘South Wales has reached the Welsh Assembly requirements for reducing the usage of primary aggregate, but North Wales where most of the slate aggregate is located has failed this target... mostly because there is no low cost rail transport and the market is far from the quarry’, (C₂M₉)‘the customers prefer buying aggregate that is readily available in their area’. Here it was recorded that the participation of (C₃) in the supply chain is of crucial importance for the formulation of an effective logistic system in the greenfield project supply chain strategy because it provides ‘access to state of the art low cost transport and virtual quarries’. Other sample questions of the data collection process in are: ‘How is this specific activity implemented in the actual practice’ or ‘How can this activity be implemented in the context of Blaenau’. In the process the support factors that companies have in place are investigated and re-examined for the activities listed in the silent areas. An example question from the interviews is: ‘What are the processes and the support factors that contributed to the successful performance of this activity’. The process considered that the investigation was aimed at researching and extracting silent activities that have not been clearly expressed until extracted through probing. Therefore, this stage remained focused on
a) Identifying additional operational activities to assemble the silent areas previously identified

b) Identifying new support resources for the silent areas in the form of operational activities.

9.5.4 Concept simplification to generalise the data analysis

In an attempt to capture and visualise the complexity of a greenfield project formulation involving multiple supply chain participants and to ensure feasibility of the concepts, the case study evaluated (SD) dimensions that are out of the control of the supply chain strategy. The following two categories are analysed in the context of how the supply chain strategic integration can mitigate the effect by focusing the collaborative activities to these dimensions. However, the external dimensions that are out of the control of the supply chain strategy are considered as beyond the context of this study. For example, the investigation reviewed the infrastructure problems discussed in the formulation areas and jointly with the industry participants concluded that such responsibilities should be undertaken by Network Rail. Network Rail is under obligation to maintain rail route availability. The scenario investigated was whether the supply chain consortium was capable of running the train and maintaining the rail infrastructure on the part of the line that has been closed for many years and is not under jurisdiction of Network Rail. Concepts extracted from secondary data from the first attempt to formulation the supply chain were analysed and the relevant concepts were applied as reference material to the primary data collection and analysis.

9.5.5 Factors driving supply chain design

Melnyk et al. (2013) claimed that future research is needed for ‘uncovering the factors driving supply design’ (Ibid., pp.6) because the topic is strongly context sensitive (ex. design elements from demand-driven would not be applicable to supply-driven supply chains). Melnyk et al. (2013) recommended that for ‘uncovering the DNA of supply chains ‘similar and distinct features must be identified along with the ‘underlying factors’ driving design and shaping the ‘resulting systems’. 
The process of analysing the influencing underlying factors in this study involved firstly, identifying a number of similar and distinct features, present in the supply chain participants that represent multiple industries. Secondly, identifying the underlying factors present in each participant and presenting them as visual concepts. Thirdly, the relationship and influence of these concepts is reviewed in the context of shaping a supply chain strategy.

The stages were performed through case study and action research, while at the same time using secondary and primary data. In the third stage a conceptual model is designed to demonstrate the process of applying the concepts to formulate and integrate the supply chain strategy. The design process involved a method for narrowing the scope of the concepts.

The process is applied firstly to the lead company. Secondary data extracted is confirmed through interviews and additional concepts are extracted from primary data. The resulting concepts are presented in Table 9-8. The resulting concepts are reconfirmed through group discussions with (C).

<table>
<thead>
<tr>
<th>(FP6C1)</th>
<th>(FP6C1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P1FP1C1) Diversify our logistics chain processes and outputs</td>
<td>(AD2P1FP1C1) Pursue supply chain integration</td>
</tr>
<tr>
<td>(AD2P1FP1C1) Increase our productivity and profits</td>
<td>(AD2P1FP1C1) Pursue productivity and profit through the slate waste product family</td>
</tr>
<tr>
<td>(AD3P1FP1C1) Reduce the cost of mining</td>
<td>(AD3P1FP1C1) Reduce the cost of outsourced mining operations</td>
</tr>
<tr>
<td>(AD4P1FP1C1) Increase the supply chain efficiency</td>
<td>(AD4P1FP1C1) Reduce the cost of delivery for the by-product</td>
</tr>
<tr>
<td>(AD1P2FP1C1) Minimise transportation cost</td>
<td>(AD1P2FP2C1) Minimise the cost of delivery</td>
</tr>
<tr>
<td>(AD1P2FP2C1) Develop sustainable transport</td>
<td>(AD1P2FP2C1) Develop rail and shipping transport</td>
</tr>
<tr>
<td>(AD1P2FP2C1) Pursue environmental sustainability</td>
<td>(AD1P3FP1C1) Reduce our impact on environment</td>
</tr>
<tr>
<td>(AD1P4FP1C1) Acquire new technology</td>
<td>(AD1P4FP1C1) Pursue technological innovations that would enable commercialising the slate aggregate by-product</td>
</tr>
<tr>
<td>(AD2P4FP1C1) Invest in supply chain capabilities</td>
<td>(AD2P4FP1C1) Develop supply chain capabilities</td>
</tr>
<tr>
<td>(AD3P4FP1C1) Maxmise usage of existing supply chain infrastructure</td>
<td>(AD3P4FP1C1) Pursue integration with consortium partners that can enable</td>
</tr>
</tbody>
</table>
usage of existing rail infrastructure

Table 9-8: Conceptual summary map resulting from progressively relating individual conceptual principles with individual conceptual imperatives

Following the same process, the strategic activities are extracted and categorised in groups to narrow the conceptual context.
| ADsP1FP1FI1C1 | Reduce the cost of outsourced mining operations | (ADsP1FP1FI1C1) Integrate waste product production with the supply chain to prevent duplicating machinery costs (ADsP1FP1FI1A2C1) Pursue integration with a consortium of companies to reduce the cost of operations |
| ADsP1FP1FI1C1 | Reduce the cost of delivery for the by-product | (ADsP1FP1FI1C1) Identify opportunities to improve the logistics of the by-product (ADsP1FP1FI1A2C1) Identify and reduce waste in the supply chain (ADsP1FP1FI1A3C1) Eliminate additional waste product accumulation |
| ADsP2FP1FI1C1 | Minimise the cost of delivery | (ADsP2FP1FI1C1) Determine the precise and accurate cost of delivery (ADsP2FP1FI1A2C1) Procure third party transport and logistics services (ADsP2FP1FI1A3C1) Pursue lower cost of transport from quarry to the market by optimising the operating network |
| ADsP2FP2FI1C1 | Develop rail and shipping transport | (ADsP2FP2FI1C1) Pursue road to multimodal shift through integrating with 3PLs |
| ADsP3FP1FI1C1 | Reduce our impact on environment | (ADsP3FP1FI1C1) Identify means to resolve the environmental damage of our mining operations (ADsP3FP1FI1A2C1) Pursue rail and sea transport opportunities to reduce environmental damage from logistic operations (ADsP3FP1FI1A3C1) Promote green activities (cycling tracks, etc.) |
| ADsP4FP1FI1C1 | Pursue technological innovations that would enable commercialising the slate aggregate by-product | (ADsP4FP1FI1C1) Integrate the supply chain to acquire access to technology for commercialising the slate aggregate by-product (ADsP4FP1FI1A2C1) Invest in IT systems to communicate more effectively with supply chain partners (ADsP4FP1FI1A3C1) Develop technology for converting the by-product to various products present in the product family |
| ADsP4FP1FI1C1 | Develop supply chain | (ADsP4FP1FI1C1) Develop supply chain |
capabilities | capability to reach profitable sub-ballast markets
(AD\textsubscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{2}C\textsubscript{1}) Invest time in supply chain integration with partners that have the required capabilities
(AD\textsubscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{3}C\textsubscript{1}) Improve and develop relationships with the supply chain participants

(AD\textsubscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{1}) Pursue integration with consortium partners that can enable usage of existing rail infrastructure
(AD\textsubscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Pursue strategic integration with partners that possess capabilities to upgrade existing supply chain infrastructure
(AD\textsubscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{2}C\textsubscript{1}) Pursue strategic integration with partners that possess capabilities to maintain existing supply chain infrastructure
(AD\textsubscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{3}C\textsubscript{1}) Integrate with supply chain partners that possess infrastructure to create virtual quarries in multiple destinations

(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{1}) Pursue profitable markets for the slate aggregate by-product
(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Offer variety of aggregate by-product products to existing and new customer base
(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{2}C\textsubscript{1}) Pursue innovative product usage in high demand aggregate materials
(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{3}C\textsubscript{1}) Better match customer demand with value for money of by-product aggregate

(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{2}FI\textsubscript{1}C\textsubscript{1}) Pursue new markets for the slate aggregate by-product
(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{2}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Offer variety of aggregate by-product products to existing and new customer base
(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{2}FI\textsubscript{1}A\textsubscript{2}C\textsubscript{1}) Target profitable customers of by-product aggregate to the additional customer base
(AD\textsubscript{1}P\textsubscript{5}FP\textsubscript{2}FI\textsubscript{1}A\textsubscript{3}C\textsubscript{1}) Add new slate aggregate by-products in the supply chain product mix to increase profits

(AD\textsubscript{1}S\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{1}) Brand the by-product family
(AD\textsubscript{1}S\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Increase profitability through branding the by-product into multiple product families

(AD\textsubscript{1}S\textsubscript{2}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{1}) Utilise the waste product to match commercial demand
(AD\textsubscript{1}S\textsubscript{2}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Manage continuous movement of the waste by-product
(AD\textsubscript{1}S\textsubscript{2}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{2}C\textsubscript{1}) Create higher product turnover to develop sales of scale
(AD\textsubscript{1}S\textsubscript{2}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{3}C\textsubscript{1}) Reduce the production cost through utilising the stockpiled reserves

(AD\textsubscript{1}S\textsubscript{3}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{1}) Forecast the by-product
(AD\textsubscript{1}S\textsubscript{3}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Perform additional...
| Demand at multiple locations | Market research to identify multiple demand locations  
(AD1S3FP1FI1A2C1) Use scenario planning to forecast the demand in different locations  
(AD1S3FP1FI1A3C1) Determine product price elasticity  
(AD1S3FP1FI1A4C1) Identify effective demand planning and forecasting tools |
|---|---|
| **(AD1S3FP1FI2C1)** Consider the supply chain cost implications when forecasting demand | **(AD1S3FP1FI2A1C1)** Forecast the supply chain cost from different transport modes  
(AD1S3FP1FI2A2C1) Promote a collaboration between the companies involved in the supply chain operations  
(AD1S3FP1FI2A3C1) Increase price elasticity by road to rail shift  
(AD1S3FP1FI2A4C1) Plan demand with building different costs (road/rail/multimodal) in the supply chain |
| **(AD1S4FP1FI1C1)** Minimise the cost of sold slate by-product | **(AD1S4FP1FI1A1C1)** Keep low cost of slate materials by focusing the sales process on price, quality, service and reliability as a supplier  
(AD1S4FP1FI1A2C1) Keep the cost of extraction at minimum |
| **(AD1S4FP2FI1C1)** Reduce the cost margin by optimising the usage of the by-product | **(AD1S4FP2FI1A1C1)** Off-set the cost of operations with profits from sales of the by-product  
(AD1S4FP2FI1A2C1) Operate using optimal roofing slate production capacity  
(AD1S4FP2FI1A3C1) Operate using optimal level of sales of the by-product |
| **(AD1S4FP3FI1C1)** Reduce the asset cost through outsourcing | **(AD1S4FP3FI1A1C1)** Prevent disruption in business by outsourcing services from low cost high reliability companies |
| **(AD1S5FP1FI1C1)** Maximise the potential of slate aggregate to offset demand and supply in existing aggregate markets | **(AD1S5FP1FI1A1C1)** Create value added by selling by-product from other operations  
(AD1S5FP1FI1A2C1) Look for ways to sell the slate aggregate as sub ballast material for building roads  
(AD1S5FP1FI1A3C1) Look for ways to sell the slate aggregate product for sea defences  
(AD1S5FP1FI1A4C1) Look for ways to sell high volumes of slate aggregate as environmentally friendly brick for building houses or fences  
(AD1S5FP1FI1A5C1) Look for selling the slate aggregate by-product |
aggregate product for a number of other potential usages

(AD1S6FP1FI1C1) Increase the sales volume of slate aggregate by-products (AD1S6FP1FI1A1C1) Add virtual quarries in multiple locations close to the markets (AD1S6FP1FI1A2C1) Grow with the demand for aggregates in the current market (AD1S6FP1FI1A3C1) Produce sustainable amount of slate aggregate by-product to match high volumes demand (AD1S6FP1FI1A4C1) Comply with the industry quality requirement

(AD1S7FP1FI1C1) Educate and develop the supply chain skills of the workforce (AD1S7FP1FI1A1C1) Provide training to improve the impact of the workforce (AD1S7FP1FI1A2C1) Develop a Rail Skills Academy (AD1S7FP1FI1A3C1) Develop Engineering Academy

(AD1S8FP1FI1C1) Pursue innovation in new materials from the slate aggregate by-product (AD1S8FP1FI1A1C1) Create our own innovative products from the aggregate (AD1S8FP1FI1A2C1) Pursue innovative product usage in high demand aggregate materials (AD1S8FP1FI1A3C1) Test the by-product suitability to be used in markets with high demand for aggregate materials

Table 9-9: Conceptual summary map resulting from progressively relating individual conceptual imperatives with individual conceptual tasks in the form of activities

The coded conceptual categories are hierarchically structured to visualise the conceptual supply chain strategy formulation (Table 9-10 and Table)

<table>
<thead>
<tr>
<th>[AD1P1C1]</th>
<th>Supply chain processes and outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P1FI1C1) Diversify logistics chain processes and outputs</td>
<td></td>
</tr>
<tr>
<td>(AD1P1FI1A1C1) Pursue supply chain integration</td>
<td></td>
</tr>
<tr>
<td>(AD1P1FI1A1A1C1) Integrate with 3PLs that can operate on Conwy Valley Line</td>
<td></td>
</tr>
<tr>
<td>(AD1P1FI1A1A2C1) Integrate with 3PLs that would enable multimodal transport</td>
<td></td>
</tr>
<tr>
<td>(AD1P1FI1A1A3C1) Pursue sea transport through Port of Mostyn</td>
<td></td>
</tr>
</tbody>
</table>

Table 9-10: Sample of the conceptual hierarchy summary map

9.5.6 Formulation and evaluation (C2,3,4,5)

The second business strategy analysed in the process of obtaining the data required for formulation is (C3) The analysis process of (Cn) does not have to be performed in a numerical order because at this stage of the formulation, it is required to determine the
support of individual \((AD_n)\) to the individual \((SC_{Cn})\) and the relationship with the integrated vision \((ISV)\) and integrated goals \((IP_n)\) The analysis and evaluation at this stage are performed with individual companies and the recommended process is to complete this task with individual companies as and when suitable, regardless of the numerical order.

<table>
<thead>
<tr>
<th>Company ((C_3)) goal ((P_1):(C_3P_1))</th>
<th>Areas of decision ((AD_{1,2})) for ((P_1of C_3)) : ((AD_{nP_1C_3}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>((C_3P_1)) Provide the supply chain with our comprehensive network of depot and terminals</td>
<td>((AD_1 P_1C_3)) Supply chain network, ((AD_2 P_1C_3)) Supply chain depot and terminals</td>
</tr>
</tbody>
</table>

Table 9-11: Example 1 of extraction process for \((C_3)\) areas of decision

From \((C_3P_2)\) ‘invest in rail terminal technology, capability and infrastructure for the supply chain’, three areas were extracted and coded.

<table>
<thead>
<tr>
<th>Company ((C_3)) strategic pillar ((P_2):(C_3P_2))</th>
<th>Areas of decision ((AD_{1,2,3})) for ((P_2of C_3)) : ((AD_{nP_2C_3}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>((C_3P_2)) Invest in rail terminal technology, capability and infrastructure for the supply chain</td>
<td>((AD_1 P_2C_3)) Supply chain technology, ((AD_2 P_2C_3)) Supply chain capability, ((AD_3 P_2C_3)) Supply chain infrastructure</td>
</tr>
</tbody>
</table>

Table 9-12: Example 2 of extraction process for \((C_3)\) areas of decision

The outlined process was applied to \((C_3P_n)\) resulting in the complete list of areas \((AD_{nP_nC_3})\) summarised in the table.

<table>
<thead>
<tr>
<th>Company ((C_3)) sum of pillars ((P_n):(C_3P_n))</th>
<th>Sum of areas of decision ((AD_n)) of ((C_3)) : ((AD_{nP_nC_3}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>((C_3P_1)) Provide the supply chain with our comprehensive network of depot and terminals</td>
<td>((AD_1 P_1C_3)) Supply chain network of virtual quarries, ((AD_2 P_1C_3)) Supply chain transportation from depot and terminals</td>
</tr>
<tr>
<td>((C_3P_2)) Invest in rail terminal technology, capability and infrastructure for the supply chain</td>
<td>((AD_1 P_2C_3)) Supply chain technology, ((AD_2 P_2C_3)) Logistics services for supply chain capability, ((AD_3 P_2C_3)) Supply chain infrastructure quality</td>
</tr>
<tr>
<td>((C_3P_3)) Keep close relationship with consortium to increase freight flow across our terminals network</td>
<td>((AD_1 P_3C_3)) Terminal maintenance and supply chain freight flow, ((AD_2 P_3C_3)) Supply chain relations</td>
</tr>
<tr>
<td>((C_3P_4)) Open virtual quarries to be used by communities in close proximity to our terminals</td>
<td>((AD_1 P_4C_3)) Supply chain proximity, ((AD_2 P_4C_3)) Supply chain market demand planning</td>
</tr>
<tr>
<td>((C_3P_5)) Provide fully integrated service</td>
<td>((AD_1 P_5C_3)) Supply chain integration</td>
</tr>
</tbody>
</table>
comprising Road, Rail and Storage for Virtual Quarries throughout the UK and Europe

<table>
<thead>
<tr>
<th>(AD3PsC3) Multimodal supply chain</th>
<th>(AD3PsC3) Supply chain storage</th>
</tr>
</thead>
</table>

Table 9-13: Summary map of supply chain areas of decision extracted from (C3)

The general statement of the business strategy as stated in their internal documents and their web page states ‘provide high quality logistics services’ representing (scC3) The logistics services represent one of the main obstacles for (C1) in utilising the slate aggregate by-product. Their business strategy represented in this statement is investigated in detail resulting in a few closely related concepts that can be applied to the greenfield project formulation. These are: 1) continually achieve customer satisfaction in service level compliance and cost by integrating road and rail (scC3P1); 2) Achieve strategically located terminal and depot facilities, with relevant ancillary services (scC3P2); 3) Continuous supply chains enhancing production efficiency (scC3P3); 4) Maximise the use of company resource and systems (scC3P4); 5) Provide the lowest cost multimodal transport (scC3P5)

<table>
<thead>
<tr>
<th>Strategic Core (SC) of (CN): (scC3)</th>
<th>Strategic pillars (PN) from (scC3): (scC3PN)</th>
<th>Extraction methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>(scC3) ‘Provide high quality logistics services’</td>
<td>(C3scP1) ‘Continually achieve customer satisfaction in service level compliance and cost by integrating road and rail.’</td>
<td>Extraction and validation of (scC3PN) and confirmation of linkages with (ADnPnC3): Secondary data: Internal and external documents. Primary data: (CsD1), (CsM9), (CsE1,2,3,4,5,6,7,8,9)</td>
</tr>
<tr>
<td></td>
<td>(C3scP2) ‘Achieve strategically located terminal and depot facilities, with relevant ancillary services.’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C3scP3) ‘Continuous supply chains enhancing production efficiency’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C3scP4) ‘Maximise the use of company resource and systems’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C3scP5) ‘Provide the lowest cost multimodal transport’</td>
<td></td>
</tr>
</tbody>
</table>

Table 9-14: Summary map of strategic pillars extracted from (C3)

For the benefit of the reader, to visualise the emerging framework, the resulting linkages between (scC3PN) and (ADnPnC3) are built and presented into a conceptual diagram:
Figure 9-14: Evaluation diagram of the relationship between strategic pillars and supply chain areas for (C3)

The construction for (C3) enabled evaluation of the linkages between; the abstract individual areas of decision, the greenfield project pillars and the existing individual strategic pillars.
Table 9-15: Evaluation diagram for analysing the relationship between the strategic goals and pillars, integrated strategic vision and goals and areas of formulation - applied to (C3)

The method for evaluating the goals of (Cn.Pn), extracting (AD) from the ideas behind (Cn.Pn) and categorising goals in the form of (ADnPn), the residual (ADnPnCn) was applied to extract the (AD) from the remaining participants (C2, C4 C5) and was built into a summary map:

<table>
<thead>
<tr>
<th>(Cn.Pn)</th>
<th>(ADnPnCn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C1P1) Diversify the processes and outputs in the quarry,</td>
<td>(AD1 P1C1) Supply chain processes and outputs</td>
</tr>
<tr>
<td></td>
<td>(AD2 P1C1) Productivity and profits</td>
</tr>
<tr>
<td></td>
<td>(AD3 P1C1) Mining cost</td>
</tr>
<tr>
<td></td>
<td>(AD4 P1C1) Efficiency</td>
</tr>
<tr>
<td>(C1P2) Develop low cost transport,</td>
<td>(AD1 P2C1) Transport cost</td>
</tr>
<tr>
<td>(C1P3) Pursue environmental sustainability,</td>
<td>(AD1 P3C1) Impact on environment</td>
</tr>
<tr>
<td>(C1P4) Develop technology, capability and infrastructure</td>
<td>(AD1 P4C1) Supply chain technology</td>
</tr>
<tr>
<td>(C1P5) Increase the market share and</td>
<td>(AD2 P4C1) Supply chain capability</td>
</tr>
<tr>
<td></td>
<td>(AD3 P4C1) Supply chain infrastructure</td>
</tr>
<tr>
<td>Secure long term market</td>
<td>(C1P6) Build strong brand for the by-product</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>(C2Pn)</td>
<td>(ADnC2)</td>
</tr>
<tr>
<td>(C2P1) Secure a position as it covers one of the key markets</td>
<td>(AD1P1C2) Market</td>
</tr>
<tr>
<td>(C2P2) Keep close relationship with suppliers and customers</td>
<td>(AD1P2C2) Supply chain network planning</td>
</tr>
<tr>
<td>(C2P3) Invest in engineering technology, capability and infrastructure</td>
<td>(AD1P2C2) Supply chain engineering technology (AD2P2C2) Product assessment capability (AD3P2C2) Supply chain engineering infrastructure</td>
</tr>
<tr>
<td>(C2P4) Provide wealth of civil engineering expertise for the supply chain</td>
<td>(AD1P4C2) Supply chain renewables and energy engineering</td>
</tr>
<tr>
<td>(C2P5) Provide waste management expertise for the supply chain,</td>
<td>(AD1P5C2) Supply chain waste management</td>
</tr>
<tr>
<td>(C2P6) Develop conceptual models for land remediation</td>
<td>(AD1P6C2) Supply chain land remediation</td>
</tr>
<tr>
<td>(C2P7) Capture substantial aftermarket service opportunities</td>
<td>(AD1P7C2) Aftermarket</td>
</tr>
<tr>
<td>(C3Pn)</td>
<td>(ADnC3)</td>
</tr>
<tr>
<td>(C3P1) Provide the supply chain with our comprehensive network of depot and terminals</td>
<td>(AD1P1C3) Supply chain network (AD2P1C3) Supply chain depot and terminals</td>
</tr>
<tr>
<td>(C3P2) Invest in rail terminal technology, capability and infrastructure for the supply chain</td>
<td>(AD1P2C3) Supply chain technology (AD2P2C3) Supply chain capability (AD3P2C3) Supply chain infrastructure</td>
</tr>
<tr>
<td>(C3P3) Keep close relationship with consortium to increase freight flow across our terminals network</td>
<td>(AD1P3C3) Supply chain freight flow (AD2P3C3) Supply chain relations</td>
</tr>
<tr>
<td>(C3P4) Open virtual quarries to be used by communities in close proximity to our terminals</td>
<td>(AD1P4C3) Supply chain proximity (AD2P4C3) Supply chain market</td>
</tr>
<tr>
<td>(C3P5) Provide fully integrated service comprising Road, Rail and Storage for Virtual Quarries throughout the UK and Europe</td>
<td>(AD1P5C3) Supply chain integration (AD2P5C3) Multimodal supply chain (AD3P5C3) Supply chain storage</td>
</tr>
<tr>
<td>(C4Pn)</td>
<td>(ADnC4)</td>
</tr>
<tr>
<td>(C4P1) Invest in rail technology, capability and infrastructure</td>
<td>(AD1P1C4) Supply chain technology (AD2P1C4) Supply chain capability (AD3P1C4) Supply chain infrastructure</td>
</tr>
<tr>
<td>(C4P2) Provide rail freight logistics for the supply chain</td>
<td>(AD1P2C4) Supply chain relations (AD2P2C4) Supply chain integration</td>
</tr>
<tr>
<td>(C4P3) Carry a wide variety of slate by-product and other products</td>
<td>(AD1P3C4) Supply chain freight flow (AD2P3C4) Supply chain market</td>
</tr>
<tr>
<td>(CnPn)</td>
<td>(ADnPnCn)</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
</tr>
<tr>
<td>(CnP1) Offer high value rail transport for the by-product at low cost</td>
<td>(AD1nPnC1) Supply chain proximity (AD2nPnC1) Transport cost</td>
</tr>
<tr>
<td>(CnP2) Develop responsive and effective supply chain rail transport</td>
<td>(AD1nPnC2) Multimodal supply chain</td>
</tr>
<tr>
<td>(CnP3) Provide track maintenance and repair services</td>
<td>(AD1nPnC3) Supply chain maintenance and repair</td>
</tr>
<tr>
<td>(CnP4) Provide effective rail transloading for the by-product</td>
<td>(AD1nPnC4) Supply chain process, (AD2nPnC4) Transloading cost, (AD3nPnC4) Efficiency</td>
</tr>
<tr>
<td>(CnP5) Develop responsive and effective supply chain rail transport</td>
<td>(AD1nPnC5) Supply chain integration, (AD2nPnC5) Multimodal supply chain, (AD3nPnC5) Supply chain storage</td>
</tr>
<tr>
<td>(CnP6) Rebalance market power and maximise the value of by-product sales to the existing market</td>
<td>(AD1nPnC6) Market power, (AD2nPnC6) Existing market, (AD3nPnC6) Maximise value</td>
</tr>
<tr>
<td>(CnP7) Provide the consortium companies with site for building, necessary infrastructure for the supply chain</td>
<td>(AD1nPnC7) Supply chain infrastructure</td>
</tr>
<tr>
<td>(CnP8) Develop a distinct brand identity and image for the by-product</td>
<td>(AD1nPnC8) Brand</td>
</tr>
<tr>
<td>(CnP9) Optimise the supply chain distribution concepts</td>
<td>(AD1nPnC9) Multimodal supply chain, (AD2nPnC9) Supply chain freight flow</td>
</tr>
</tbody>
</table>

Table 9-16: Conceptual summary map resulting from the evaluation of the relationship between individual strategic goals and individual areas of decision from (Cn)

The summary map of extracted (ADn) from the residual (Cn) is used to evaluate are the (ADnPnCn) supportive of individual (sCnPn) and (CnSC) and to evaluate the linkages...
between the individual company (ADnPNCN) and intercompany (IPN), (ISV). For the evaluation, the complete sample set of (scCNPN) it is required. This represents the second summary map containing the extraction, validation and evaluation methods applied to evaluate the linkages between (scCNPN) and (ADnPNCN):

<table>
<thead>
<tr>
<th>Strategic Core (SC) of (CN): (scCN)</th>
<th>Strategic pillars (PN) from (scCNPN)</th>
<th>Extraction and validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(scC1) 'Diversify to evolve the slate industry'</td>
<td>(C1scP1) 'Better match customer demand for value for money slate products (C1scP2) Reduce the cost margin of roofing slate by offsetting the cost of production with profits from sales of slate aggregate’</td>
<td>Secondary data: Internal documents. Primary data: (C1D1,2,3,4,5,6,7,8,9), (C1M3,4,8), (C1E1,2,3,4,9),</td>
</tr>
<tr>
<td></td>
<td>(C1scP3) ‘Achieve lower cost of transport from quarry to the market by operating with a lean supply chain network’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C1scP4) ‘Pursue innovation in new materials from slate aggregate’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C1scP5) ‘Maximize the potential of slate aggregate to offset demand and supply in existing aggregate markets’</td>
<td></td>
</tr>
<tr>
<td>(scC2) 'Be one of the UK’s leading civil engineering companies for innovation and expertise’</td>
<td>(C2scP1) ‘Become a significant nationwide civil engineering company and civil engineering contractor’</td>
<td>Secondary data: Internal and external documents. Primary data: (C2M4)</td>
</tr>
<tr>
<td></td>
<td>(C2scP2) ‘Build reputation for innovation in civil engineering’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C2scP3) ‘Increase sustainability and minimise environmental impact’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C2scP4) ‘Remain at the forefront in engineering safe, cost-effective schemes for the construction and operation of landfill sites, including the entire associated infrastructure and recycling facilities’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(C2scP5) ‘Provide a full service using materials and equipment at our own quarry, or by establishing a quarry at your site using our range of crushing and screening equipment’</td>
<td></td>
</tr>
<tr>
<td>(scC3) ‘Provide high quality logistics services’</td>
<td>(C3scP1) ‘Continually achieve customer satisfaction in service level compliance and cost by integrating road and rail’</td>
<td>Secondary data: Internal and external documents. Primary data:</td>
</tr>
<tr>
<td></td>
<td>(C3scP2) ‘Achieve strategically located terminal and depot facilities, with relevant ancillary’</td>
<td></td>
</tr>
</tbody>
</table>
services’

(C3scP3) ‘Continuous supply chains enhancing production efficiency’

(C3scP4) ‘Maximise the use of company resource and systems’

(C3scP5) ‘Provide the lowest cost multimodal transport’

(C3scP1) ‘Focus on smaller feeder railroads and increase their value to rail customers and the communities they serve, through improvements in services, facilities and equipment’

(C3scP2) ‘Continuously seek opportunities to increase rail freight business on our railroads through growth of existing traffic, adding contiguous lines, relocation of new customers on-line or in conjunction with trucking to non-rail-served sites’

(C3scP3) ‘Continually explore expansion of our portfolio through development of passenger business, car storage, car repairs, car leasing, property development, as well as continuing to seek additional rail acquisitions’

(C3scP4) ‘Develop a distinct brand identity and image for the by-product’

(C3scP5) ‘Optimise the value of the brownfield site through recycling plant’

Table 9-17: Summary map of individual strategic pillars extracted from (CN)

The (ADnPnPnCN) represent individual areas as formulation categories that enable identification of the tasks and operations, therefore signifying a crucial element in confirming the areas of integrated decision. The (ADnPnPnCN) must be formulated and evaluated prior to being grouped into concepts for formulating strategy. This stage focused on evaluating the areas of integration and formulation through the implicit operational processes of the stated strategic goals.

The process was implemented after the participants could not define the strategic tasks and operations required to perform the integrated goals formulating the integrated
vision. The recommended design process involved embodying the ideas expressed in the vision and goals to the integrated areas that enable investigation of the operations, aimed to record the action and eliminating the uncertainties.

9.6 Confirming validity

The fourth stage is focused on reviewing and double-checking the validity and wordings of the activities in the silent areas collected in the form of conceptual summaries. For each silent area or activity to be considered valid and be used as data set for conceptual model, firstly it was required to gather sufficient amount of evidence of supporting factors in the form of either a) Secondary data from internal and external documents, or b) Sufficient amount of primary data collected from the case study (interviews) or obtained through action research data collection (direct observations).

Following this validity evaluation criteria, wherever there was a lack of sufficient factual data in the secondary data analysis, support statements from the interviews, or direct observations through action research, the validity of these activities is disregarded. In any of the silent areas presented, if there was a lack of activities to be classified in that specific silent area, following the same principle, its validity is also disregarded. Following this evaluation criteria, designed at confirming conceptual validity, some of the predefined formulation areas that resulted with small number of activities were also evaluated. However, prior to disregarding activities or areas, the wording must be considered. The wording can be amended in the process of obtaining additional data regarding a specific activity or area. In the process of amending the wording, it was often found that validity can also be confirmed through c) Individual predefined or silent areas can be merged with another or that d) If there is lack of data, the wording used to describe the silent areas can be amended and the previous three criteria for confirming validity can be reapplied.

9.6.1 Hierarchical summary maps

Research framework key illustrated with a section of the summary map of the silent area:
‘Become more efficient and competitive’ (Figure 9-15). One of the first activities that was allocated to the undefined area was ‘provide access to low cost transport of the slate aggregate product’. In the action research with (C3) an additional four areas of activities were identified. Each area had individual supporting activities that were possible to record with factual data illustrated in Figure 9-15.

**Silent Area of Formulation: ‘become more efficient and competitive’**

*a) ‘Increase market share’*
- ‘Low cost rail transport will decrease cost of the final product and increase the market share through more competitive price’
- ‘The virtual quarries will represent the slate industry in multiple places of the UK, it is similar to immediate access to multiple stores to sell the product’

*b) ‘Provide access to low cost transport of the slate aggregate product’*
- ‘The experience and know-how of a logistics company would benefit the quarry in terms of lowering the cost and knowledge database when formulating the supply chain strategy’
- ‘Multimodal transport would speed up the supply chain and the rail element will reduce the cost of transport, therefore, the slate aggregate can compete for markets further than 50 miles, the limit that makes economic benefit if transported by road’

*c) ‘Provide access to means to create virtual quarries’*
- ‘(C3) has terminals across the UK and many of these terminals have sufficient space for creating virtual quarries of slate aggregate, it would in fact be beneficial for the business as it would increase freight flows’
- ‘(C3) is fully capable of running a new multi freight terminal in Blaenau Ffestinog containing virtual quarries close to the quarry and the rail transport’

*d) ‘Provide the quarry with inventory management’*
- ‘It is in the terminal interest to create rail freight flows. (C3) does not require to have staff on the terminals, the multimodal transport can be performed without (C3) involvement’
- ‘By collaborating with (C3) there is a mutual benefit of cost reduction, one

Figure 9-15: Table example of the hierarchical summary maps assembling process

In addition to the evaluation criteria stated above, to confirm validity, the outlined process also involved focusing the observation on extracting additional concepts that had arisen throughout the interviews. Concepts such as: activities that should be in
place for the formulation to be successful, but are not mentioned during the data collection, or things that are creating conflicts of interest between the supply chain participants.

Addressing these areas is considered of crucial importance for formulating the integrated supply chain strategy. For example, if sufficient factual data is obtained regarding a new concept that is required to be validated, or a process that should be in place but is not discussed, this data was applied to assemble that section to ensure the formulation is complete. These concepts are considered as crucial to the data collection and analysis process because these concepts can be applied as factual data, but also as an extension to the supply chain activities that were not identified in detail during the interviews.

The categorised summary map (Figure 9-15) is interpreted into a conceptual diagram map (Figure 9-16). The design methods applied to visualise and conceptualise the silent areas and concept are redesigned to visualise and conceptualise the hierarchical summary maps. In previous sections of the concept assembly, conceptual diagrams are demonstrated and assembled into wider conceptual diagrams. To create the illustrations Visio was used to categorise the data in smaller conceptual diagrams and larger conceptual diagrams. The same method is applied to create illustration of the summary maps assembled by applying the methods stated above. The summary map presented as a conceptual diagram signifies a map that enables linking the aggregated data in a clear and concise visual method.
"help the quarry to increase their market share"

"provide access to low cost transport for the slate aggregate product"

"provide access to means to create virtual quarries"

"provide the quarry with inventory management"

"Provide multimodal transport: road, rail"

"Help the quarry to transport the slate aggregate to the terminals"

"Help the quarry in securing quality training in transport related issues"

"Help with engineering on the Conwy Valley Line"

"low cost rail transport will decrease cost of the final product and increase the market share through more competitive price"

"the virtual quarries will represent the slate industry in multiple places of the UK, it is similar to immediate access to multiple stores to sell the product"

"the experience and know how of a logistics company would benefit the quarry in terms of lowering the cost and tapping into their knowledge database when designing the supply chain strategy"

"multimodal transport would speed up the supply chain and the rail element will reduce the cost of transport, therefore, the slate aggregate can compete for markets further than 50 miles, the limit that makes economic benefit if transported by road"

"(C) has terminals across the UK and many of those terminals have sufficient space for creating virtual quarries of slate aggregate, it would in fact be beneficial for the business as it would increase freight flows"

"(C) is fully capable of running a new multi freight terminal in Blaenau Ffestiniog containing virtual quarries close to the quarry and the rail transport"

"it is in the terminal interest to create rail freight flows. (C) does not require to have staff on the virtual quarries, the multimodal transport can be performed without Llechwedd involvement"

"by collaborating in the Slate by Rail project there is a mutual benefit of cost reduction, one of them being the inventory management in multiple locations across the UK"

"we promote and encourage the transfer of freight from road to rail and we are committed to supporting the use of rail in the future"

"we operate seven rail linked depots throughout the UK offering a choice of mode for freight movement in the UK"

"rail cannot operate in isolation from other transport modes and as such all our rail linked depots are road connected with a distribution fleet on site enabling smooth transfer of goods for onward delivery"

"[C] has terminals in close proximity to Blaenau Ffestiniog. Telford is the nearest terminal to Blaenau Ffestiniog"

"the capability of handling top & bottom lift intermodal traffic (including containers, tanks & swap bodies), bulk freight (steel, timber, aggregate etc) wagon load and palletised traffic"

"the ability to offer facilities for receipt, despatch and storage by intermodal unit, by pallet, by weight, or by dedicated space"

"we have a mix of internal and external training providers delivering high quality training in relation to transport"

"we provide training in identified skill shortages that may take various forms; such as on the job, off the job and shadowing"

"the newly proposed terminal in Blaenau Ffestiniog will require train drivers familiar with the Conwy Valley Line. We have a fully qualified Driver Trainer employed with the sole purpose of developing the existing skills of our driving workforce"

"we have extensive engineering capabilities whereby the assorted vehicles and trailers operated by the group and external customers ensure that at all times they meet the requirements of VOSA and other regulators"

"our services cover scheduled/unscheduled commercial vehicle and trailer maintenance, manufacture and modification of trailers and bespoke solutions, and container repair. We also provide a mobile support service for vehicles and trailers"

"our engineers can help in the repair of a wide variety of makes of vehicle, box vans, curtain-sided and skeletal trailers and tankers, and the associated ancillary equipment"

Figure 9-16: Example of hierarchical summary maps interpreted into hierarchical concept diagram
9.6.2 Eliminate concepts that lack authentic validity

The data sets collected through interviewing are based on individual opinions. To confirm the validity of the data sets, firstly, the conceptual diagrams had to be presented to the individuals interviewed. Secondly, the validity is further authenticated and confirmed through group discussions with the supply chain participants interviewed. The conceptual diagrams were revised accordingly to ensure that the summary maps are an accurate representation of the individual supply chain participants’ activities. However, considering that the interviews are performed in great detail and the data is written in a strict scrutiny these changes are minor.

Nevertheless, some large concepts were dropped from the conceptual diagrams on the third year of the research due to a change in direction of the consortium business strategy. The most noticeable change was the need for governmental funding in infrastructure. For example, later on in the study, it became clear that infrastructure funding from the companies is not an option because the infrastructure is financed and controlled by governmental organisation (Network Rail). The government organisation was under legal obligation not to sell active rail-lines, only those closed for operation. Therefore Network Rail was under no obligation to give up the rail-line. It was also unrealistic and controversial to seek for governmental investment in the time of severe budget cuts. Nevertheless, the consortium discovered that the organisation operating the rail-line is under contractual obligation to maintain the rail-line to the stated route availability if a rail operator requests the service of the rail-line. Therefore, the concept was considered out of the control of the supply chain strategy formulation. This represents one concept that was dropped from the diagrams.

To validate the data collected and data dropped out of the conceptual diagrams, a number of group discussions were scheduled with the supply chain participants to review the data. Some of the group discussions were scheduled well in advance with the participants because some of representatives were traveling from multiple locations. Other group discussions have been scheduled on the day, during the 6 months action research at (C4) Some of the most important changes made were in the wording of the activities.

The process started with analysis of the summary maps. Some of the summary maps did not require any changes, while other summary maps required significant changes. For
example the statement ‘provide access to low cost transport’ was changed to include the product ‘for the slate aggregate by-product’. Therefore, the final statement was reading ‘provide access to low cost transport for the slate aggregate by-product’. This was seen as a crucial difference in wording because low cost rail transport depends on high volumes of heavy material to transport. The rail mode option, despite the lower cost per tonne, could be a more expensive option than road mode if only roofing slate was transported. The relatively small volume and high cost of the roofing slate makes it cheaper and affordable to transport by road. The slate aggregate by-product on the other hand is a heavy, bulky and low cost product that can only be transported economically by low cost rail or multimodal transport.

Regarding some of the areas, it was determined during the validation process that they were not grounded on factual activities. For example the original statement of ‘By collaborating in the greenfield project supply chain strategy there is a mutual benefit of cost reduction, one of them being the virtual quarries acting as stores, with staff dealing with the orders, in multiple locations across the UK’. During the validation process through group discussion with (C3) at their company location, it was determined that despite the enthusiasm, such activity would be difficult to perform in practice. There was no possibility of interaction between the product on the terminals and the (C3) staff on the terminals. The common approach observed was for inventory to be distributed was prior to the arrangements of large shipments, such approach would also be beneficial to the quarry and the terminal operator by creating freight flows. Therefore, the concept concerning the multiple stores across the UK was dropped and replaced with the concept: By collaborating there is a mutual benefit of cost reduction, one of them being the inventory management in multiple locations across the UK’. Furthermore, during the group discussion the number of concepts increased. In some examples, through the group discussion, the number of executed activities was even doubled. For example, in one formulation area, it was found that prior to the validation; the summary maps only listed two activities. From the group discussion two additional activities were identified that needed to be listed under that area in the summary map, resulting with four executed activities identified, doubling the activities in that specific area.
9.6.3 Link the data sources of closely associated areas

Considering the complexity of formulating a greenfield project supply chain strategy, the field-interviews resulted with far too many associated areas. Some of the areas are combined to reduce complexity in interpreting the data sources into associated headings. The linking of associated areas was considered a necessary task. This consideration was a result of the main idea and purpose for using a conceptual diagram, which was the need of a visual tool that is easy to understand. It was determined that the number of areas should not exceed 10 otherwise it will create confusing results for the supply chain participants, resulting with a failure to achieve its main purpose. However, differentiating from previous methods, the conceptual method does not set limits to concepts or areas. Different supply chain strategies will contain variable sets of areas to be categorised and such complexities must be given a degree of flexibility to categorise the concepts.

To understand this process, an example is presented of two closely related areas of activities that were linked. First area was: 'help the slate industry in Blaenau Ffestiniog to increase their profit margin' and second: 'help the slate industry in Blaenau Ffestiniog to increase their sales margin'. These silent areas were linked in one silent area ‘help the quarry to increase their market share’ and later even further generalised into ‘increase market share’. This summarises the two statements and represents the idea of the activities under each silent area. Therefore, when the activities can remain in a merged silent area and the idea remains, the wording can be amended.

Another example of two areas merged is: ‘provide low cost rail transport’ and ‘provide multimodal transport to lower the cost of transportation’. Considering that the two areas were linked to the logistics of the product these two areas were linked with ‘provide access to low cost transport of the slate aggregate product’. In the process, it was found that many silent areas can be linked and merged. Following this a more forceful approach was taken in limiting these areas, which resulted with only a limited number of silent areas.
Figure 9-17: Example of the concept simplification process

In applying the same method with a different supply chain participant (C₃), there was no reason to merge any of the areas. This was a result of the number of areas being small and focused, while the activities were distinct in many ways. In the case study with another
participant the group discussions were assisted by a great deal of understanding of the problem investigated. This result was possibly related to the main contact from (C_2) being the manager of the previous attempt to formulate the supply chain strategy. The areas and the activities related to these areas was not a new concept to somebody that has previously made an attempt to identify these areas through applying different methods.

9.6.4 Clarification of the logic and core concepts behind the conceptual approach

The logic and the core concepts of Chapter 9 can be outlined as a framework for categorising individual goals into integrated goals, through systematically grouping concepts into formulation areas, principles, imperatives and concept tasks. The logic of the core concepts is to advance the supply chain architecture into integration design with a consistent set of interrelated ideas and interworking set of objectives.

The core concept in this chapter is to derive using a process of converting tacit into explicit knowledge, and to identify a process for simplifying, merging, re-evaluating or eliminating excessive concepts. The conceptual logic is to resolve emerging complex problems by perceiving them as systems, where the objective complexity of the system is determined by: (i) the number of elements in the system, (ii) the number of their possible states, (iii) the number of relationships between them; and subjective complexity of the system is determined by: (i) the objective complexity, (ii) by our capacity or ability to understand the system, (iii) the time pressure exerted upon us to make a decision.

The core concept behind the approach can be further clarified by differentiating between well-defined and other types of problems. The well-defined problems can be identified by (1) the desired goal state and the criteria that must be met are exactly known, and (2) the field of reality in which the problem is found is precisely known. While the other type of problems, or the problems this study is trying to address can be identified by: (1) the goal criteria are vague, and one is not at all certain what the desired goal state is to be, (2) there are conflicts between goals, due to the contradictory relationships between partial goals, (3) there is a lack of knowledge as to the possible operators and possible states of the system, and (4) it is often necessary to act with incomplete, inexact and/or incorrect information.
The conceptual logic in Chapter 9 is to design the supply chain formulation criteria. The core concept of the formulation is to have the right imperatives for the formulation and the process allows for rewriting the imperatives for clarity at any point that confusion arises. Some of the imperatives produced in this study were not as clear as they could have been and this resulted in the recommendation that imperatives should be: (a) specific enough for you to know when they've been achieved, and (b) general enough not to describe how to achieve them. The method of recording the imperatives is crucial and there are 3 easy checks to evaluate an imperative: (i) the imperative should be written as an imperative statement and should be checked by reading it as follows: “We want to ____ (imperative goes here)____”, (ii) the imperative should be such that we can know when we have achieved it, (this can be checked by asking if it can be claimed that this imperative has been achieved), (iii) the imperative should be about goals/ends, and not about means, this can be checked by confirming that the imperative does not already contain the means through which it can be pursued (Perez-Franco et al., 2010).

9.7 Conclusion

The evaluation and critical analysis process of the relationship between business and supply chain architecture, in the context of greenfield project integration strategy resulted with a framework design for categorising individual into integrated goals (Postulate 3 and 4). The process involved following existing literature on applying engineering mind-set to supply chain strategy (Perez-Franco et al., 2010) for systematically grouping and categorising concepts into formulation areas, formulation principles, imperatives and concept task. The categories are evaluated through summary maps, concepts maps and conceptual diagrams with the pre-established evaluation criteria. The process resulted in the advancement of the framework for greenfield project strategy architecture, into a conceptual framework for supply chain strategy, consistent of a set of interrelated ideas and interworking set of objectives. The findings in this chapter are related to addressing Gap 8 and 9 (Figure 4-2)

This chapter derived a process of segregating individual business goals into formulation areas. The objective of the process was to formulate supply chain strategy imprinted by all the participants in the supply chain (Postulate 4 and 5). The conceptual diagrams categorising the synthesised knowledge, represented a method for explicit and easily identifiable architecture and design for visualising the conceptual framework consistent of
strategic vision, goals, areas, principles, imperative narratives and concept tasks (Postulate 3).

The critical analysis and evaluation are based on a case study that included 5 participant companies and derived a strong contribution to practice, which is further evaluated to generalise the findings and create contributions to theory. The 5 participants represented multiple data sources to validate the theory and strengthen the argument. The case study method enabled detailed and systematic evaluation of the outlined architecture and design. Through applying content and discourse analysis, the case study firstly identified and defined the formulation areas of interest, decisions and problem. The articulation proceeded with extracting the concepts from individual participants and converting from implicit into an explicit form, then categorising the concepts and identifying the relationship between: individual participants’ strategic goals and the integrated formulation areas.

The process resulted in the cataloguing of emerging concepts into strategic categories and building new integration theory as outlined in Postulate 6, followed by building the emerging concepts into conceptual diagrams, that enables the evaluation process and allowed for adding additional emerging concepts to the categories (Postulate 3). The process of categorising individual supply chain strategic areas was aimed at defining the integration process, as a system of concepts containing formulation areas; principles; imperative narratives; and concept tasks. The conceptual framework is designed with the objective to derive insights, through tacit knowledge, into the complex and abstract concept of greenfield project business and supply chain strategy formulation (outlined in 1.7).

The architecture aspect in this chapter is advancing in analysing the relationship between the formulation areas, the individual business goals and the predetermined integrated vision and goals in the concept of integrating the formulation areas towards achieving the individual and the integrated goals of the supply chain participants.

The process advocates tapping into the silent areas and principles to solve the predefined critical problems related to the conversion of tacit into explicit knowledge, extracted through verbalism, or distilled through content and discourse analysis and presented in an explicit form. The conceptual summary maps of silent areas and principles, are critically
evaluated through the evaluation criteria and guided by the BB’s, to design evidence based solutions for the elements, factors and forces identified in the SD (Figure 6-16).

In the theory building process, through applying the evaluation criteria to the formulation criteria, a number of feasibility challenges emerged in the context of the concepts articulated. The merging process represents a method for linking the closely associated areas to reduce complexity in interpreting the emerging concepts. The framework developed in this thesis recommends that such concepts are simplified or merged with other concepts through double checking the ideas behind the wording. In some scenarios, the evaluation criterion failed to provide a valid concept. After the process of simplifying and merging, these concepts need to be re-evaluated with the supply chain participants or eliminated from the conceptual system.

This process resulted with further contribution to practice. Future research studies, at this stage must remain independent and not give into pressure from executive directors or other participants, to adding unfeasible concepts into the framework. Such concepts are bound to emerge, considering that the framework is architected and designed to address the problem of greenfield project integration strategy. In such scenarios, as confirmed in the literature review Chapter 3, there is a strong presence of strategy abstention and focus on desired as opposed to feasible strategy. To uncover the DNA of supply chain strategy formulation in the context selected, the researcher must focus on the underlying factors that shape the resulting system (Melnyk et al., 2013). Building a desired concept as an underlying factor, will in most cases result in multiple conflicts of interest in the formulation process outlined. The framework outlined eliminated the conflict of interest, and through building the concepts into the summary map, from applying the conceptual framework, the formulation retains only the feasible concepts.

The strategy formulation process, presented in the conceptual framework, outlined a practise of progressively building concepts, in a framework designed to integrate PAO (Figure 4-1). The PAO are integrated through systematically analysing the absence of operational capabilities, aimed at determining the right level of integration (Gap 10, Postulate 5, Figure 4-2). If the process of formulation is followed as outlined, the conceptual framework will automatically eliminate conflict of interest. The framework will also eliminate unfeasible concepts that lack authentic validity, while in the same time, allow for an area to be filled if concepts are expected to be explicit, but are left in implicit
form and present the strategy in a clear and visual method. The framework represents a method that can be used by other researchers in the process of formulating greenfield project integration strategy.

The following and last research chapter is focused on detailing and documenting the evaluation process, of the system architecture and integration design detailed in previous chapters.
Chapter 10 Evaluation of the conceptual framework

10.1 Introduction

The evaluation and validation process of the generated theory, considered industry involvement and collaboration as essential to confirm validity of the findings. The theory building approach applied the evaluation criteria with: individual participants, questionnaires and through group discussions. The evaluation approach identified gaps in operations and articulating concepts for building a conceptual system. Subsequently, a new process based on realigning existing evaluation tools and methods was designed for evaluating greenfield project supply chain strategy formulation as a conceptual system. The evaluation design process outlined in this chapter was applied and validated by a consortium of companies, co-operating to formulate a greenfield project supply chain strategy for the slate mining industry. The evaluation process determined a conceptual system (Figure 10-3) that evaluates the required steps and phases in the conceptual framework (Figure 10-2) to formulate greenfield project supply chain strategy and integrate multiple participants. The conceptual system extracts the tacit strategy from the participants and presents it in an explicit form to be visualised by the group. The design process developed is evaluated and validated on the slate mining industry (Figure 10-1).

The evaluation design was focused on confirming the conceptual validity of the academic argument and confirming the credibility of the stated evaluation criterions (10.2) to assist future research in differentiating between desirable and feasible concepts of new integrated supply chain strategies. The evaluation process was built and is consistently presented in a number of chapters in this thesis: Chapter 1 focused on scoping the project, Chapter 7 focused on making the supply chain strategy explicit, Chapter 8 focused on linking the supply chain to individual business strategies, Chapter 9 integrates the business and supply chain strategies and validates the conceptual framework through designing a conceptual system and Chapter 1 evaluates the validity of the findings.

10.1.1 Evaluation design

The first action research (Chapter 1) was conducted to analyse and evaluate the coverage of activities behind the stated operations of (C1) the lead company. The second action
research (Chapter 9) was performed individually with the participant companies (C2,3,4,5). The complete formulation was conducted over a 5 year period through case study research, applied to test, validate and refine the formulation framework.

The process outlined below (section 10.3) developed a new evaluation approach for confirming validity, consistent with applying the criteria (10.1.3) for evaluating the conceptual framework with the study participants. A significant contribution to literature that differentiates between the previous evaluation methods and the new framework can be identified in the form of evaluating the integration aspect in a greenfield project supply chain strategy, in a multiple-participant scenario, where strategy formulation was represented through combining the operational concepts.

10.1.2 Critical analysis to contextualise feasibility

In order to identify and differentiate between desirable and feasible (executable) in greenfield project strategy formulation, the study discussed what was generally considered as desirable and feasible in a supply chain strategy. From the interviews with the consortium partners it was discovered that the managers considered the limitations of a greenfield project supply chain integration strategy to be;

a) Conflicts between different aspects of their individual supply chain strategies
b) The formulation not being inclusive of the required areas of decision
c) Absence of support from the supply chain strategy towards individual business strategies

These topics were extensively covered and evaluated in the study (Chapter 7, Chapter 8, and Chapter 9). The evaluation of the findings in the stated chapters lead to the conclusion that companies value their individual goals in the business strategy as the main drive for formulating the greenfield project supply chain strategy (7.1.1).

This finding contradicted arguments in existing literature (Perez-Franco et al., 2010, Schnetzler et al., 2007), with the conclusion that operational capabilities of the supply chain are seen as the means for accomplishing the vision and not the other way around (7.1.1).

These findings are applied to provide consistency in the evaluation design, where the focus
is placed primarily on verifying the criteria for evaluating the operational aspect of the supply chain strategy.

10.1.3 Assembling the evaluation criteria to the conceptual framework

To conceive the stated perceptions and descriptions of the interviewed participants, the conceptual system applied a number of criteria (Perez-Franco et al., 2010) in the evaluation design of the conceptual framework:

a) When there are a number of companies involved in one project its desirable to have consistency between the different companies representing different components of the supply chain strategy. The evaluation design in this thesis conceived consistency in one evaluation criterion: compatibility, followed by two evaluation clarification criterions: parsimony, synergies. As consistency is conceived as desirable, the thesis adapts the rationale that the outlined criteria can be applied independently or systematically, as implemented in the conceptual system.

   a. **Compatibility** (coded Cm) is implemented for critically analysis of whether the areas, principles, imperatives and concepts harmoniously coexist with all other formulation criteria. This evaluation criterion is adapted to evaluate flexibility of the conceptual system and has two related clarification criterions.
      
      i. In relation to **compatibility** the evaluation criterion is supported by clarification criterion **parsimony** (Pa) and conceives if the formulation concept economically makes the best use of resources and is therefore the preferred concept for achieving the required action.
      
      ii. Second clarification criterion contextualising the evaluation criterion **compatibility** is **synergies** (Sy) This clarification criterion critically evaluates **compatibility** by investigating the desirable concept of formulation and is aimed towards implementing mutually positive, complimenting and reinforcing relationships between the formulation areas. This clarification criterion evaluates the conceptual system in the context of integration.

b) To evaluate the supply chain strategy it was identified that the research must firstly ensure that the supply chain strategy covers individual participants’ formulation
areas, as specified by the consortium companies individual business goals. The evaluation process referred to this as: **sufficiency** (coded Sf), and **support** (coded Su)

a. **Sufficiency** (coded Sf), conceives that greenfield project formulation needs to consider concepts as objectives that are satisfied by the support received. The architecture and design criteria outlined in the thesis argues that without sufficient coverage the supply chain strategy cannot be executed effectively in sustaining the ‘goals’ of the integrated companies. The evaluation criterion is adapted to address ‘visibility’ (Inkpen and Choudhury, 1995, Fisher, 1997, Fisher, 2003).

i. Evaluation clarification criterion: to evaluate **sufficiency**, additional clarification criterion is implemented for critically analysis: **coverage** (coded Co) The clarification criterion is designed to ensure the emerging concepts cover all the determined formulation areas as expressed in the integration process of the consortium companies and as identified through applying the action research and case study method.

b. **Support** (coded Su) is adapted to evaluate individual formulation concepts and critically analyse if the concepts are targeted at providing support to at least one of the categories with higher ranking in the conceptual system. The evaluation criterion is adapted to address ‘participation’ (Menda and Dilts, 1997, Karl-Erik, 2001, Zhou and Chen, 2001, Qureshi et al., 2009), communication (Tracey et al., 1999), and formality (Andrews et al., 2009).

i. The evaluation criterion **support** is reinforced with the clarification criterion **adapting and alignment** (Coded AA), the formulation needs to be focused on adapting and aligning individual assets, capabilities and culture towards predetermined goal. This clarification criterion is adapted to address ‘acceptance’ (Saad et al., 2002), adaptability (Sakka et al., 2011, Saad et al., 2002).

c) The final and most obvious criterion for evaluation is that the supply chain strategy must accomplish its strategic objective as specified by all the consortium companies together in the form of integrated vision and goals. The evaluation methodology referred to this as: **feasibility** (coded Fe) and is applied to critically analyse whether the articulated concepts are feasible and whether the integrated
capabilities of the participants enable the performing the formulation criteria. The evaluation criteria is adapted to address the problem of ‘strategy absence’ (Andrews et al., 2009, Inkpen and Choudhury, 1995), and to evaluate the process of ‘accepting’ and ‘acting’ upon reality (Pettigrew, 1977).

a. Evaluation clarification criterion adapted to conceive **feasibility** is **executability** (coded as Ex) In the context of this clarification criterion, all emerging concepts must be executable through the combined effort of the supply chain strategy companies. The clarification criterion is based on ‘responsiveness’ (Fisher, 1997).

These criteria are applied progressively in the interviews and in the evaluation process with the groups for confirming validity, with the objective to evaluate the greenfield project supply chain strategy formulation. Despite the numerous amendments to the wordings in the research design process, the evaluation design process resulted with a strong confirmation in regards to simplicity and visibility from the participants.

**10.2 Apply the evaluation criteria to authenticate the conceptual framework**

To authenticate the conceptual framework, the hierarchical concept summary maps (Table 9-16 and Table 9-17) and conceptual diagrams (Figure 9-6) are used to evaluate the supply chain strategy with the study participants. The concept maps and diagrams are applied in this study to capture the real-world activities from the supply chain strategies of the participants. To authenticate the validity of the complete process, the findings are firstly presented to individuals and secondly to groups of the supply chain participants. The new advanced video conferencing technologies enabled the concept validation with the supply chain participants located in distant places (USA, Scotland, England and Wales). The internet was used as the main tool; Skype and Cisco video conferencing were used for voice and video conferences, Microsoft SkyDrive and Dropbox for file and data sharing. Email communications were used as a means for obtaining a recorded confirmation of the statements.

However, a large proportion of the time was also allocated to physical meetings. The extracted data for the assembled conceptual system (Table F-1) was firstly presented individually to all the interviewees that participated in the research study. Confirmation
regarding the validity of the data applied in the conceptual model has been requested by asking: ‘in your opinion, does the categories in the hierarchical concept summary map and the illustration presented in the conceptual framework represent in an accurate manner, the integration of a greenfield project supply chain strategy for the mining industry’. By this stage, sufficient understanding of the supply chain participants’ activities was gathered. This understanding was gathered from the case study and action research primary data that is collected and validated in the study.

The categories with aggregated data were then presented, including the individual feedback regarding the conceptual framework to a group discussion where a copy of the simplified framework was provided to individual group members. The framework was discussed with the group collectively, by going through each and every section, discussing all the changes stated above. At this stage it was considered crucial to validate that the framework represented the aggregated data and the activities the supply chain participants must perform.

10.3 Adapt design engineering methods to determine conceptual validity

The extensive data collection methods applied resulted with more than the manageable number of concepts in the design process of assembling the conceptual system. To reduce it to a manageable quantity, the generated number of concepts, principles from controlled convergence (Pugh, 1990, Perez-Franco et al., 2010) were applied. The controlled convergence is a time-tested engineering design tool and proven method that has been previously applied in this study in a similar context for validating and reducing the number of strategic goals (section: 8.2) The traditional controlled convergence method (Pugh, 1990) has been considered unsuitable in supply chain strategy reformulation (Perez-Franco et al., 2010). The model simplifications recommended in Perez-Franco et al. (2010) were built in the evaluation design to eliminate the constrains of the original design and to ensure the evaluation design is applicable to the aim and objectives of the thesis.

Therefore, an alternative, faster approach was developed in this study and was field-tested earlier in this study (section: 8.2) and proven valid in this research. The alternative approach was designed after an initial attempt to apply the existing engineering design method. When the original method was applied, experts from each participating company presented individual lists of concepts in an electronic response. The attempts to assemble
the concepts discovered a number of conflicting or duplicate concepts. The controlled convergence design process is changed to ensure validity and eliminate conflicts or duplicate concepts and to articulate superior candidate concepts.

The redesign process in this study is focused on confirming and evaluating validity of the conceptual framework and includes 3 rounds of expert opinions; the first round with individuals, the second with sub-groups, and the third with groups. The process is illustrated in Figure 10-1. The redesign process was required for the method to identify superior concepts from multiple companies and to eliminate conflicting areas of interest. By dividing the concepts into 3 groups, involving external experts, academic as well as industry, the probability of specific groups establishing preferred concepts according to their industry interests was eliminated.

These changes are made to avoid the element of preference in the selection design. The difference in this approach is that the method is specifically designed for greenfield project formulation and integrates multiple participants in the supply chain design. The modification is a result of the failure of the initial attempt, which resulted with most of the concepts being perceived unfeasible and as a result, multiple conflicts of interest emerged.

a) First segmentation: electronic lists of aggregated concepts from an individual company were sent to individual industry experts from the company participating in the interviews. At this stage it was requested from each industry expert to evaluate the generated concepts from the individual company in accordance to the scales provided and to send back the electronic list with feedback.

b) Second segmentation: the individual feedback enabled a feedback follow up conversation regarding the aggregated data in the electronic lists. The list from individual industry experts was analysed and the weakest ranked concepts were eliminated while remaining concepts were considered as ‘reference’ in the process of designing a more comprehensive list.

c) Third segmentation: the reference lists with remaining concepts were further evaluated and the weakest concepts eliminated from the presented lists through sub-group discussions with academic experts and participants from individual company categorised as group A. The aim of this segregation was to identify the unfeasible concepts with the team of executive directors.
d) Fourth segmentation: the final lists from individual companies were aggregated into one integrated list, containing only the highest ranked concepts in accordance to the evaluation criteria. The integrated list was further evaluated and presented in group discussions to the 3 groups; group 1: external experts, group 2: academic experts, group 3: industry representatives from category A, B and C. Each group was requested to determine only the best concepts by applying the evaluation criteria. The outlined process ensured that any remaining unfeasible concepts were detected and eliminated. The process also ensured that the formulation attained the superior concepts, where the expert opinion, academic opinion and industry opinions were used as a criterion that ensures validation of the superior candidates, and in the process detects duplicated or unfeasible concepts. Finally, the last step in the evaluation design eliminated the conflict of interest and the concept of preference bias.
Figure 10-1: Evaluating the conceptual framework through building upon the controlled convergence

The evaluation design method in Figure 10-1 was applied after the case study interviews were transcribed. The interviews were transcribed through applying content and discourse analysis. The aggregated data was presented in the form of individual lists of concepts generated by company experts and validated by the same experts, sub-groups of level A participants within individual companies and collectively with the industry participants.

The evaluation design process is applied to reduce the list of concepts and to validate the hierarchical classifications of concept categories for supply chain strategy formulation. In the evaluation design process the following criteria were considered:
• It was agreed that the evaluation criteria should be applied to the vision presented in the integrated business strategy as defined by the supply chain participants in the form of strategic vision and goals.

• It was agreed with the participating experts that it was necessary for the concept solutions to be representative of operational activities that would represent the interests of all the companies in the supply chain strategy.

• Through group discussions, confirmation was pursued of the relationship between the integrated strategic vision with the strategy salient dimensions and the integrated strategic goals. The confirmation was obtained in the form of a statement guiding the evaluation design towards the objective of the strategic vision which is ‘commencement of increased sales of secondary aggregate’.

• The ‘reference’ concepts were established by individual experts to guide the evaluation process and to ensure validity of the strategy formulation. The reference concepts were evaluated with sub-groups to identify synergies between the numerous individual industry concepts. The evaluation process applied was proven in this study as a strong tool for eliminating conflicts of interest that arise from individual companies integrating in a supply chain strategy.

• Three repetitions are performed (illustrated in Figure 10-1) to identify the best possible concepts for strategy formulation. New lists of alternative concepts were designed following the data transcription from each repetition. The final list is evaluated and confirmed through group discussion involving 3 sub-groups and is aimed at deriving the superior concept solutions and validating the findings with the group.

The evaluation design process is contributing to existing literature within the topic of design engineering through building upon the principles from controlled convergence. The evaluation design, enabled the process of validating the conversion of the concept solutions for supply chain strategy formulation, from tacit form into an explicit form for strategy formulation. The study considered that making the strategy explicit would ensure accuracy in formulating the supply chain activities in a form of concept solutions. The method for formulating strategy by decomposing the concept solutions clearly and an
observably, displays a new simple and visible method for further research to address the complexities presented in supply chain strategy formulation.

The aim in making the strategy formulation explicit is that without explicit strategy, the supply chain participants would not be benefiting from their knowledge and neither would they know how it could be valuable to other supply chain participants and the supply chain formulation. Despite individual participants possessing specific knowledge; the study discovered a strong absence of supply chain strategy visibility between the supply chain participants. The expertise is a tacit knowledge and as such is not easy to record and share, between companies or even within companies.

The evaluation method designed and applied in this chapter to the strategy formulation, enabled identifying and visualising of the factual know-what, the systematic implications of the know-why to the concept solutions, and even the benefits of the integrated strength of the companies know-who networks. However even though we tried to record through codification and specification the know-how, the tacit knowledge possessed by individual companies is difficult to communicate to others. The resulting conclusion was that tacit knowledge is hard to codify but can be conveyed through the integration process. The process of conveying and transferring tacit to explicit knowledge should involve constant interaction between the tacit and explicit knowledge. In that respect, the tacit knowledge creates greater added value. That added value is created through integration, but questions remain whether the attempt in this study to codify such knowledge resulted in a valid solution. It is possible that the conversion of such knowledge requires long term relationships between the supply chain partners and therefore, represents a research problem for supply chain management.

10.4 Outline of the conceptual framework

The process of applying the aggregated data to assembling the conceptual framework expands over a period of over 5 years. In the process the idea has been simplified through the research a number of times for the benefits of future research studies testing and advancing of the method. The data collected from each individual company has been extracted from the consortium partners and progressively assembled into concept maps. The full hierarchical concept summary map (Appendix F) is too large to build in a concept diagram summary map for an A4 size document, so an example of a partial map is
illustrated in Appendix D, and coded summary map of the conceptual framework is illustrated in Figure 10-2.

Figure 10-2: Coded conceptual framework for greenfield project formulation

The proposed conceptual framework is representative of the integrated areas and activities from the supply chain participants. The outcomes derived from applying the conceptual framework have been presented in the form of a full coded hierarchical concept summary map (Appendix F). The illustrations in (Figure 10-3 and Figure 10-4) represent the
conceptual system in a step by step explanation. The conceptual system can be applied by practitioners in the field to: extract and capture supply chain strategic activities from individual business and supply chain strategies, apply the activities for formulating a greenfield project business and supply chain strategy and to integrate the business goals of multiple participants in the supply chain strategy. The complete conceptual system for integrating the business and supply chain strategies is represented in Figure 10-3 and simplified description in Figure 10-4.

Figure 10-3: Conceptual system for greenfield project strategy formulation
The data collected through applying the case study research and action research is illustrated in conceptual diagrams, hierarchical summary and conceptual maps. Some of the analysed data is primary for this research, while some of the analysed data is secondary from previous reports related to the case study investigated. The aggregated data is progressively applied to assemble the conceptual framework that is built upon through the inductive and deductive theory building approach that derived from a conceptual system for greenfield project formulation and is evaluated through the evaluation criteria.

After assembling the collected data, the conceptual framework and system structures are revised. The conceptual model diagram (Figure 10-2 and Figure 10-3) was considered by some of the industry representatives as too complex and to ensure visibility of the concept, the model was simplified by decomposing the system into hierarchical categories shown in Figure 10-4. Simplification of the conceptual system allowed the method to be presented through a visual illustration with an idea that is easy to grasp. The decision to simplify the conceptual system was found suitable as that the original method had expanded substantially towards the end of the data collection process. There were far too many operational choices and activities than were intended to be presented in the conceptual framework and the resulting system.
10.5 Step by step explanation of the execution process

The step by step explanation of the summary map and the conceptual three execution process can be described as an attempt to apply analytical target cascading and systems approaches to tame supply chain complexities when such complexities cannot be eliminated.

While the complexities of the scenario researched and the research subject area in general cannot be eliminated, the conceptual logic in the conceptual approach is to:
(a) reduce subjective complexities through: (1) reducing the objective complexity by scoping and focusing on a part of the supply chain whose objective complexity can be handled, (2) increasing the ability to understand the supply chain strategy by better structuring its context, (3) reducing the time pressure in decision making by visioning and anticipating the effects of future events, which enable reacting faster to change.

(b) define the problem better through: (1) clearly specifying the desired end state where specification enables defining a set of clear goals for the supply chain strategy, (2) eliminating the conflicts between partial goals and formulate a greenfield supply chain strategy, while promoting compatibility and synergy among the elements, (3) increasing knowledge about the structure of the supply chain strategy by better understanding the supply chain strategy as a system, and (4) getting more complete information.

The execution process can be summarised as (1) the formulation represents a mechanism for progressive assembling of a supply chain strategy, by a group of experts from each participant. In this case study, the formulation is applied to assemble a supply chain strategy for the mining industry, (2) the concept emerges from previously generated concepts, from a previous formulation or it can be generated on the spot by the group, however, only eligible concepts can be used, (3) a concept is eligible for use in the assembly only if it fulfils all of the following three conditions: (i) it is deemed feasible, at least in principle, (ii) it is deemed supportive of the imperatives of that area of interest, and (iii) it is deemed compatible with all concepts that are already placed in the template. The formulation process in this thesis dictates that whenever more than one eligible concept is available, the strongest concept should be chosen, where compared to other available concepts, the stronger concept should: (i) provide more support to the imperatives, (ii) is more economical in the use of the resources, (iii) have more synergy (positive interaction) with concepts already in the template, (iv) have less trade-offs (negative interaction) with the concepts already in the template.

In terms of prior selection, the wording of an imperative should be revised for clarity and after the chosen concept is added, the next concept should be addressed. The selection process is repeated until reaching the last area. In the first pass, a concept must be selected for each area. In subsequent passes, a cell can be left empty if there are no eligible concepts left, for example in cases of incompatibility. The sequence of the assembly is to be respected.
If a change has to be made, the assembly can be undone back to the point where the change is being made, and then remade anew from there.

10.6 Conclusion

This chapter evaluated the validity of the conceptual framework through building upon the controlled convergence engineering design (Perez-Franco et al., 2010) and presented a new evaluation design for applying the evaluation criteria derived from this study. The process of applying engineering design principles (Perez-Franco et al., 2010) to supply chain integration design, derived new findings for integrating multiple participants in a supply chain strategy.

The synthesised knowledge from the conceptual framework and the conceptual system is evaluated through applying the evaluation criteria to confirm validity of the findings and generalise the knowledge for applying the framework in future research studies. The contribution to knowledge from this chapter can be identified in the new method for evaluating the greenfield project and integration aspects in supply chain strategy formulation, represented through combining the operational concepts in a multiple-participant scenario.

The validity of the complete process for conceptual system assembling is authenticated by presenting the findings to individual participants and through group discussions with the study participants. The extracted concepts for articulating the categories in the assembled conceptual system (Table F-1) were firstly presented individually to all the interviewees that participated in the research study. Secondly the categorised concepts were presented, including the individual feedback regarding the conceptual system, in a group discussion where the full findings and a copy of the simplified conceptual system was provided to individual group members. The conceptual system was discussed with the group collectively, by going through each and every section of the system. This was considered crucial in validating that the conceptual system represented the operational concepts and the activities the supply chain participants must perform.

Principles from existing design engineering methods have been adapted to determine conceptual validity of the concepts present in the conceptual system. The uniqueness of the evaluation approach designed is the capacity to address integration obstacles by
eliminating conflict of interest, eliminating duplicate concepts, merging conceptual ideas, determining validity of outlined concepts, eliminating the probability of preference concepts, converting tacit into explicit strategy and identifying superior concepts for strategy formulation. The process involves four steps for segmentation of ideas.

In addition, the evaluation method designed in this chapter, contributes to knowledge through representing a method for identifying and visualising the factual know-what, the systematic implications of know-why to the concept solutions, the integrated strength of the companies know-who networks and results with codification and specification of the know-how, the tacit knowledge transferred into explicit knowledge through constant interaction between the tacit and explicit knowledge. In that respect, the tacit knowledge creates added value in this process of integration in formulating a greenfield project supply chain strategy.

The following chapter summarises the findings from this thesis and includes a section on contributions, broken down into contributions to method, theory and practice. The following section also provides a limitations section from which future research avenues are identified, including discussion of method applicability to other sectors.
Chapter 11 Conclusion and Further Work

11.1 Introduction

This study has examined formulation of supply chain strategy in a single case study research of the slate mining industry in North Wales (Chapter 2). The aim and objectives of the thesis (1.7) were to architect, design and implement, a conceptual framework, for formulating a greenfield project business and supply chain integration strategy. The process involved integrating a group of companies, in a supply chain consortium (Chapter 4 and Chapter 5) to: enable the formulation and assembly of a strategy; to verify the framework; and generalise the findings. The theoretical framework derived from the case study and was applied on the study participants to formulate a greenfield project supply chain strategy for the slate mining industry in North Wales (Chapter 2).

This chapter presents the final conclusions of the research and final remarks. It starts by reviewing the theoretical purpose (3.9 and 5.5) and the implications of the conceptual framework, which relate to objectives one, two and three (1.7 and 11.2). Then it focuses on the study’s main findings from the application of the conceptual framework, which is relevant to objective four (1.7 and 11.2). The next part concerns the contribution of the conceptual framework (10.4), then the strengths of this research are discussed, followed by a description of the limitations of the research. The chapter finalises the thesis with recommendations for future research and the thesis ends with some concluding comments.

11.2 Key findings and contribution to theory: conclusions about the research problem

The key aim of this thesis was to develop a conceptual framework, to understand the relationship between greenfield project architecture (Chapter 1) and integration design (Chapter 7 and Chapter 8), in the context of supply chain strategy formulation (Chapter 8 and Chapter 9). In order to achieve this broad research aim, four specific research objectives were set related to the aim of the thesis (1.7) They were:

1. To derive, using the formulation criteria, the formulation of greenfield project supply chain strategy, with respect to supplier relationship strategy, with
multiple supply chain participants and an internal supply chain strategy against strategic, tactical and operational levels for supply chain strategy formulation framework.

2. To derive, using the evaluation criteria for eliminating conflict of interest, the formulation of supply chain integration design.

3. To develop a conceptual framework, based on the formulation and evaluation criteria for systematically prioritising individual activities, towards pre-defined supply chain formulation and integration areas.

4. To validate the proposed framework by applying it to the case study participants in the mining industry for the following purposes:
   1. To evaluate supply chain architecture in relation to formulation criteria
   2. To evaluate the greenfield project integration design with the evaluation criteria

The research examined three main industrial groups in the mining industry, as case study companies: the transportation and logistics (stands for the three case study companies that represented the transportation and logistics industry group); the civil engineering company (stands for the case study company that represented the civil engineering industry group); and the slate mining quarry (stands for the case study company that represented the mining industry group). They were selected on the basis of the representativeness of the main industry groups and the practical feasibility of access to the case study companies.

The process of building the conceptual framework involved a detailed case study research applying grounded theory and action research. One key type of data collection used in this study was in-depth interviews, with these being used to understand the views of industry groups related to supply chain strategy formulation of the mining industry in North Wales. The analysis in the study is based on the empirical data, collected through the case study research and is purely based on contribution to knowledge and academic advancement. The research methodology was grounded on existing literature and represents a process of reconceptualising and field-testing finding from methods present in literature.
11.2.1 Theoretical purpose and application of the conceptual framework in this study

This section relates to objectives one, two, three and four and examines the conceptual framework in relation to the formulation and evaluation criteria, including the purpose of the conceptual framework and its application.

To achieve objectives one and two, literature was critically reviewed on supply chain strategy formulation criteria and supply chain strategy evaluation factors for greenfield project supply chain integration strategy formulation.

Then the conceptual framework was developed based on key concepts from this literature review, the case study research and the grounded theory building approach.

Using holistic supply chain formulation criteria, as described in objective one, a review of previous research (Chapter 3) in relation to supply chain strategy formulation, has highlighted a lack of consideration of formulation criteria, particularly in strategy absence scenarios. By exploring the integration vision and goals, the study established categories relating to supply chain integration as a form of greenfield project formulation criteria. It is anticipated that this research will lead to a more comprehensive understanding of supply chain strategy formulation criteria in the mining industries, in this case the mining industry in North Wales.

The attention of many researchers has often focused on a single area of supply chain strategy, while they have generally neglected research on the whole performance of the supply chain strategy formulation. Considering these gaps, objective one for this study established a framework, which used the concept of strategic decision making levels and supply chain integration processes, as the approach to the study of the holistic supply chain strategy formulation. In the theory generation stages, the framework was designed towards greenfield project strategy formulation for integrating multiple participants. The concept of greenfield project integration sets this apart from existing methods, which are designed to reformulate existing strategies of individual companies.

Concerning objective two, to derive, using evaluation criteria for eliminating conflict of interest in supply chain integration design, the theory building in this thesis firstly conceptualised strategy as a system of choices, patterns or decisions. In a scenario where
the phenomenon of strategy absence is present, to derive with evaluation criteria for 
eliminating conflict of interest, the operational aspects of integration design were 
categorised in the conceptual framework. The evaluation criteria design established the 
conclusion, that reaching a consensus on the strategic action objectives and strategic 
activities is required to enable the integration designs. The investigation into the strategic 
operational activities was focused on avoiding prescriptive and descriptive approaches and 
addressed the operationalisation aspects of formulation. The operationalisation aspect was 
addressed through the evaluation criteria: visibility, acceptance, formality, adaptability, 
integration, effectiveness, flexibility and responsiveness. The evaluation criteria were 
applied in the interviewing stage, through the process of systematic innovation, as a 
method for distilling innovation to strategy.

The evaluation criteria were then applied in combination with principles from controlled 
convergence, to evaluate the findings and to derive the concept validity.

The extensive coverage in the evaluation criteria and the application of systematic 
innovation, in the form of organised brain storming, was applied to the formulation and 
evaluation design, mainly because the supply chain strategy and competitive strategy were 
not linked in the case study investigated. Therefore, the failures of adapting supply chain 
principles and aligning operations are still strongly present in industry. The objective of the 
conceptual framework in this thesis was to address the issues of aligning and adapting. The 
complexity was addressed by applying an ontological approach for semantic alignment 
where knowledge elicitation, containing, mapping and merging serves as the basics for 
adapting or aligning the supply chain strategy principles (outlined in Chapter 8 and Chapter 
9).

Concerning objective three, to develop a new conceptual framework based on the 
formulation and evaluation criteria, the study’s aim was for the framework to be a more 
integrative, comprehensive and relational framework than others developed in existing 
literature. The framework investigates a more holistic perspective of supply chain strategy 
formulation. The framework guided the field-work, notably in developing the topic and 
addressing the supply chain complexities (3.9), which represented a real life phenomenon 
with multiple variables. The literature review evaluation through summary tables (Table 
A-1) directed towards conceptual approach, for developing theory to evaluate supply chain 
decision makers vision and goals.
There are significant differences, between the conceptual framework in this thesis and existing models, which were lacking the notion of integrated core strategy and are based on a hypothesis of causality among the concepts (Perez-Franco et al., 2010, Schnetzler et al., 2007). Nevertheless, these corresponding models have provided significant background understanding for the creation of the new theory. This study contributed to knowledge in the field of supply chain strategy formulation, by successfully implementing the additional aspect of integrating a consortium in a greenfield project formulation. The study derived a formulation of a new approach, represented as a conceptual framework.

The synthesised knowledge from the literature reviewed in Chapter 3, and the theory building process in Chapter 1 and Chapter 7, conceptualised the supply chain strategy formulation problem into the direction of: (1) demand for a product; (2) market standards and influencers; (3) product variety and life cycle; (4) investigating the internal and external factors; (5) supplier level of integration; (6) trust and commitment, or interdependence and organisational compatibility. The literature (in section 3.4) outlined strong rationale for supply chain strategy architecture and design, based on these formulation criteria, and evaluation design that compliments the evaluation criteria.

The development of the conceptual framework anticipated the findings from early literature (section 3.1.3) relevant to the research topic. These findings directed this thesis towards the conclusion that: Strategy formulation represents a process of accepting the reality and acting upon that reality, by designing patterns of choices and evaluating the outcome of these choices. The outcome’s evaluation in this thesis involved architecting the objectives and the perceived state in a given business environment. The literature review in Chapter 3 also concluded that the topic outlined in the thesis remains elusive in industry, which was further confirmed in Chapter 1, Chapter 7 and Chapter 8. Therefore, the interview design considered recommendations from existing literature (Menda and Dilts, 1997, Platts et al., 1996) and separated the topics of strategy and operations to avoid confusion.

Objective four in the thesis referred to validating the proposed framework, through evaluating the supply chain strategy in relation to the formulation criteria and the integration design through the evaluation criteria. The process of confirming validity in this thesis refers to the process of ensuring that descriptions produced are valid interpretations. The framework enabled organisation of the presentation of the results,
helping to outline the categories in the result chapters and to confirm recommendations resulting from the research. Furthermore, the conceptual framework helped in understanding the process of supply chain strategy formulation in the slate mining industry in North Wales, and thus it has potential value for application in other mining industry sectors in Wales and potentially in other mining regions and countries. The findings derived from objective four are further discussed in 11.4. To complement the credibility of the presented conceptual framework, confirming validity was performed through observant analysis of compatible theories 11.3 and 11.3.1.

11.3 Key findings and contribution to method: conceptual framework and supply chain strategy formulation

The conceptual framework for strategy formulation in this thesis firstly considers demand for the product supplied (3.5, 6.4 and 6.6); secondly, internal and external factors are considered in terms of contributions and limitations for success (Chapter 1) Focus and level toward supplier or customer was chosen (detailed in 7.2), along with additional features such as the ‘efficiency’ and ‘responsiveness’ of a supply chain strategy formulation (Chapter 9) and enhancing factors such as trust and commitment were considered as values (3.4.2) while interdependence and organisational compatibility are contextualised as concepts for strong and effective supply chain relationships (9.3) These factors are determined as crucial for assembling a supply chain strategy, as a conceptual system in this thesis, combined with additional performance forecasting measures, represented in the form of evaluation criteria (4.10.2), specific to the architecture and design of a greenfield project supply chain strategy formulation.

Architecture and design of a supply chain strategy, is confirmed in existing literature (3.4.1) to be representative of a dynamic process. The thesis follows recommendations in existing literature and analyses the interdependencies from within and between in an individual context (Table 8-1 and Table 9-5) The conceptual framework adopted the hierarchical method for network design and case study for verifying the results. The approach was based on the principles from Analytical Target Cascading, to design an approach that could handle all parameters and complexities, in the context of decomposing a complete supply chain hierarchical tree, in a complimenting context to the supply chain design decomposition (Schnetzler et al., 2007).
To address the problem of building the conceptual framework based on actual instead of desired strategy outcomes, operational activities were investigated (9.5.2 and 9.5.3) to design the conceptual framework (Figure 10-4), which serves as the foundation for strategy formulation and enables real-life instead of philosophical strategy. In the process of building the foundation of the new theory, a solid background understanding was provided by the techniques applied for realignment (discussed in 3.4.4) of the concept of formulation. To address the supply chain complexities arising from multiple supply chain participants, the conceptual framework included the participants’ main aim and objectives (PAO), to conceptualise on (PR) the process of getting from the present (Chapter 1 and 7.2), to the required stage (Chapter 8).

In this context, the conceptual framework outlined the process of DSCHT and composed the supply chain strategy as a structured process with pyramidal arrangements (Chapter 8 and Chapter 9). The conceptual framework builds upon an approach, similar to Schnetzler et al. (2007), in a combination of techniques from CPPR (Martínez-Olvera and Shunk, 2006) to contextualise a new framework evaluated in Figure 10-3. The ideas presented in the framework, highlighted some of the existing principles (Ivanov, 2009, Perez-Franco et al., 2010), and distinguished between (1) the planning and functional elements of the supply chain strategy, recognising that they are strongly interlinked; (2) applied the principle that a supply chain is composed of setting goals and measures for achievement.

These principles are generalised through investigating the AA, through an OASA to conceptualise on the problem of PR, with architecture of the process of DSCHT, resulting with a design for CSSCD. Therefore, the conceptual framework for supply chain strategy formulation, builds upon the operational capabilities, through EC of the internal capabilities and inter-organisational integration, in the form of CSCIOI. The process is followed in conjunction with internal operation reformulation, in the form of IMSC, to identify the barriers to change and approaches to overcome. The process addressed the aspect of AA to characterise greenfield project supply chain strategy integration.

The idea for such a design originated from previous attempts in existing literature (Hafeez et al., 1996) to decompose the supply chain into separate business units, recompose these into conceptual diagrams, then into block diagrams (examples in Figure 7-1 and Figure 7-2). This approach was also applied as a visualisation tool to present and interlink multiple supply chain areas with external business dimensions.
The conceptual framework approach of this thesis builds upon the most recent literature that separates between architecture and design and confirms that supply chain design concept cannot be generalised within a single dimension. The conceptual framework was built in the context of advancing the most recent literature on uncovering the factors driving supply chains, through exploring various pieces that orchestrate the overall supply chain architecture and design, and investigating the underlying factors and salient dimensions. The theory building in this thesis adapts the most recent approach for conceptualising on supply chain strategy.

Therefore, it is not a surprise that the extensive and prolonged literature review in Chapter 3, resulted in insufficient established and detailed methods, relevant to the context of greenfield project and integration architecture and design as a system of concepts. A number of postulates are developed (5.5) for conceptualising the formulation of a supply chain strategy.

### 11.3.1 Conceptual framework and supply chain strategy evaluation

The theory building process in the thesis followed recommendations from Lamothe et al. (2006) that supply chain strategy must anticipate product and PF in the design process, while supply chain architecture must anticipate the BPOC in the process of determining the best product for the supply chain strategy (6.4). Furthermore, the theory building considered Liu and Hipel (2012) argument that product quality control can improve the overall performance of a supply chain (6.4.4 and 6.6.1) and can be monitored through a hierarchical decision framework to assist in determining the optimal quality control strategy (Figure 6-5, Figure 6-6, Figure 6-7, Figure 6-8 and Figure 6-9). Apart from the PF and BPOC, additional formulation criteria reconceptualised from existing literature in the context of the research question in the thesis includes the product development design. The product development design and the supply chain strategy formulation must be synchronously coordinated (6.4.1, 6.4.4 and 6.6.1).

These findings created a significant impact on the architecture and design of the conceptual framework. Research in this context is performed to examine specific aspects of diversification and integration, with the objective of identifying the best combination in the specific dimensions (Chapter 1). By other variables of interaction, referred to the cross functional integration and coordination of integrated activities. The study extended into
analysing the value of these activities on the strategy formulation because without an over-arching strategy it is unlikely that supply chain participants will achieve best performance.

11.3.2 Contribution of the conceptual framework and strengths of the study

The synthesised knowledge applied to the architecture of the conceptual system concluded that the business objectives represent a vision that serves as a central idea that is best articulated through the integrated operational capabilities and operational strategies. Setting up ambitious action objectives without considering the assets, logistics capabilities, transportation infrastructure, know-how, and culture, will inevitably result with a formulation that contains desired vision and action objectives. The lack of operational capabilities creates areas of problems that require integration, where in a scenario of strategy absence, the strategy formulation must determine the right level of integration. Therefore, business and supply chain architecture in the conceptual framework is focused on coordinated efforts between the supply chain participants.

The theory building on the relationship between the business and supply chain strategy architecture was based on a range of data sources to validate the theory. The theory building process identified the implicit visions and goals of individual supply chain participants and presented a new approach for converting implicit vision and goals into an explicit form. The framework was validated through case study, which involved an inductive and deductive theory building process with multiple supply chain participants, resulting in a new tool for extracting and relating individual strategic goals to integrated strategic goals. The process of instigating the conceptual framework applied content and discourse analysis, for converting the tacit into explicit knowledge.

The synthesised knowledge, articulated through an evidence based case study, formulated a solution for the process of making strategy in an explicit state and concluded that such a process is essential for simplifying the strategy integration process. To address reservations related to conversion of strategy, the articulation approach presented a formulation solution and documented the approach, to serve as a tool for future studies presented with this obstacle. The tool designed, enables dealing with the complexity of the research problem and enables the process of making informed judgements in a situation where absence of complete or consistent data or information is present. The tools are designed
and field-tested through cases study and action research for eliminating the obstacles that emerged in extracting tacit strategic interests.

Through the case study responses collected, it was determined that the process of making strategy explicit, is a pre-requirement for integration of the strategic goals. The case study exercise resulted in a new process for extracting implicit concepts and presenting them into summary maps in an explicit form.

The process of evaluating the summary maps of individual goals concluded that the architecture for greenfield project business strategy formulation is consistent with articulating, evaluating and integrating individual goals. The integrated business goals represented a vision that serves as a central idea, articulated through evaluating the integrated operational capabilities and the individual operational strategies.

The framework is applied for designing integrated vision and goals, through critically reviewing the salient dimensions, in combination with the supply chain assets, transportation and logistics capabilities, know-how, and culture. The aim of architecting business and supply chain strategy was to formulate a feasible vision and action objectives in a scenario where there is lack of operational capabilities. The conceptual framework systematically evaluates the absence of operational capabilities and formulates the strategy through determining the right level of integration.

11.4 **Key findings and contribution to practice**

The strategy formulation from an implementation standpoint required identifying relevant theories and re-contextualising the theories in a new setting, to identify new emerging concepts that enabled building a new theory. This research applied qualitative content analysis, narrative enquiry and explained the results with conceptual diagrams, which were used to create hierarchical concept summary maps and enabled the creation of hierarchical conceptual diagrams. This method is demonstrated through concept diagrams, concept maps and through applying the cascading strategy. Followed by the formulation and evaluation criteria, the findings are generalised into creating a conceptual framework for integrated supply chain strategy formulation.

The process is initiated using primary and secondary data gathering and analysis, resulting in a conceptual design, relevant to the first company participating in the supply chain.
Most of the examples used in building the preliminary theory are taken from the case study of the lead company supply chain strategy, resulting in a detailed preliminary theory. To enrich and validate the theory, case study and action research was conducted with a consortium of companies. Confidentiality checks were performed by carefully selecting the text to protect the privacy of the study participants.

11.4.1 Greenfield project business and supply chain strategy integration

The advancement of the conceptual framework involved a process of systematically grouping and categorising the emerging concepts, into formulation areas, formulation principles, imperatives and concept task. These are contextualised and evaluated with summary maps, concepts maps and conceptual diagrams, and are critically analysed through the pre-established evaluation criteria. The process of advancement from strategy architecture into strategy design, is consistent with conceptualising a set of ideas into an interrelated, interworking set of objectives.

The process outlined, places the individual goals into formulation areas, compliments the greenfield project architecture and formulates a design imprinted by all the participants in the integrated strategy. The conceptual diagrams categorising the synthesised knowledge from the interviews, represented a method for explicitly and easily identifiable architecture and design that enables visualising the conceptual logic behind the system, consistent of strategic vision, goals, areas, principles, imperative narratives and concept tasks.

The process of categorising individual supply chain strategic areas of interest, decisions and problems into formulation areas, was aimed at deriving insights on the relationship between the formulation areas; the individual business goals; the integrated vision and goals. Such insights become visible from the process of integrating the formulation areas towards achieving the individual and the integrated goals of the supply chain participants.

The process outlined, extracts the silent areas and principles to solve the predefined critical problems related to conceiving, designing and instigating the conversion of tacit into explicit knowledge. The emerging design represented a process of eliminating obstacles in extracting tacit knowledge from areas that are left silent in the formulation process.

In the process of applying the evaluation criteria to the formulation criteria, a number of feasibility challenges emerged in the context of the concepts articulated. The merging
process represents a method for linking the closely associated areas to reduce complexity in interpreting the emerging concepts.

The framework developed in this thesis recommends that such concepts are either simplified or merged with other concepts through double checking the ideas behind the wording. If the formulation criterion fails to provide a valid concept after the process of simplifying and merging, then the design advocates that these concepts need to be re-evaluated with the supply chain participants or eliminated from the conceptual system. Such concepts are bound to emerge considering that the framework is architected and designed to address the problem of greenfield project integration strategy. To uncover the DNA of supply chain strategy formulation in the context selected, the conceptual system is focused on the underlying factors that shape the resulting system, and building a desired concept as underlying factor, will in most cases result in multiple conflicts of interest. The conceptual framework developed in this thesis, eliminates the conflict of interest and through building the concepts into the conceptual hierarchy summary map outlined in (Chapter 1), the formulation retains only the feasible concepts.

If the process of formulation is followed as outlined, the conceptual framework will automatically eliminate conflict of interest, along with unfeasible concepts that lack authentic validity. At the same time the framework will fill in areas that are expected to be explicit but are left in implicit form and present the strategy in a clear and visual method.

This approach provides academic and industry understanding of strategy, where the operations performed in individual activities, are conceptually aligned towards integration with the desired goals behind the actions. However, the conceptual framework must not be applied as a constraining paradigm. As this study has evolved existing theoretical frameworks, to resolve the emerging obstacles when integrating multiple participants in a greenfield project strategy formulation, the framework can be amended and adopted to confirm other aspects of strategy in future studies.

In brief, this study derived a conceptual framework for strategy formulation that can be applied in greenfield project integration. The framework was field-tested on the slate mining industry and in the process; the study advanced the academic knowledge on: ‘how’ in a consortium of companies the business strategy is naturally connected to the supply chain strategy. The present knowledge from existing literature was utilised, to advance the
understanding in the field of strategy formulation, by including the additional aspects of integrated greenfield project business and supply chain strategy formulation.

11.5 **Summary of contributions**

Chapter 1 derived a greenfield architecture for supply chain strategy formulation, represented in 2 external and 5 salient dimensions that affect the supply chain strategy in the mining industry. The supply chain architecture derived findings that BPOC depends on the product properties and confirmed that performance of the product must be separated from the limitations of various test methods. Furthermore, the supply chain architecture confirmed that transport cost must be built in as a variable in the final product cost.

Chapter 7 derived a new understanding of the process of integrating a greenfield business strategy and redefined existing understanding of the problems conceiving the relationship between business and supply chain strategy. The integration design derived insights into the shortcomings of the methods in existing literature, brought new understanding and confirmed that corporate strategy represents a vision that serves as a central idea but it emerges from the business objectives and is articulated through evaluating the operational capabilities and the operational strategies. The findings concluded that the greatest obstacle in formulating supply chain strategy for the mining industry is the transportation and logistics cost. The integration with 3PLs and creating a networked organisation with the related industries is therefore a crucial aspect for transporting waste by-products from mining operations.

Chapter 8 derived a new process and a new perception for integrating business strategy in the greenfield context, and articulated original and new ideas related to the process of identifying and evaluating individual business goals and integrating the goals with the supply chain participants. The findings contributed with a new process for solving critical problems for integrating business and supply chain strategy and derived a conclusion that making strategy explicit is essential in the strategy integration process. The research findings from this chapter concluded that tacit strategic interests are required in an explicit form for the integration of the strategic goals to be considered representative of a supply chain consortium.
Chapter 9 designed a framework for categorising individual goals into integrated goals, through systematically grouping concepts into formulation areas, principles, imperatives and concept tasks. The research findings advanced the architecture of the conceptual framework into integration design for supply chain strategy formulation, consistent with a set of interrelated ideas and interworking set of objectives.

The findings in this chapter derived a process for tapping into the silent areas and principles to solve the predefined critical problems related to the conversion of tacit into explicit knowledge, extracted through verbalism, or distilled through content and discourse analysis and presented in an explicit form. The contribution to knowledge can also be identified in the recommended process for simplifying, merging, re-evaluating or eliminating concepts.

Chapter 1 evaluated the validity of the conceptual framework with principles from engineering design and controlled convergence resulting in a new evaluation design. The evaluation process derived a new method for evaluating strategy formulation. The uniqueness of the evaluation design is the capacity to address integration obstacles by eliminating conflict of interest, eliminating duplicate concepts, merging conceptual ideas, determining validity of outlined concepts, eliminating the probability of preference concepts, converting tacit into explicit strategy and identifying superior concepts for strategy formulation.

11.5.1 Contributions to theory

The thesis contributed to theory with a new conceptual framework for:

a) Supply chain system architecture in a greenfield project context and

b) Supply chain integration design with multiple participants

The supply chain system architecture derived a new set of formulation criteria based on external and salient dimensions. Significant contribution to theory emerges from the thesis in the format of applying the system architecture to a single case study research, documenting the process and generalising the findings. Furthermore, the thesis derived a set of evaluation criteria, some based on existing literature (Perez-Franco et al., 2010) other based on addressing the specific problems that emerged during the case study.
11.5.2 Contributions to method

The thesis derived a new method for extracting tacit knowledge and converting it to explicit knowledge. The conversion method enabled the supply chain integration design and was confirmed effective in identifying and eliminating multiple conflicts of interest that emerged in the integration process. The research encountered multiple obstacles in synthesising knowledge from recent literature and addressed these obstacles by combining findings from recent literature with findings from early literature. The result was a new method for holistic supply chain strategy formulation.

11.5.3 Contributions to practice

The conceptual framework derived from the thesis is applied to the mining industry in North Wales and contributed to practice with

a) A new approach for systematically applying the formulation criteria

b) A new approach for evaluating the supply chain formulation with a set of evaluation criteria

The findings are applied to participants operating in the three main industry groups predominating in the mining sector. The participants were selected based on representativeness and feasibility of access. Nevertheless, by identifying and applying the analysis to the main industry groups and documenting the findings, the thesis derived a conceptual framework that can be applied to other mining industries in Wales and beyond. The study contributed to practice with the conceptual framework for supply chain system architecture and integration design, and by successfully implementing the framework to a consortium of supply chain participants.
11.6 Recommendations and further work

11.6.1 Recommendations for future studies

To validate the data collection through group discussion, the experiences obtained in applying this research method derived to a number of recommendations that build upon previous literature (Perez-Franco et al., 2010) to be considered in future research studies:

1) The crucial task in group discussions is to ensure that the discussion is leading towards validating the facts in the aggregated data sets.
2) The research process must be controlled to ensure that the group discussion does not lose the focus of validating the aggregated data sets. Failure to stay in control of the discussion will result in most cases with the group drifting into non related subjects and there being a lack of the required results.
3) The process of applying the method will commonly result with silent areas or activities that are missed out during the data collection. These can be added to the conceptual diagram only if sufficient concepts are identified.
4) The research process will also discover that some of the areas need to be merged, rewritten, or dropped from the conceptual diagram and consequently, from the conceptual model. This should be considered acceptable as long as the changes contribute to ensuring that the aggregated data set represents a factual conceptual diagram of activities and not desirable activities.
5) Future research studies applying this method must resist any pressure to delete areas or activities if based on grounded factual data, despite that the facts may not be perceived as desirable by some individual participants.
6) By the same principle, future research studies must not fall to pressures to state that there are silent areas or activities if there is no grounded factual data for such statements. Such a scenario is more likely to occur than the previous one mentioned. In many interviews and group discussions it was determined that the participants were easily confused with the criteria. Presenting the conceptual diagrams could be the researchers’ best approach in such scenarios.
7) Future research studies must expect that, after the group discussion, the conceptual diagram may require changes depending on the outcome of the discussion. For example some conceptual diagram elements may need to be reviewed extensively,
while others, if data collection and analysis was performed correctly, will need only small changes or no changes at all.

8) The most common changes would be related to wording in the field of silent activities; however, the activities would be easily confirmed with factual data if the case study research and the recommended methods are performed correctly.

9) The silent areas will create a number of challenges for future research. That is the reason why this study has named them silent areas. While some participants may consider them as factual, other will consider them as desired goals. When faced with this issue in this research, in the design process this study decided to invest in time and discuss this area with the group in detail. If a specific silent area is perceived by the group as not grounded on facts, this area is deleted from the conceptual diagram.

10) The research studies will find a further challenge from the group discussion is that the identified silent areas would be much more easily named during the group discussion, if the group reaches a consensus on the wording of the undefined area. If the wording has been decided then it can be added straight away to the conceptual diagram.

11) This study mentioned previously that a new silent area can be discovered in the group discussion. Future research studies need to take a note of the advice that this area must not be added to the conceptual diagram without the factual data of the activities within the area being scrutinised in the same manner as the rest of the identified areas. If the study fails under the pressure of the group to add a silent area to the concept map without scrutinising the factual data, the study will compromise the soundness of the conceptual model.

11.7 Limitations of the study

The conceptual framework is designed to integrate the business objectives of multiple companies on a strategic level. The conceptual design is aimed at generalising the idea behind the framework for greenfield project formulation for the mining supply chain strategy, to other sectors. The framework contributes to and enriches the existing literature and provides background for further academic research in this subject. However, this study involved a single case study and while it is anticipated that the proposed conceptual framework is suitable for other sectors, the findings would need to be delimited through further research. The framework was developed through a 5 year-long case study, resulting in recommendations for strategy formulation, based on the intensive analysis in
the case study. To generate the theoretical framework content and discourse analysis were applied.

The resulting framework is not all-inclusive. Nevertheless, it is developed through comprehensive investigation and was field-tested on an industry project, resulting in an easy to visualise, convincing structure. The thesis derived a conclusion that consortiums of companies, through reaching a strategic alliance are able to perform the operation that none of the companies can only perform. The theoretical framework presented a methodology for assembling complex concepts as a conceptual system for strategy formulation. The conceptual framework in this study was based on supportive interconnection between the participants’ activities, taken in the context of the study as actionable concepts.

As discussed in the research methodology chapter, there is ambivalence in generalising the findings based on diversity as opposed to representativeness.

The first challenge is represented in the relationship between the concepts, (ex. product family and the supply chain strategy) and is exposed to uncertainties when taken out of the context of the mining industry.

A second challenge became clearer when attempting to compare the results between industries. If it is possible to synthesise data in one industry but not in another, the research will end up describing different industries, but would not be able to compare them by applying the same formulation parameters.

The third challenge can be anticipated in using qualitative interviews for specific data collection in a small industry, such as the mining industry in North Wales. The size of the industry increases the possibility of bias and distortions in the conclusions, while the sensitive data would be difficult to collect.

The fourth challenge future research studies will face in extracting tacit knowledge and converting it into explicit, is the preference towards desirability over feasibility. This issue becomes one of a degree in an integration scenario if a researcher is faced with the responders’ avoidance of criticism, conflict, disagreement, and controversy. The topic of strategy formulation requires interviewing executives, managers and supervisors and some of the responders can be quite reserved in offering critiques. There are a number of
recommendations made in the thesis towards addressing these problems. Nevertheless, future research studies should be aware that these challenges will occur, regardless of confidentiality agreements.

11.8 Future research avenues

11.8.1 Systematic innovation and strategy absence

The investigation into the strategic operational activities in this thesis is aimed at designing operational greenfield project formulation. The operationalisation aspect is addressed through applying the evaluation criteria through systematic innovation. However, systematic innovation brings strategy dynamics through the feedback mechanisms, where strategy absence effectively disables the feedback mechanisms. Further research is required into the topic of addressing strategy absence in scenarios of high strategy absence, because in such scenarios, the formulation and evaluation criteria would be difficult to implement.

11.8.2 Lean or agile supply chain strategy

The literature review determined that the supply chain decoupling point determines the position of a company in a given supply chain and determines whether lean or agile paradigms should be followed (3.6.3), which in effect determines whether the strategic focus should be on product differentiation instead of cost reduction. This topic has not been covered in great detail in the theory building process. Future research should focus on investigation of the impact from employing agility downstream from the decoupling point in a supply chain. Enriched information flow could increase the supply chain agility, further study on reducing lead times for information and material flow could benefit the conceptual framework designed in the thesis.

11.8.3 Heuristic and metaheuristic algorithms

The thesis derived a conceptual framework for holistic supply chain system architecture and integration design. The findings bring a degree of imperative certainty to the topic of formulating a holistic method for supply chain design. The findings from this thesis would
benefit from being further investigated and delimited through developing a heuristic or metaheuristic algorithm that would be applicable to multiple business environments.

Supply chains evolve in dynamic and uncertain environments and forecast or resources can change triggering a requirement for change of all operational planning and coordination. The findings in the thesis can be combined with a heuristic dynamic mutual adjustment approach for supply chain operations planning and co-ordination (Taghipour and Frayret, 2013), or Tabu Search algorithm to simultaneously investigate synchronised design of a product family and the supply chain (Khalaf et al., 2011).

The findings from this thesis concluded that supply chain decisions are based on individual company profitability goals. This has been defined as the supply chain paradox in this thesis. Supply chain coordination has also been investigated by Leng and Chen (2012) who proposed a mechanism for coordination based on ‘theory of constraints’ and applied genetic algorithm for solving the optimal model. Future research is needed in combining the findings from this thesis and applying the postulates to design a similar algorithm.

Alternatively, the postulates can be combined with Yadav et al. (2011) who designed a framework based on a generic bill of materials and stochastic genetic algorithm that considered product development issues through adapting an arithmetic crossover, dynamic mutation and variable penalty strategies. The framework considers: flexibility and dominance of product planning and mixed market strategies over product variety, with the main aim to minimise cost and design complexity and maximise the sales of final product. The model is useful for matching a product to the best market segment and for determining optimum prices. The study concluded that a number of other algorithms can be applied and recommends future research in designing multi-agent supply chain framework for product development. This approach would also provide strong research potential for applying the postulates from this thesis.

The most recent approach relevant to the research postulates in this thesis can be identified in Fahimnia et al. (2012), who employed the ‘robust techniques’ generic algorithm to aggregate production-distribution supply chain plans that integrated the decision in multi: production, transportation, warehousing and inventory management, presenting complex problems for solving and a large number of parameters for optimising. Real life case study testing concluded that decisions in production-distribution plan
significantly impacts the performance of a supply chain. Therefore, the actual complexity of supply chain performance evaluation is greatly determined by the modelling and optimisation of the production-distribution plan.

Fahimnia et al. (2012) recommended that further study in the area of ‘three-echelon supply chain: developing an optimisation model for the entire supply network requires the consideration of procurement activities and the associated transportation of raw material from vendors to manufacturers.’ (pp.92). While Khalaf et al. (2011) recommended that ‘it would be of interest to treat a problem with more than one assembly site, which would involve defining the costs of transportation from a distant facility to an assembly facility. Doing so would result in more complete modelling and a better understanding of the influence of transportation costs on supply chain design.’ (pp.5655).

Future research studies aiming to apply the findings from this thesis to design supply chain algorithms should carefully investigate the strengths and weaknesses of their approach before engaging in the design process. Existing literature holds a wealth of advice on identifying the design parameters. For examples, Che et al. (2012) developed a decision methodology for supply chain planning in a ‘multi-echelon non-balanced supply chain system’, that considered four criteria: cost, quality, delivery and supplier relationship management, along with considering quantity discount and capacity constraints. The methodology applied the analytic network process and turbo particle swarm optimisation algorithm to evaluate partners and to determine an optimal supply chain network pattern and production-distribution mode. The results are presented through comparative numerical experiments, particle swarm optimization and genetic algorithm. Empirical analysis results demonstrate that turbo particle swarm optimisation algorithm can outperform particle swarm optimization and genetic algorithm in non-balanced supply chain planning problems.

Another example of a future research avenue is applying the findings from this thesis to Lee et al. (2010), who investigated the multi-level, multi-facility industrial supply chain problem and established as key areas the interdependence between the location and allocation of facilities, and supply chain routing of raw materials and products, concluding that it is required that 3PLs design the network and operate the transportation. However, Lee et al. (2010) compared results between a number of heuristic algorithms and concluded that ‘in terms of real time application, the size of the problem might be larger than that of the test
data. In such environments, it is not feasible to find an optimal solution in a reasonable amount of time.’ (pp.3974). The study concluded that developing metaheuristics and comparing them with heuristic algorithms could present interesting results.

Griffis et al. (2012) outlined the advances in metaheuristics development and analysed the ability of those advanced techniques to resolve various logistics and supply chain problems. The capacity of metaheuristics techniques to simultaneously analyse risk, disruptions, intermodal operations, customer service, backhaul strategies, facility locations and vehicle route problems represents a strong method for addressing the logistics aspect of supply chain design techniques. Also, metaheuristics enables the performance of a detailed search of inferior and infeasible moves in the solution space seeking for new solutions, and in complex real-world problems, they are increasingly becoming the preferred methods for generating solutions where other methods have failed (Griffis et al., 2012), furthermore; ‘existing metaheuristic algorithms already hold the potential to revolutionize how supply chains are designed, managed, analysed, and improved. In particular, these metaheuristics appear capable of addressing the cross-functional complexity of modern supply chains, including the large size, multiple parameters, multiple objectives, and the often nonlinear aspects of such problems.’ (pp.99).

But metaheuristics would hardly anticipate aspects such as individual decisions of decision makers in the vast number of dimensions in multiple business environments. The conceptual system approach has been proven effective for all wide strategy evaluation and optimal solution detection in the thesis. However, further research into applying the findings to metaheuristics, would be beneficial for developing the logic from the conceptual system into metaheuristic algorithm, to delimit the applicability of the findings in this thesis to multiple business environments and specific case scenarios.

### 11.9 Final remarks

This chapter provided the final critical analysis of the research. The aim and objectives were also revisited as well as the main contributions from the conceptual framework and the resulting conceptual systems were discussed. Limitations and recommendations for further research were also identified.
The research on supply chain strategy evaluation criteria provided new insights on approaches and concepts that are undeveloped in existing literature. The formulation criteria have been critically reviewed through applying engineering design for validating the findings. The results offer new perceptions and insights for the study of supply chain strategy in relation to greenfield project integration in the mining industry and elsewhere.

Figure 11-1: Photo taken by the author 12/12/2012
References


BAUMARD, P. 1999. Tacit knowledge in organizations, Sage Publications Ltd.


BOWERSOX, D. J. C., DAVID J., STANK, THEODORE, P. 1999. 21st century logistics: making supply chain integration a reality.


FISHER, M. L., TENNESSEE. 1997. What is the right supply chain for your product?

FISHER, M. L. 2003. What is the right supply chain for your product?


GOULDEN, E. 1992. Slate waste aggregate for unbound pavement layers. MSc, University of Nottingham.


HMRC 2010. A general guide to landfill tax.


Supply Chain Management. Springer.


LETTPATTARAPONG, C. 2002. Applying system dynamics approach to the supply chain management problem. Master of Science in Engineering and Management MSc, Massachusetts Institute of Technology.


addition progress towards the adoption of supply chain materials and business Students, 5/e.

SHEFFI, Y. 2013. Logistics THIRD PARTY LOGISTICS SHEFFI, Y. 1990. THIRD PARTY LOGISTICS SHEFFI, Y. 1990. THIRD PARTY LOGISTICS


## Appendices

*Appendix A: Summary table of the literature review*

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2. Engineering design  
1. Mechanisms for capturing, evaluating and reformulating a supply chain strategy  
2. Pugh controlled convergence (PuCC), conceptual design, | Perez-Franco et al. (2010)  
Pugh (1990)  
Bartolomei et al. (2007) |
### Strategic factor (C-9): Supply chain strategy design

| 1. Research framework | 1. Framework for understanding supply chain design by following three key level factors: influencers, design decisions and building blocks. | Melnyk et al. (2013) |

---

### Strategic factor (D): Product and supply chain strategy

#### 1. Optimisation model
1. Supply chain design by firstly selecting a product and designing its supply chain.
2. Product quality and quality control strategy can significantly improve performance of a supply chain.
3. Cost efficiency is the mostly pursued from the relationship between product and supply chain strategy.

<table>
<thead>
<tr>
<th>1. Environmental policies</th>
<th>1. Environmental supply chain policies are increasingly more relevant.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Product development</td>
<td>2. Product development design (design for environment and design for disassembly).</td>
</tr>
<tr>
<td>3. Disposal costs</td>
<td>3. Reverse logistics is influenced by avoidance of disposal costs.</td>
</tr>
<tr>
<td>5. Green supply chain management</td>
<td>5. Reverse logistics promotes synergy and efficiency between supply chain partners and cross functional coordination of activities.</td>
</tr>
</tbody>
</table>

#### 1. Time postponement, place postponement, form postponement
1. Rigid, postponed, modularised, flexible
2. Information sharing and delayed differentiation.

<table>
<thead>
<tr>
<th>Postponement strategies</th>
<th>Postponement strategies</th>
</tr>
</thead>
</table>

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|-----------------------|-----------------------|

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Lee et al. (1997)</td>
<td>Lee et al. (1997)</td>
</tr>
</tbody>
</table>
| Marketing and Distribution Planning | 1. Cost based framework  
2. Customer traveling problem | Korpela et al. (2001b)  
Bogataj and Bogataj (2001) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic factor (E): Transportation and Logistics</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1. Deterministic and stochastic optimisation model  
2. Direct interviews | 1. Altering the logistics operations occurs to gain competitive advantages  
2. Economic improvement and logistic value of products can be achieved through integration of the logistics chain  
3. 3PLs should design the logistic network and operate the transportation | Fuller et al. (1993)  
Perona et al. (2001)  
Lee et al. (2010) |
| **Strategic factor (E-2): Transportation and logistics integration** | | |
| 1. Supply chain coordination | 1. Logistics can serve as coordinating mechanism between supply chain participants | Chen and Paulraj (2004) |
| **Strategic factor (E-3): Strategic elements of transport and logistics Integration** | | |
| 1. Survey  
2. Empirical analysis, secondary data  
3. Literature review  
4. Examined secondary data from Australian companies | 1. Supply chain integration and performance ‘ark of integration’  
2. Recommended seeking the right level and form that optimises the company performance  
3. Framework on the drivers and enablers of logistics integration  
4. Integration in information and material flows create significant effect on performance | Frohlich and Westbrook (2001)  
Jayaram and Tan (2010)  
Prajogo and Olhager (2012) |
| **Strategic factor (E-4): Supply chain agility** | | |
| 1. Process re-engineering | 1. Agility can be achieved through establishing a seamless supply chain | Towill (1997) |
| **Strategic factor (F): Supply chain performance.** | | |
| 1. Computational process model  
2. Performance value analysis | 1. Complexity and adaptability in supply networks CASN framework  
2. Diagnosis of global supply chains  
Soni and Kodali (2010)  
Bryceson and Slaughter |
and strengths, weaknesses, opportunities and threats
3. Case study, participative action research

<table>
<thead>
<tr>
<th>Strategic factor (F-1): Performance measurement and supply chain evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Performance measurement</td>
</tr>
<tr>
<td>2. Cross-company supply chain</td>
</tr>
<tr>
<td>3. Computing performance measures</td>
</tr>
<tr>
<td>4. Analytical hierarchy process</td>
</tr>
<tr>
<td>5. Narrow study of performance concepts</td>
</tr>
<tr>
<td>6. Empirical examination</td>
</tr>
<tr>
<td>7. Case study</td>
</tr>
<tr>
<td>8. Mean, standard deviation and correlation</td>
</tr>
<tr>
<td>9. Business re-engineering, benchmarking and process measurement</td>
</tr>
</tbody>
</table>

| 1. Balanced scorecard-based framework |
| 2. Coordination and integration of supply chain functions |
| 3. Coordination and integration of supply chain functions, computing performance measures through publicly available information |
| 4. Analytical hierarchy process |
| 5. Impact of supply chain complexity |
| 6. Business environment uncertainty |
| 7. In certain business environments, a low level of integrative practices is the best strategy to engage |
| 8. Supply chain strategy and practices effect on supply chain performance |
| 9. Supply chain operations reference or SCOR model |

Kaplan and Norton (1996)
Brewer and Speh (2000)
Shah and Singh (2001)
Korpela et al. (2001a)
Bozarth et al. (2009)
Qi et al. (2011)
van Donk and van der Vaart (2005)
Sukati et al. (2012)
SCC (2000)

Strategic factor (G): Supply Chain integration

Strategic factor (G-1): Outsourcing and strategic alliances

<table>
<thead>
<tr>
<th>Supply chain outsourcing strategic alliances, third party logistics outsourcing, transportation outsourcing, global sourcing, supplier sourcing, and information technology sourcing, deterministic demand, weighted point, cost ratio methods, principal component analysis and Analytic Hierarchical Process, outsourcing through ‘abstention’ and</th>
</tr>
</thead>
<tbody>
<tr>
<td>---</td>
</tr>
<tr>
<td>Strategic factor (G-5): Information sharing and supply</td>
</tr>
</tbody>
</table>
3. Information technology have a direct positive elements with supply chain strategy integration
4. Process chain for collaborative commerce and synchronisation
5. Investment in IT

| chain integration | 3. Information technology have a direct positive elements with supply chain strategy integration
4. Process chain for collaborative commerce and synchronisation
5. Investment in IT | Manthou et al. (2004)
Vickery et al. (2003)
Kim (2006)
Al-Mudimigh et al. (2004) |

**Table A-1: Summary table of literature reviewed**
Appendix B

Figure B-1: Alternative analysis of categories and subcategories
Appendix C

Figure C-1: Preliminary formulation
Appendix D

Figure D-1: Sample conceptual framework map
Figure E-1: Alternative sample
**Appendix F**

Output of the Supply Chain Strategy Formulation field-test with a Slate Mining Quarry

Aggregated Primary Data through Case Study Research

<table>
<thead>
<tr>
<th>Area of Formulation (Areas of Problems, Areas of Decisions, Areas of Interest)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Recognition (Principles)</td>
<td></td>
</tr>
<tr>
<td>Problem Narrative (Imperatives)</td>
<td></td>
</tr>
<tr>
<td>Solution Concept (Concept Tasks, Operation Activities)</td>
<td></td>
</tr>
</tbody>
</table>

Table F-1: Hierarchical concept summary map – framework
## Output of the Supply Chain Strategy Formulation field-test
with a Slate Mining Quarry

### Aggregated Primary Data through Case Study Research

<table>
<thead>
<tr>
<th>Area of Formulation (Areas of Problems, Areas of Decisions, Areas of Interest)</th>
<th>Problem Recognition (Principles)</th>
<th>Problem Narrative (Imperatives)</th>
<th>Solution Concept (Concept Tasks, Operation Activities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD\textsubscript{1}P\textsubscript{1}C\textsubscript{1}) Supply chain processes and outputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{1}P\textsubscript{1}FP\textsubscript{1}C\textsubscript{1}) Diversify logistics chain processes and outputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{1}P\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{1}) Pursue supply chain integration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{1}P\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Integrate with 3PLs that can operate on Conwy Valley Line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{1}P\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{2}C\textsubscript{1}) Integrate with 3PLs that would enable multimodal transport</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{1}P\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{3}C\textsubscript{1}) Pursue sea transport through Port of Mostyn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{2}P\textsubscript{1}C\textsubscript{1}) Productivity and profits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{2}P\textsubscript{1}FP\textsubscript{1}C\textsubscript{1}) Increase our productivity and profits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{2}P\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{1}) Pursue productivity and profit through the slate waste product family</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD\textsubscript{2}P\textsubscript{1}FP\textsubscript{1}FI\textsubscript{1}A\textsubscript{1}C\textsubscript{1}) Increase productivity through by-product sales for sea defences (subject to product suitability)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD1 P2C1)</td>
<td>Transport Cost</td>
<td>(AD1 P2F1C1)</td>
<td>Minimise transportation cost</td>
</tr>
<tr>
<td>------------</td>
<td>----------------</td>
<td>--------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>(AD1 P2F1C1)</td>
<td>(AD1 P2F1C1)</td>
<td>Minimise the cost of delivery</td>
<td></td>
</tr>
<tr>
<td>(AD1 P2F1C1)</td>
<td>(AD1 P2F1C1)</td>
<td>Determine the precise and accurate cost of delivery</td>
<td></td>
</tr>
<tr>
<td>(AD1 P2F1C1)</td>
<td>(AD1 P2F1C1)</td>
<td>Procure integration instead of outsourcing third party transport and logistics services</td>
<td></td>
</tr>
<tr>
<td>(AD1 P2F1C1)</td>
<td>(AD1 P2F1C1)</td>
<td>Pursue lower cost of transport from quarry to the market by optimising the operating network</td>
<td></td>
</tr>
<tr>
<td>(AD1 P2F2C1)</td>
<td>Develop sustainable transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AD1 P2F2C1)</td>
<td>(AD1 P2F2C1)</td>
<td>Develop rail and shipping transport</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD3 P1C1)</th>
<th>Mining cost</th>
<th>(AD3 P1F1C1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD3 P1F1C1)</td>
<td>Mining cost</td>
<td>Increase productivity by loading virtual quarries in multiple destinations at times of low demand</td>
</tr>
<tr>
<td>(AD3 P1F1C1)</td>
<td>Reduce the cost of mining</td>
<td></td>
</tr>
<tr>
<td>(AD3 P1F1C1)</td>
<td>Reduce the cost of outsourced mining operations</td>
<td></td>
</tr>
<tr>
<td>(AD3 P1F1C1)</td>
<td>Integrate waste product production with the supply chain to prevent duplicating machinery costs</td>
<td></td>
</tr>
<tr>
<td>(AD3 P1F1C1)</td>
<td>Pursue integration with a consortium of companies to reduce the cost of supply chain operations</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD4 P1C1)</th>
<th>Supply chain efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD4 P1F1C1)</td>
<td>Supply chain efficiency</td>
</tr>
<tr>
<td>(AD4 P1F1C1)</td>
<td>Increase the supply chain efficiency</td>
</tr>
<tr>
<td>(AD4 P1F1C1)</td>
<td>Reduce the cost of delivery for the by-product</td>
</tr>
<tr>
<td>(AD4 P1F1C1)</td>
<td>Identify opportunities to improve the logistics of the by-product</td>
</tr>
<tr>
<td>(AD4 P1F1C1)</td>
<td>Identify opportunities to reduce cost and waste in the supply chain</td>
</tr>
<tr>
<td>(AD4 P1F1C1)</td>
<td>Eliminate additional waste product accumulation</td>
</tr>
</tbody>
</table>

| (AD2 P1F1C1) | (AD2 P1F1C1) | Develop supply chain capability to reach profitable sub-ballast markets |

| (AD2 P1F1C1) | Increase productivity by loading virtual quarries in multiple destinations at times of low demand |

<table>
<thead>
<tr>
<th>(AD3 P1C1)</th>
<th>Mining cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD3 P1F1C1)</td>
<td>(AD3 P1F1C1)</td>
</tr>
<tr>
<td>(AD3 P1F1C1)</td>
<td>Reduce the cost of mining</td>
</tr>
<tr>
<td>(AD3 P1F1C1)</td>
<td>Reduce the cost of outsourced mining operations</td>
</tr>
<tr>
<td>(AD4 P1C1)</td>
<td>Supply chain efficiency</td>
</tr>
<tr>
<td>(AD4 P1C1)</td>
<td>Increase the supply chain efficiency</td>
</tr>
<tr>
<td>(AD4 P1C1)</td>
<td>Reduce the cost of delivery for the by-product</td>
</tr>
<tr>
<td>(AD4 P1C1)</td>
<td>Identify opportunities to improve the logistics of the by-product</td>
</tr>
<tr>
<td>(AD4 P1C1)</td>
<td>Identify opportunities to reduce cost and waste in the supply chain</td>
</tr>
<tr>
<td>(AD4 P1C1)</td>
<td>Eliminate additional waste product accumulation</td>
</tr>
<tr>
<td>AD1P3C1</td>
<td>Impact on environment</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>AD1P3FP1C1</td>
<td>Pursue environmental sustainability</td>
</tr>
<tr>
<td>AD1P3FP1FI1C1</td>
<td>Reduce our impact on environment</td>
</tr>
<tr>
<td>AD1P3FP1FI1A1C1</td>
<td>Identify means to resolve the environmental damage of our mining operations</td>
</tr>
<tr>
<td>AD1P3FP1FI1A2C1</td>
<td>Investigate the transport mode shift impact on environmental damage from logistic operations</td>
</tr>
<tr>
<td>AD1P3FP1FI1A3C1</td>
<td>Promote green activities (cycling tracks, etc.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AD1P4C1</th>
<th>Supply chain technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD1P4FP1C1</td>
<td>Acquire new technology</td>
</tr>
<tr>
<td>AD1P4FP1FI1C1</td>
<td>Pursue technological innovation</td>
</tr>
<tr>
<td>AD1P4FP1FI1A1C1</td>
<td>Integrate the supply chain to acquire access to technology for commercialising the slate aggregate by-product</td>
</tr>
<tr>
<td>AD1P4FP1FI1A2C1</td>
<td>Invest in IT systems to communicate more effectively with supply chain partners</td>
</tr>
<tr>
<td>AD1P4FP1FI1A3C1</td>
<td>Develop technology for converting the by-product to various products present in the product family</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AD2P4C1</th>
<th>Supply chain capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD2P4FP1C1</td>
<td>Invest in supply chain capabilities</td>
</tr>
<tr>
<td>AD2P4FP1FI1C1</td>
<td>Develop supply chain capabilities</td>
</tr>
<tr>
<td>AD2P4FP1FI1A1C1</td>
<td>Develop supply chain capability to reach profitable sub-ballast markets</td>
</tr>
<tr>
<td>AD2P4FP1FI1A2C1</td>
<td>Invest time in supply chain integration with partners that have the required capabilities</td>
</tr>
<tr>
<td>AD2P4FP1FI1A3C1</td>
<td>Improve and develop relationships with the supply chain partners</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AD3P4C1</th>
<th>Supply chain infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD3P4FP1C1</td>
<td>Maximise usage of existing supply chain infrastructure</td>
</tr>
<tr>
<td>(AD₁P₅₁C₁)</td>
<td>Supply chain market</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>(AD₁P₅₁₁C₁)</td>
<td>Be effective in the market</td>
</tr>
<tr>
<td>(AD₁P₅₁₁C₁)</td>
<td>Pursue profitable markets for the slate aggregate by-product</td>
</tr>
<tr>
<td>(AD₁P₅₁₁₁C₁)</td>
<td>Offer variety of aggregate by-product products to existing and new customer base</td>
</tr>
<tr>
<td>(AD₁P₅₁₁₁C₁)</td>
<td>Pursue innovative product usage in high demand aggregate materials</td>
</tr>
<tr>
<td>(AD₁P₅₁₁₁C₁)</td>
<td>Better match customer demand with value for money of by-product aggregate</td>
</tr>
<tr>
<td>(AD₁P₅₂₁C₁)</td>
<td>Increase sale volumes</td>
</tr>
<tr>
<td>(AD₁P₅₂₁C₁)</td>
<td>Pursue new markets for the slate aggregate by-product</td>
</tr>
<tr>
<td>(AD₁P₅₂₁₁C₁)</td>
<td>Offer variety of aggregate by-product products to existing and new customer base</td>
</tr>
<tr>
<td>(AD₁P₅₂₁₁C₁)</td>
<td>Target profitable customers of by-product aggregate to the additional customer base</td>
</tr>
<tr>
<td>(AD₁P₅₂₁₁C₁)</td>
<td>Add new slate aggregate by-products in the supply chain product mix to increase profits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD₁S₁C₁)</th>
<th>Supply chain brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD₁S₁₁C₁)</td>
<td>Develop new supply chain brand</td>
</tr>
<tr>
<td>(AD₁S₁₁C₁)</td>
<td>Brand the supply chain according to the by-product family</td>
</tr>
</tbody>
</table>
### Supply chain and economy of scale

<table>
<thead>
<tr>
<th>(AD1S2C1)</th>
<th>Develop supply chain economy of scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1S2FP1C1)</td>
<td><strong>Utilise the waste product to match commercial demand</strong></td>
</tr>
<tr>
<td>(AD1S2FP1FI1C1)</td>
<td>Manage continuous movement of the waste by-product</td>
</tr>
<tr>
<td>(AD1S2FP1FI1A1C1)</td>
<td>Create higher product turnover to develop sales of scale</td>
</tr>
<tr>
<td>(AD1S2FP1FI1A2C1)</td>
<td>Reduce the production cost through utilising the stockpiled reserves</td>
</tr>
</tbody>
</table>

### Demand planning

<table>
<thead>
<tr>
<th>(AD1S3C1)</th>
<th>Plan by-product demand for long term advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1S3FP1C1)</td>
<td><strong>Forecast the by-product demand at multiple locations</strong></td>
</tr>
<tr>
<td>(AD1S3FP1FI1C1)</td>
<td>Perform additional market research to identify multiple demand locations</td>
</tr>
<tr>
<td>(AD1S3FP1FI1A1C1)</td>
<td>Use scenario planning to forecast the demand in different locations</td>
</tr>
<tr>
<td>(AD1S3FP1FI1A2C1)</td>
<td>Determine product price elasticity</td>
</tr>
<tr>
<td>(AD1S3FP1FI1A3C1)</td>
<td>Identify effective demand planning and forecasting tools</td>
</tr>
</tbody>
</table>

### Production cost

<table>
<thead>
<tr>
<th>(AD1S4C1)</th>
<th>Minimise cost of sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1S4FP1C1)</td>
<td><strong>Brand the supply chain as commercialising green by-product (according to multiple product families)</strong></td>
</tr>
</tbody>
</table>

#### Production cost

- **Forecast the supply chain cost implications when forecasting demand**
  - Forecast the supply chain cost from different transport modes
  - Promote a collaboration between the companies involved in the supply chain operations
  - Increase price elasticity by road to rail shift
  - Plan demand with building different costs (road/rail/multimodal) in the supply chain

#### Furtherующие пояснения

- **Demand planning**
  - **Plan by-product demand for long term advantages**
    - **Forecast the by-product demand at multiple locations**
      - Perform additional market research to identify multiple demand locations
      - Use scenario planning to forecast the demand in different locations
      - Determine product price elasticity
      - Identify effective demand planning and forecasting tools
  - **Consider the supply chain cost implications when forecasting demand**
    - Forecast the supply chain cost from different transport modes
    - Promote a collaboration between the companies involved in the supply chain operations
    - Increase price elasticity by road to rail shift
    - Plan demand with building different costs (road/rail/multimodal) in the supply chain

- **Production cost**
  - **Minimise cost of sales**
    - Brand the supply chain as commercialising green by-product (according to multiple product families)
    - Utilise the waste product to match commercial demand
    - Manage continuous movement of the waste by-product
    - Create higher product turnover to develop sales of scale
    - Reduce the production cost through utilising the stockpiled reserves
    - Forecast the supply chain cost implications when forecasting demand
      - Forecast the supply chain cost from different transport modes
      - Promote a collaboration between the companies involved in the supply chain operations
      - Increase price elasticity by road to rail shift
      - Plan demand with building different costs (road/rail/multimodal) in the supply chain

#### Additional Notes

- **Consider the supply chain cost implications when forecasting demand**
  - Forecast the supply chain cost from different transport modes
  - Promote a collaboration between the companies involved in the supply chain operations
  - Increase price elasticity by road to rail shift
  - Plan demand with building different costs (road/rail/multimodal) in the supply chain
<table>
<thead>
<tr>
<th>(AD1S4FP1f1C1)</th>
<th><strong>Minimise the cost of sold slate by-product</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1S4FP1f1A1C1)</td>
<td>Keep low cost of slate materials by focusing the sales process on price, quality, service and reliability as a supplier</td>
</tr>
<tr>
<td>(AD1S4FP1f1A2C1)</td>
<td>Keep the cost of extraction at minimum</td>
</tr>
<tr>
<td>(AD1S4FP2C1)</td>
<td><strong>Reduce the by-product cost margin</strong></td>
</tr>
<tr>
<td>(AD1S4FP2f1iC1)</td>
<td><strong>Reduce the cost margin by optimising the usage of the by-product</strong></td>
</tr>
<tr>
<td>(AD1S4FP2f1A1C1)</td>
<td>Off-set the cost of operations with profits from sales of the by-product</td>
</tr>
<tr>
<td>(AD1S4FP2f1A1C1)</td>
<td>Operate using optimal roofing slate production capacity</td>
</tr>
<tr>
<td>(AD1S4FP2f1A1C1)</td>
<td>Operate using optimal level of sales of the by-product</td>
</tr>
<tr>
<td>(AD1S4FP3C1)</td>
<td><strong>Reduce asset cost</strong></td>
</tr>
<tr>
<td>(AD1S4FP3f1iC1)</td>
<td><strong>Reduce the asset cost through outsourcing</strong></td>
</tr>
<tr>
<td>(AD1S4FP3f1A1C1)</td>
<td>Prevent disruption in business by outsourcing services from low cost high reliability companies</td>
</tr>
<tr>
<td>(AD1S5C1)</td>
<td><strong>Supply chain potential</strong></td>
</tr>
<tr>
<td>(AD1S5FP1C1)</td>
<td><strong>Maximise the supply and usage of the by-product</strong></td>
</tr>
<tr>
<td>(AD1S5FP1f1iC1)</td>
<td><strong>Maximise the potential of slate aggregate to offset demand and supply in existing aggregate markets</strong></td>
</tr>
<tr>
<td>(AD1S5FP1f1A1C1)</td>
<td>Create value added by selling by-product from other operations</td>
</tr>
<tr>
<td>(AD1S5FP1f1A2C1)</td>
<td>Look for ways to sell the slate aggregate as sub ballast material for building roads</td>
</tr>
<tr>
<td>(AD1S5FP1f1A3C1)</td>
<td>Look for ways to sell the slate aggregate product for sea defences</td>
</tr>
<tr>
<td>(AD1S5FP1f1A4C1)</td>
<td>Look for ways to sell high volumes of slate aggregate as environmentally friendly brick for building houses or fences</td>
</tr>
</tbody>
</table>
### Supply chain volume

<table>
<thead>
<tr>
<th>Area of Decision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase sale volumes</td>
<td>Look for selling the slate aggregate product for a number of other potential usages</td>
</tr>
<tr>
<td>Increase the sales volume of slate aggregate by-products</td>
<td>Add virtual quarries in multiple locations close to the markets</td>
</tr>
<tr>
<td></td>
<td>Grow with the demand for aggregates in the current market</td>
</tr>
<tr>
<td></td>
<td>Produce sustainable amount of slate aggregate by-product to match high volumes demand</td>
</tr>
<tr>
<td></td>
<td>Comply with the industry quality requirement</td>
</tr>
</tbody>
</table>

### Supply chain education

<table>
<thead>
<tr>
<th>Area of Decision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educate and develop</td>
<td>Educate and develop the supply chain skills of the workforce</td>
</tr>
<tr>
<td></td>
<td>Provide training to improve the impact of the workforce</td>
</tr>
<tr>
<td></td>
<td>Develop a Rail Skills Academy</td>
</tr>
<tr>
<td></td>
<td>Develop Engineering Academy</td>
</tr>
</tbody>
</table>

### Supply chain innovation

<table>
<thead>
<tr>
<th>Area of Decision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation in new materials</td>
<td>Pursue innovation in new materials from the slate aggregate by-product</td>
</tr>
<tr>
<td></td>
<td>Create our own innovative products from the aggregate</td>
</tr>
<tr>
<td></td>
<td>Pursue innovative product usage in high demand aggregate materials</td>
</tr>
<tr>
<td></td>
<td>Test the by-product suitability to be used in high demand aggregate materials</td>
</tr>
</tbody>
</table>

### Area of Decision

<table>
<thead>
<tr>
<th>Area of Decision</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Principle</td>
<td>Imperative</td>
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<tr>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>(AD1P1C2)</td>
<td>Market</td>
</tr>
<tr>
<td>(AD1P1FP1C2)</td>
<td>Market analysis</td>
</tr>
<tr>
<td>(AD1P1FP1FI1C2)</td>
<td>Analyse the market for secondary aggregates</td>
</tr>
<tr>
<td>(AD1P1FP1FI1A1C2)</td>
<td>Reach agreement with the supply chain consortium on performing additional new market analysis of secondary aggregates (by-products) consumption</td>
</tr>
<tr>
<td>(AD1P1FP1FI1A2C2)</td>
<td>Jointly with the consortium determine the aggregates market profitability considering the aggregate levy</td>
</tr>
<tr>
<td>(AD1P1FP1FI1A3C2)</td>
<td>Agree with the consortium on performing additional market analysis of the existing secondary aggregate markets (volumes, prices, etc.)</td>
</tr>
<tr>
<td>(AD1P1FP1FI1A4C2)</td>
<td>Reach agreement with the consortium on performing additional market analysis of aggregates consumption in urban centres (subject to distance and cost)</td>
</tr>
<tr>
<td>(AD1P1FP1FI2C2)</td>
<td>Have a product variety</td>
</tr>
<tr>
<td>(AD1P1FP1FI2A1C2)</td>
<td>Make sure the supply chain is considered in product assortment decisions</td>
</tr>
<tr>
<td>(AD1P1FP1FI2A1C2)</td>
<td>Grow awareness throughout the market of the potential variety from slate aggregate product family</td>
</tr>
<tr>
<td>(AD1P2C2)</td>
<td>Supply chain network planning</td>
</tr>
<tr>
<td>(AD1P2FP1C2)</td>
<td>Market network focusing</td>
</tr>
<tr>
<td>(AD1P2FP1FI1C2)</td>
<td>Establish target market areas for the supply chain network</td>
</tr>
<tr>
<td>(AD1P2FP1FI2A1C2)</td>
<td>Jointly with the consortium determine the market network for aggregates (current and future)</td>
</tr>
<tr>
<td>(AD1P2FP1FI2A2C2)</td>
<td>Use existing tools and data to forecast the market network growth rate</td>
</tr>
<tr>
<td>(AD1P3C2) Supply chain engineering technology</td>
<td></td>
</tr>
<tr>
<td>(AD1P3FP1C2) Provide supply chain engineering technology</td>
<td></td>
</tr>
<tr>
<td>(AD1P3FP1FI1C2) Engineer the supply chain from production line to distribution centre</td>
<td></td>
</tr>
<tr>
<td>(AD1P3FP1FI2A1C2) Build the supply chain infrastructure from quarry to distribution centre</td>
<td></td>
</tr>
<tr>
<td>(AD1P3FP1FI2A2C2) Design the supply chain conveyor belt from slate heaps to crushing machinery</td>
<td></td>
</tr>
<tr>
<td>(AD1P3FP1FI2A3C2) Establish on site crushing and screening equipment</td>
<td></td>
</tr>
</tbody>
</table>

| (AD1P3C2) Product assessment engineering capability |
| (AD2P3FP1C2) Assess available reserves |
| (AD2P3FP1FI1C2) Make sure of the available reserves |
| (AD2P3FP1FI2A1C2) Review and assessment of available reserves of slate waste owned by Llechwedd |
| (AD2P3FP1FI2A2C2) Establish that the available reserve is of sufficient and consistent quality |
| (AD2P3FP1FI2A3C2) Perform technical assessment of the available reserves for producing the chosen products |

| (AD3P3C2) Supply chain engineering infrastructure |
| (AD3P3FP1C2) Develop supply chain engineering infrastructure |
| (AD3P3FP1FI1C2) Engineer the supply chain bulk excavation and infrastructure |
| (AD3P3FP1FI2A1C2) Build supply chain engineering infrastructure with creativity and innovation |
| (AD3P3FP1FI2A2C2) Strip and re-deposit slate waste to create new infrastructure profile for the supply chain |
| (AD3P3FP1FI2A3C2) Use the site strip, map and sample method to ensure wider picture of the site and protect heritage sites |
### Supply chain renewables and energy engineering

**Engineer sustainable supply chain future**

- Manage the complex logistics of working over large expanses in remote areas
- Construct access roads to accommodate abnormal loads, turbine foundations, substation buildings and electrical infrastructure
- Construct eco-control centre at the site

### Supply chain waste management

**Develop land restoration solutions**

- Engineer safe and cost-effective waste management scheme
- Develop the mining supply chain associated infrastructure and recycling facilities
- Engineer safe and cost-effective construction and operation of a landfill site
- Site to creative use

**Handle competently the reclamation of brownfield sites**

- Handle competently the reclamation of brownfield sites
- Handle competently contaminated sites with dangerous substances
- Provide skills and practised for restoring brownfield such sites innovatively, safely and economically.

### Supply chain land remediation

**Land remediation strategy for the supply chain**

- Develop process for reclamation of brownfield sites for the supply chain
- Handle competently the reclamation of brownfield sites
- Handle competently contaminated sites with dangerous substances
- Provide skills and practised for restoring brownfield such sites innovatively, safely and economically.

### Aftermarket opportunities management

**Make sound aftermarket decisions**
<table>
<thead>
<tr>
<th>Area of Problems</th>
<th>Problem Narative</th>
<th>Solution concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply chain transportation from depot and terminals</td>
<td>Ensure the most efficient transportation mode solution that meets the quarry requirements</td>
<td>Encourage the use of rail freight transportation whenever possible, Encourage the use of multimodal freight transportation whenever possible, Schedule inbound deliveries and coordinate with the quarry and virtual quarries</td>
</tr>
<tr>
<td>Supply chain technology</td>
<td>Provide supply chain technology</td>
<td>Utilise our supply chain technology, Offer our broad portfolio of engineering services, Help in cost reduction through sharing maintenance services, Offer our variety of mechanical repairmen services</td>
</tr>
<tr>
<td>Logistics services for supply chain capability</td>
<td>Provide high quality logistics services</td>
<td></td>
</tr>
<tr>
<td>(AD2P2FP1FI1C3)</td>
<td><strong>Maximise the use of company resources</strong></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>(AD2P2FP1FI1A1C3)</td>
<td>Continually improve rail freight fill rate</td>
<td></td>
</tr>
<tr>
<td>(AD2P2FP1FI1A2C3)</td>
<td>Provide know-how in managing the cost of transportation</td>
<td></td>
</tr>
<tr>
<td>(AD2P2FP1FI1A3C3)</td>
<td>Ensure the product arrives in the highest quantity per shipment possible</td>
<td></td>
</tr>
<tr>
<td>(AD2P2FP1FI1A4C3)</td>
<td>Deliver to customers within the promised dates</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD3P2C3)</th>
<th><strong>Supply chain infrastructure quality</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD3P2FP1C3)</td>
<td><strong>Reduce delivery disruptions</strong></td>
</tr>
<tr>
<td>(AD3P2FP1FI1C3)</td>
<td><strong>Increase rate of delivery through our chain of terminal</strong></td>
</tr>
<tr>
<td>(AD3P2FP1FI1A1C3)</td>
<td>Continually improve rail freight fill rate</td>
</tr>
<tr>
<td>(AD3P2FP1FI1A2C3)</td>
<td>Ensure the product arrives in the highest quantity per shipment possible</td>
</tr>
<tr>
<td>(AD3P2FP1FI1A3C3)</td>
<td>Enable continuous supply and delivery to customers in urban areas</td>
</tr>
<tr>
<td>(AD3P2FP1FI2C3)</td>
<td><strong>Increase the quantity of products shipped through our chain of terminals</strong></td>
</tr>
<tr>
<td>(AD3P2FP1FI2A1C3)</td>
<td>Use multimodal logistics to handle rail containers with products</td>
</tr>
<tr>
<td>(AD3P2FP1FI2A2C3)</td>
<td>Ensure machinery to handle the product volume appropriately</td>
</tr>
<tr>
<td>(AD3P2FP1FI3C3)</td>
<td><strong>Be friendly to environment</strong></td>
</tr>
<tr>
<td>(AD3P3FP1FI3A1C3)</td>
<td>Ensure appropriate rail delivery when possible</td>
</tr>
<tr>
<td>(AD3P2FP1FI3A2C3)</td>
<td>Operate in a safe and environmentally responsible manner</td>
</tr>
<tr>
<td>(AD3P2FP1FI3A3C3)</td>
<td>Time rail shipments of by-product to non-peak passenger hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD1P3C3)</th>
<th><strong>Supply chain relations</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P3FP1C3)</td>
<td><strong>Improve customer relations</strong></td>
</tr>
<tr>
<td>(A1P3FP1FI1C3)</td>
<td>Continually improve service by integrating transport modes</td>
</tr>
<tr>
<td>(AD1P3FP1FI1A1C3)</td>
<td>Deliver world class transport and logistics service through integrating the transport modes</td>
</tr>
<tr>
<td>(AD1P3FP1FI1A2C3)</td>
<td>Ensure appropriate road to rail shift when achievable</td>
</tr>
<tr>
<td>(AD1P3FP1FI1A3C3)</td>
<td>Prevent disruptions in transportation process through keeping continuous supply in the virtual quarries</td>
</tr>
<tr>
<td>(AD1P3FP1FI1A4C3)</td>
<td>Fulfil delivery of logistics and transport expectations through avoiding to make unachievable commitments</td>
</tr>
</tbody>
</table>

**Terminal maintenance and supply chain freight flow**

| (AD1P4FP1FI1C3) | Manage the supply chain freight flow |
| (AD1P4FP1FI1A1C3) | Continually improve service level by integrating road, rail and sea transport |
| (AD1P4FP1FI1A2C3) | Deliver reliably even in the face of disruptions by developing understanding of the potential disruptions |
| (AD1P4FP1FI1A3C3) | Promote road to rail shift as priority for carbon and cost mitigation |
| (AD1P4FP1FI1A4C3) | Prevent disruptions in transportation process through keeping the flexibility provided by road transport |
| (AD1P4FP1FI1A4C3) | Manage in a professional manner all the cross-function tasks |

**Supply chain network of virtual quarries**

<p>| (AD2P4FP1FI1C3) | Virtual quarries on our network of terminals |
| (AD2P4FP1FI1A1C3) | Maintain and continually improve operations through virtual quarries |
| (AD2P4FP1FI1A1C3) | Understand how virtual quarries operations are done today |
| (AD2P4FP1FI1A2C3) | Identify opportunities for improvement in virtual quarries operations |
| (AD2P4FP1FI1A3C3) | Reduce cost of terminal operations through virtual quarries |
| (AD2P4FP1FI1A4C3) | Implement improvements in the operations and communications between the quarry and the virtual quarries |</p>
<table>
<thead>
<tr>
<th>(AD\textsuperscript{3}P\textsubscript{4}C\textsubscript{3})</th>
<th><strong>Supply chain proximity</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD\textsuperscript{3}P\textsubscript{4}FP\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Close proximity to our terminals</strong></td>
</tr>
<tr>
<td>(AD\textsuperscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Increase our network of strategically located terminals</strong></td>
</tr>
<tr>
<td>(AD\textsuperscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1A1}C\textsubscript{3})</td>
<td>Offer product delivery in the UK main markets</td>
</tr>
<tr>
<td>(AD\textsuperscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1A2}C\textsubscript{3})</td>
<td>Ensure machinery to handle the product volume appropriately</td>
</tr>
<tr>
<td>(AD\textsuperscript{3}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1A3}C\textsubscript{3})</td>
<td>Design online communication facilities: allow the transportation company to include comments and include delivery conditions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD\textsuperscript{4}P\textsubscript{4}C\textsubscript{3})</th>
<th><strong>Supply chain market demand planning</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD\textsuperscript{4}P\textsubscript{4}FP\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Plan the freight transport demand</strong></td>
</tr>
<tr>
<td>(AD\textsuperscript{4}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Have a suitable structure for freight flows demand</strong></td>
</tr>
<tr>
<td>(AD\textsuperscript{4}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1A1}C\textsubscript{3})</td>
<td>Plan the demand by using information from multiple sources (from the supply chain consortium)</td>
</tr>
<tr>
<td>(AD\textsuperscript{4}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1A2}C\textsubscript{3})</td>
<td>Develop a consensus with the supply chain consortium of demand forecasted</td>
</tr>
<tr>
<td>(AD\textsuperscript{4}P\textsubscript{4}FP\textsubscript{1}FI\textsubscript{1A3}C\textsubscript{3})</td>
<td>Conduct an annual demand forecast for by-product freight flows on our operating terminals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD\textsuperscript{1}P\textsubscript{5}C\textsubscript{3})</th>
<th><strong>Supply chain integration</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD\textsuperscript{1}P\textsubscript{5}FP\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Integrate our supply chain</strong></td>
</tr>
<tr>
<td>(AD\textsuperscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Integrate work in projects with other companies</strong></td>
</tr>
<tr>
<td>(AD\textsuperscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1A1}C\textsubscript{3})</td>
<td>Continually improve our capabilities through the chain of terminals</td>
</tr>
<tr>
<td>(AD\textsuperscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1A2}C\textsubscript{3})</td>
<td>Integrate operations to achieve new freight flows in the strategically located terminals</td>
</tr>
<tr>
<td>(AD\textsuperscript{1}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1A3}C\textsubscript{3})</td>
<td>Take ownership of the tasks allocated to perform in the collaborative supply chain project</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD\textsuperscript{2}P\textsubscript{5}C\textsubscript{3})</th>
<th><strong>Multimodal supply chain</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD\textsuperscript{2}P\textsubscript{5}FP\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Integrate in multimodal supply chain</strong></td>
</tr>
<tr>
<td>(AD\textsuperscript{2}P\textsubscript{5}FP\textsubscript{1}FI\textsubscript{1}C\textsubscript{3})</td>
<td><strong>Integrate work in projects with other companies</strong></td>
</tr>
</tbody>
</table>
### Supply chain storage

**Problem Narative**

*Provide storage for continuous distribution through our terminal network.*

**Solution concept**

- Integrate multimodal distribution to the virtual quarries

### Area of Problems

**Problem recognition**

**Problem Narative**

**Solution concept**

### Supply chain technology

**Problem recognition**

**Problem Narative**

**Solution concept**

- Continually focus on reducing supply chain technological shortages
- Develop and understand how and why the supply chain is short of rail technology
- Develop mitigation plan for enabling supply chain rail technology (smaller longer trains)
- Develop awareness of the supply chain technological benefit
- Promote raising value awareness of the technical benefits from the by-product supply chain
- Develop technology for communication between quarry, virtual quarries and other long term by-product markets
- Provide the quarry with timely and continuous updates of the supply chain and the virtual quarry operations
<table>
<thead>
<tr>
<th>AD2P1FP1C4</th>
<th>Improve the supply chain capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD2P1FP1F1C4</td>
<td>Maintain and improve the by-product supply chain capabilities</td>
</tr>
<tr>
<td>AD2P1FP1F1A1C4</td>
<td>Understand how the by-product supply chain will contribute to our rail freight capabilities</td>
</tr>
<tr>
<td>AD2P1FP1F1A2C4</td>
<td>Identify areas for improvement of the by-product supply chain capabilities</td>
</tr>
<tr>
<td>AD2P1FP1F1A2C4</td>
<td>Ensure effectiveness of the supply chain capabilities</td>
</tr>
<tr>
<td>AD2P1FP1F2A1C4</td>
<td>Raise awareness of our capabilities and their value for the supply chain</td>
</tr>
<tr>
<td>AD2P1FP1F2A2C4</td>
<td>Develop new methods to apply our supply chain capabilities for the slate mining industry</td>
</tr>
<tr>
<td>AD2P1FP1F2A3C4</td>
<td>Provide the quarry with timely and continuous rail freight transport to the virtual quarries and other markets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AD3P1C4</th>
<th>Supply chain infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD3P1FP1C4</td>
<td>Improve the supply chain infrastructure</td>
</tr>
<tr>
<td>AD3P1FP1F1C4</td>
<td>Continually pursue opportunities to increase rail line infrastructure</td>
</tr>
<tr>
<td>AD3P1FP1F1A1C4</td>
<td>Develop understanding of how the old rail line can be upgraded for supply chain operations</td>
</tr>
<tr>
<td>AD3P1FP1F1A2C4</td>
<td>Develop understanding of how the closed line can be purchased</td>
</tr>
<tr>
<td>AD3P1FP1F2C4</td>
<td>Develop reputation of promoting rail heritage values</td>
</tr>
<tr>
<td>AD3P1FP1F2A1C4</td>
<td>Investigate how the closed lines will benefit the supply chain and the local community</td>
</tr>
<tr>
<td>AD3P1FP1F2A2C4</td>
<td>Develop passenger trains and by-product rail freight on the closed heritage lines</td>
</tr>
<tr>
<td>AD3P1FP1F2A3C4</td>
<td>Provide stores timely and continuous updates of the supply chain and how it affects store operations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AD3P2C4</th>
<th>Supply chain relations</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD3P2FP1C4</td>
<td>Improve the experience delivered by the supply chain</td>
</tr>
<tr>
<td>(AD1P2FP1FI1C4)</td>
<td>Develop supply chain heritage value for the community</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>(AD1P2FP1FI1A1C4)</td>
<td>Campaign to raise awareness of value of the supply chain</td>
</tr>
<tr>
<td>(AD1P2FP1FI1A2C4)</td>
<td>Develop a two-way communication with franchisees</td>
</tr>
<tr>
<td>(AD1P2FP1FI1A3C4)</td>
<td>Provide park and ride services to offset supply chain costs</td>
</tr>
</tbody>
</table>

**Supply chain integration**

<table>
<thead>
<tr>
<th>(AD2P2FP1C4)</th>
<th>Participate in the slate by-product supply chain integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD2P2FP1FI1C4)</td>
<td>Integrate with the slate by-product supply chain consortium</td>
</tr>
<tr>
<td>(AD2P2FP1FI1A1C4)</td>
<td>Develop integration strategy for participating with the supply chain consortium</td>
</tr>
<tr>
<td>(AD2P2FP1FI1A2C4)</td>
<td>Develop mitigation plan for integration obstacles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD2P2FP1FI2C4)</th>
<th>Develop relationships with the supply chain consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD2P2FP1FI2A1C4)</td>
<td>Allocate a representative to attend meetings at the quarry</td>
</tr>
<tr>
<td>(AD2P2FP1FI2A2C4)</td>
<td>Develop means for communication with the supply chain participants</td>
</tr>
<tr>
<td>(AD2P2FP1FI2A3C4)</td>
<td>Provide the supply chain consortium with detailed solutions for the rail infrastructure obstacles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD1P3C4)</th>
<th>Supply chain freight flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P3FP1C4)</td>
<td>Explore potential supply chain rail freight flows</td>
</tr>
<tr>
<td>(AD1P3FP1FI1C4)</td>
<td>Develop supply chain rail freight</td>
</tr>
<tr>
<td>(AD1P3FP1FI1A1C4)</td>
<td>Develop plans for rail freight flows that would bypass the tunnelling obstacles</td>
</tr>
<tr>
<td>(AD1P3FP1FI1A2C4)</td>
<td>Develop plan for delivering the by-product to the virtual quarries</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD1P3FP1FI2C4)</th>
<th>Develop value for the community</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P3FP1FI2A1C4)</td>
<td>Develop passenger train service on closed heritage line</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD2P3C4)</th>
<th>Supply chain market</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD2P3FP1C4)</td>
<td>Improve market access</td>
</tr>
<tr>
<td>(AD2P3FP1F1C4)</td>
<td>Ensure most effective access to distant markets</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(AD2P3FP1F1A1C4)</td>
<td>Eliminate perception within the supply chain that speed to market is related to delivery rate (in related context)</td>
</tr>
<tr>
<td>(AD2P3FP1F1A2C4)</td>
<td>Develop facilities for returning recycling products on the reversed journey</td>
</tr>
<tr>
<td>(AD2P3FP1F1C4)</td>
<td>Investigate market potential in existing regions of operations</td>
</tr>
<tr>
<td>(AD2P3FP1F1A1C4)</td>
<td>Investigate potential for reducing cost of running trains by loading slate by-product on return to base journeys</td>
</tr>
<tr>
<td>(AD2P3FP1F1A2C4)</td>
<td>Investigate loading recycling materials on the train journey to quarry</td>
</tr>
<tr>
<td>(AD2P3FP1F1A3C4)</td>
<td>Investigate other potential freight trade between regions</td>
</tr>
</tbody>
</table>

**Supply chain proximity**

<table>
<thead>
<tr>
<th>(AD1P4FP1C4)</th>
<th>Improve the supply chain proximity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P4FP1F1C4)</td>
<td>Investigate potential proximity to the supply chain</td>
</tr>
<tr>
<td>(AD1P4FP1F1A1C4)</td>
<td>Investigate potential base in Blaenau</td>
</tr>
<tr>
<td>(AD1P4FP1F1A2C4)</td>
<td>Investigate potential base in the closed rail station</td>
</tr>
</tbody>
</table>

**Transport cost**

<table>
<thead>
<tr>
<th>(AD2P4FP1C4)</th>
<th>Improve the supply chain cost of transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD2P4FP1F1C4)</td>
<td>Keep the cost of transport minimal</td>
</tr>
<tr>
<td>(AD2P4FP1F1A1C4)</td>
<td>Reach agreement for keeping the cost of transport minimal to reach break even point</td>
</tr>
<tr>
<td>(AD2P4FP1F1A2C4)</td>
<td>Investigate alternative cargo to reduce cost of transport</td>
</tr>
<tr>
<td>(AD2P4FP1F1C4)</td>
<td>Operate using optimal transport capabilities</td>
</tr>
<tr>
<td>(AD2P4FP1F1A1C4)</td>
<td>Run only fully loaded trains</td>
</tr>
<tr>
<td>(AD2P4FP1F1A2C4)</td>
<td>Avoid unnecessary train journeys</td>
</tr>
</tbody>
</table>

**Multimodal supply chain**

<table>
<thead>
<tr>
<th>(AD1P5FP1C4)</th>
<th>Anticipate and prepare for supply chain disruptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P5FP1F1C4)</td>
<td>Anticipate rail transport disruptions</td>
</tr>
<tr>
<td>(AD1P6C4)</td>
<td>Supply chain maintenance and repair</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>(AD1P6FP1C4)</td>
<td>Manage supply chain maintenance and repair</td>
</tr>
<tr>
<td>(AD1P6FP1FI1C4)</td>
<td>Manage maintenance and repair of rail lines</td>
</tr>
<tr>
<td>(AD1P6FP1FI1A1C4)</td>
<td>Manage maintenance and repair of our purchased rail lines</td>
</tr>
<tr>
<td>(AD1P6FP1FI1A2C4)</td>
<td>Investigate outsourcing expertise's to related parties in the region</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD1P7C4)</th>
<th>Supply chain process</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P7FP1C4)</td>
<td>Encourage jointly defined supply chain processes</td>
</tr>
<tr>
<td>(AD1P7FP1FI1C4)</td>
<td>Encourage the supply chain process integration</td>
</tr>
<tr>
<td>(AD1P7FP1FI1A1C4)</td>
<td>Define scope of operations to eliminate conflict of interest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD2P7C4)</th>
<th>Transloading</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD2P7FP1C4)</td>
<td>Transloading cost</td>
</tr>
<tr>
<td>(AD2P7FP1FI1C4)</td>
<td>Manage transloading to reduce cost</td>
</tr>
<tr>
<td>(AD2P7FP1FI1A1C4)</td>
<td>Provide assistance in transloading of products between rail and other modes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD3P7C4)</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD3P7FP1C4)</td>
<td>Improve fleet management</td>
</tr>
<tr>
<td>(AD3P7FP1FI1C4)</td>
<td>Improve rail fleet management</td>
</tr>
<tr>
<td>(AD3P7FP1FI1A1C4)</td>
<td>Provide sufficient freight cars for the shipping needs</td>
</tr>
<tr>
<td>(AD3P7FP1FI1A2C4)</td>
<td>Assist the supply chain with repairs and program to modify cars</td>
</tr>
</tbody>
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<th>C 5</th>
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<tbody>
<tr>
<td>(AD1P1C5)</td>
</tr>
<tr>
<td>(AD1P1FP1C5)</td>
</tr>
<tr>
<td>(AD1P1P1F1I1C5)</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>(AD1P1P1F1I1A1C5)</td>
</tr>
<tr>
<td>(AD1P1P1F1I1A2C5)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD2P1C5)</th>
<th><strong>Profits</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD2P1P1C5)</td>
<td><strong>Increase profits</strong></td>
</tr>
<tr>
<td>(AD2P1P1F1I1C5)</td>
<td><strong>Increase profits from the Brownfield site</strong></td>
</tr>
<tr>
<td>(AD2P1P1F1I1A1C5)</td>
<td>Outsource the site to develop virtual quarry for easier transloading</td>
</tr>
<tr>
<td>(AD2P1P1F1I1A2C5)</td>
<td>Increase profits through outsourcing the recycling plant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD1P2C5)</th>
<th><strong>Market power</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD1P2P1C5)</td>
<td><strong>Improve market power</strong></td>
</tr>
<tr>
<td>(AD1P2P1F1I1C5)</td>
<td><strong>Investigate product families to increase market power</strong></td>
</tr>
<tr>
<td>(AD1P2P1F1I1A1C5)</td>
<td>Develop freight movements for high turnover market (sub-ballast, sea defences)</td>
</tr>
<tr>
<td>(AD1P2P1F1I1A2C5)</td>
<td>Target the road building market</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD2P2C5)</th>
<th><strong>Existing market</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD2P2P1C5)</td>
<td><strong>Maximise potential</strong></td>
</tr>
<tr>
<td>(AD2P2P1F1I1C5)</td>
<td><strong>Maximise potential of existing markets</strong></td>
</tr>
<tr>
<td>(AD2P2P1F1I1A1C5)</td>
<td>Inform existing markets of the potential products from the by-product family</td>
</tr>
<tr>
<td>(AD2P2P1F1I1A2C5)</td>
<td>Brand the products from the by-product family to maximise potential</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(AD3P2C5)</th>
<th><strong>Maximise value</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(AD3P2P1C5)</td>
<td><strong>Improve understanding</strong></td>
</tr>
<tr>
<td>(AD3P2P1F1I1C5)</td>
<td><strong>Improve understanding of the by-product specifications</strong></td>
</tr>
<tr>
<td>(AD3P2P1F1I1A1C5)</td>
<td>Develop material to promote the product physical and chemical characteristics</td>
</tr>
</tbody>
</table>
(AD1P3CS) **Supply chain infrastructure**

| (AD1P3FP1CS) | Improve the supply chain infrastructure |
| (AD1P3FP1FI1CS) | Address the distribution problem |
| (AD1P3FP1FI1A1CS) | Provide site for building the by-product distribution centre |

(AD1P4CS) **Brand**

| (AD1P4FP1CS) | Improve the by-product brand |
| (AD1P4FP1FI1CS) | Develop new brand names |
| (AD1P4FP1FI1A1CS) | Pattern multiple slate by-product brand names |

(AD1P5CS) **Multimodal supply chain**

| (AD1P5FP1CS) | Improve transport |
| (AD1P5FP1FI1CS) | Distribute through multimodal transport |
| (AD1P5FP1FI1A1CS) | Provide site for a distribution centre with the capability for rail and road transport of the by-product |

(AD2P5CS) **Supply chain freight flow**

| (AD2P5FP1CS) | Increase freight flow |
| (AD2P5FP1FI1CS) | Reach break even point and aim for a profitable freight flow |
| (AD2P5FP1FI1A1CS) | Pursue strategy of 'burning gold' until profitable freight flows are reached |

Table F-1: Hierarchical concept summary map – framework