Designing a Conceptual Framework to Investigate the Influences of Sustainability on Demand Chain Studying New Product Development in Manufacturing Sector

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A thesis submitted in partial fulfilment of the requirements of the University of Greenwich for the Degree of Doctor of Philosophy

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I dedicate this thesis to

The queen of my heart

My lovely & beautiful Mom

Mrs Akram Babaei

DECLARATION

I certify that the work contained in this thesis, or any part of it, has not been accepted in substance for any previous degree awarded to me or any other person, and is not concurrently being submitted for any other degree other than that of Doctor of Philosophy which has been studied at the University of Greenwich, London, UK.

I also declare that the work contained in this thesis is the result of my own investigations, except where otherwise identified and acknowledged by references. I further declare that no aspects of the contents of this thesis are the outcome of any form of research misconduct.

I declare any personal, sensitive or confidential information/data has been removed or participants have been anonymised. I further declare that where any questionnaires, survey answers or other qualitative responses of participants are recorded/included in the appendices, all personal information has been removed or anonymised. Where University forms (such as those from the Research Ethics Committee) have been included in appendices, all handwritten/scanned signatures have been removed.

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ABSTRACT

Industrialisation has resulted in global competition requiring businesses to enhance their products and services to survive. Besides, the global climate emergency and sustainability challenges are not issues to be taken lightly. Industrial activities can play a critical role in mitigating environmental impacts. Manufacturing corporations as well as their entire supply chain stakeholders are accountable for taking action and seeking innovative solutions towards sustainability. In this respect, consumers, as end-users of distribution networks, are no exception, especially in light of the emerging circular economy (CE) concept. Consumer empowerment has resulted in the emergence of a new demand chain management (DCM) system to replace the traditional supply chains. In this situation, there is uncertainty regarding the sustainable preferences of consumers and their willingness to pay premium prices. This is where the impact of sustainability on both new product development (NPD) and DCM becomes critical for further research. Several studies have been conducted to examine the relationship between DCM and NPD, as well as the influence of sustainability on both. However, the issue of how the three concepts interact has remained unsolved.

This research initially conducts a systematic review of literature consisting of 75 resources to provide a profound review of previous academic efforts and examine the possible associations between the main three study concepts. A qualitative case study analysis of four manufacturing companies from various global locations provides the input data for this study. Through content analysis and categorisation of qualitative data into final themes, this study ultimately develops a conceptual research framework. The generated framework highlights the sustainability influences on DCM and NPD as promised by the main study aim. It comprises four stages, starting with preliminary planning for sustainability and its influence on demand-driven product development, which then continues with innovative manufacturing and environmental management. Some moderating variables within different stages modify the relationships between dependant and independent variables. The final dependent variable and the output of the framework is NPD success, brand image, reputation, and competitive advantage, which describe the key benefits of associating sustainability with DCM and NPD.

This study used four qualitative case studies to shed some light on the implications of sustainability for demand-driven product development. However, to overcome the limited target population, future researchers may conduct surveys to obtain a larger statistical sample. Furthermore, a longitudinal study would be beneficial to ensure the long-term benefits of sustainability applications within DCM and NPD contexts.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AM	Additive Manufacturing
ASEAN	Association of Southeast Asian Nations
BOT	Build-Operate-Transfer
B2B	Business to Business
CEO	Chief Executive Officer
CF	Customer Focus
CIA	Chemical Industries Association
CI	Customer Involvement
CIMO	Context, Interventions, Mechanisms, Outcomes
COVID	Coronavirus Disease
CSR	Corporate Social Responsibility
CSV	Creating Shared Value
DCM	Demand Chain Management
DDSC	Demand-Driven Supply Chain
DT	Design Thinking
ED	Endocrine Disruptor
EDI	Electronic Data Interchange System
EMS	Environmental Management System
ERP	Enterprise Resource Planning
EU	European Union
GPDP	Green Product Development Projects
HDPE	High-density Polyethylene
JIT	Just in Time
LCA	Life Cycle Assessment
MN	Market Newness
NHS	National Health Service in UK
NPD	New Product Development
NRBV	Natural-Resource-Based View
OEM	Original Equipment Manufacturer
OSCM	Operations and Supply Chain Management
PDA	Personal Digital Assistant
POS	Point of Sale
R&D	Research and Development
ROI	Return on Investment
RVB	Resource-based View
SAS	Statistical Analysis System
SC	Supply Chain
SCC	Supply Chain Council
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference
SDCM	Sustainable Demand Chain Management
SDS	Safety Data Sheet
SME	Small and Medium-sized Enterprise
SMOI	Social Media-Driven Inbound Open Innovation
SMP	Strategic Market Plan
SNPD	Sustainable New Product Development
SO	Sustainable Orientation

SPD	Sustainable Product Design
SSCM	Sustainable Supply Chain Management
SSCP	Sustainable Supply Chain Performance
SSN	Sustainable Supply Network
TBL	Triple Bottom Line
TN	Technological Newness
TRL	Technology Readiness Level
UNCSD	United Nations Commission on Sustainable Development
UREC	University Research Ethics Committee
USP	Unique Selling Proposition
UV	Ultraviolet
VC	Vice-Chancellor
VRIN	Valued, Rare, Inimitable, Non-substitutable resources
VRIO	Valuable, Rare, Inimitable, Organization
WBCSD	World Business Council for Sustainable Development
WTP	Willingness to Pay

CHAPTER ONE: INTRODUCTION

This chapter provides a prelude to the fundamental components of this study. It identifies why the role of sustainability is significant within demand chain management (DCM) and manufacturing environments, specifically new product development (NPD) projects. The chapter outlines the research aim and objectives as well as the research scope and plan.

1.1 Research Background

"To worship the product and ignore its development leads to dilettantism and reaction" (Perl, 2014). In present day-to-day changing demands, a key enabler of growth in the industrial competition would be research and development (R&D) optimisation and boosting innovation to introduce new products and services to the market. With the beginning of industrialisation, companies started exploiting economies of scale by mass production and delivery of high order volumes worldwide. In the meantime, globalisation enabled companies to integrate and interconnect to international economies and also support shareholders to benefit from global sourcing, reduction of costs and increase of sales. Besides, globalisation has brought severe competition both within the national and international scale that cause the companies and organisations to continually enhance their services and products to be able to survive within the markets (Hanson et al., 2016). Such developments range from shortening product lifecycles, improving market research practices, developing manufacturing design and processes to changing their organisational structure and even altering the entire distribution networks. Due to all the additional management challenges, it seems that markets are getting disorganised and unpredictable (Christopher and Peck, 2004), leading business executives to strategize, plan and adopt new approaches within supply chain processes. This necessitates the creation of project teams, strong support of senior managers and the allocation of extra time and budget to ensure the success of development projects.

Despite the significant advantages of NPD approaches, a massive number of products face failure while entering to market (Markham and Lee, 2013). Therefore, companies are now becoming more aware of adopting efficient SCM strategies, and this requires the establishment of internal collaboration and teamwork between all the internal entities of the firm including the NPD team, R&D, manufacturing team, commercial and marketing departments. On a broader aspect, associations between the company, its global suppliers and potential markets play a vital role as external strategies towards NPD success. The interrelation between supply chain management (SCM) and NPD is broadly deliberated through the literature, which provides inclusive input data for further studies.

Researchers and practitioners are now considering customers and markets as valuable sources of external knowledge while asking for their engagement into NPD processes from the very early stages (Menguc et al., 2014; Feng et al., 2016; Tan and Tracey, 2007; Ogawa and Piller, 2006). In this context, the demand-driven chain is still in its infancy as a novel concept to be integrated with the supply chain concept. This concept is entitled DCM and some authors believe that it addresses the synergies between marketing and SCM activities leading to greater competitive advantages for the companies (Mentzer et al., 2001; Hilletofth et al., 2009).

Furthermore, in recent years, sustainability has gained significance as a major knowledge topic. This is due to the increased consideration to emerging concepts such as corporate social responsibility (CSR), climate emergency and also sustainable development, often known as triple bottom line (TBL) of sustainability including conservation of people, planet, and profits (Elkington, 1997). In this regard, a critical review of the demand chain was presented by Santos and D'Antone (2014). This study calls for further research to explore DCM through the vital scenario of sustainability to understand how the marketing – as an essential part of NPD projects and DCM operations – could contribute to business sustainability (Santos and D'Antone, 2014). Given this, it is essential to investigate the applications of sustainability within broader aspects of NPD and also DCM to reduce the NPD failures and to become more customer responsive in the context of the demand-driven supply chain. Due to rapidly evolving technology trends and increasing customer expectations; this research attempts to focus on the dynamic "demand" concept where all the supply chain stakeholders consider the consumers through a specific integrated lens.

Unlike SSCM, SDCM is a novel concept and not significantly studied within the literature which necessitates further investigations to replace the traditional supply chain structures and to clarify the rising theory on DCM within SSCM especially through product development projects (Vural, 2015). There has been a lack of academic sources investigating the influence of sustainability on both DCM and NPD, and this makes the novel contribution of this study. The need behind the linkage of these three concepts is firstly the importance of sustainability. Secondly, the customer-oriented supply chains which are nowadays the key to business success and thirdly, the importance of NPD projects which is highly dependent on customer involvement and satisfaction.

1.2 Research Scope

The scope of this study is on “Incorporation of sustainability dimensions with DCM and NPD” that is considered by all the business ecosystem entities to facilitate the product portfolio novelty and to create unique competitive advantages. One of the most important components of this project is its emphasis on DCM as a revolutionary idea in the supply chain area. The main concepts of this research are shown in Figure 1.1. This study will investigate the influence of sustainability on both DCM and NPD. However, it also seeks to fulfil the gaps within the SDCM concept due to the current gaps within its context.

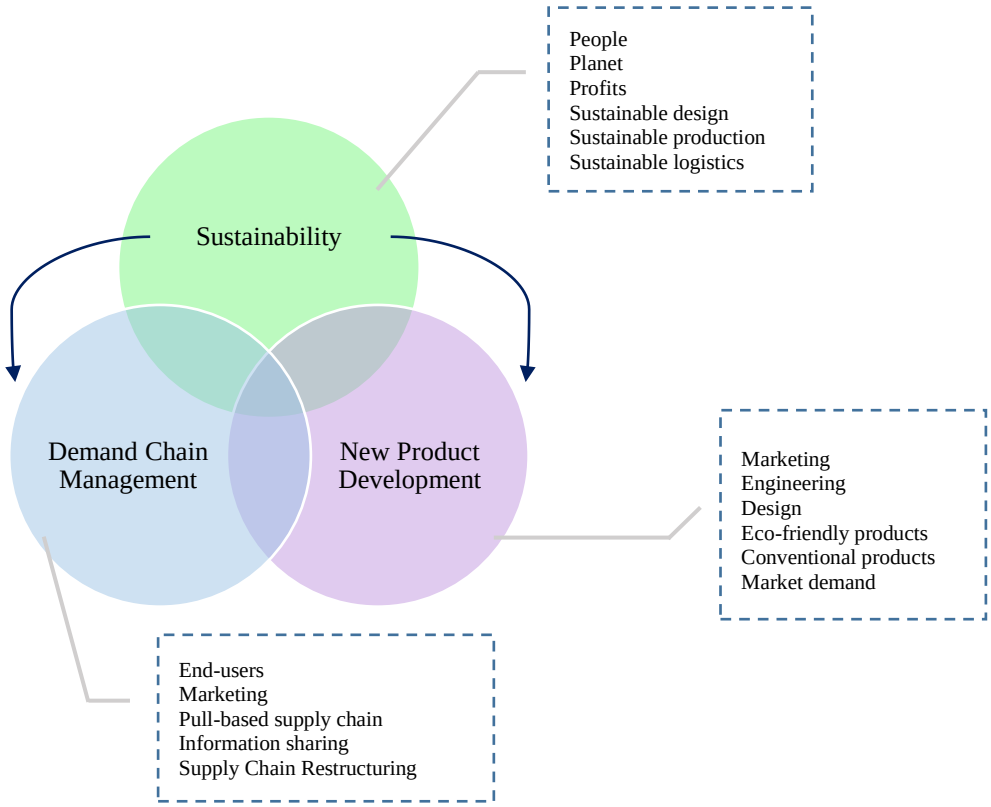

Figure 1.1 Main Research Pillars

The study will be initialised based on a systematic review of literature and practices, followed by case study investigations in collaboration with relevant manufacturing companies. The companies need to be familiar with the research concepts and also be practising the defined approaches to a certain level to be able to act as respondents to the research questions. The key limitations of this study are the access to those companies which are fully experienced regarding the research concepts, and since these companies are usually large enterprises, it can be an obstacle to be able to approach them and obtain desired data relevant to this research.

1.3 Research Questions

An initial set of questions will help to make a foundation for initialising the research. The following questions have been derived as a result of the primary pilot research on the main three research components of sustainability, DCM, and NPD.

RQ1) *What is the driving role of sustainability towards NPD?*

RQ2) *What is the driving role of sustainability towards DCM?*

RQ3) *What is the relationship between a demand-driven chain and the marketing pillar of NPD?*

RQ4) *Considering the driving roles of sustainability, what are the interrelationships between the three research components?*

1.4 Aim and Objectives

The research aim is to investigate the interrelationships between DCM, NPD and sustainable practices with the intention of understanding and managing the risks associated with NPD failures and business success.

Based on the formulated research questions and to fulfil the research aim, the following objectives are defined:

1. To examine the applications of sustainable practices within NPD projects of manufacturing organisations through an empirical study;
2. To examine the applications of sustainable practices within the context of DCM;
3. To evaluate the barriers associated with the applications of sustainability within both NPD and DCM, and how to minimise them;
4. To develop a conceptual framework illustrating the interrelationships between research concepts to assist organisations towards minimising the DCM and NPD failures as a result of sustainability adoption.

1.5 Research Plan

To fulfil the defined objectives, a four-stage research plan is developed as shown in Figure 1.2. The final outputs of each stage are shown as deliverables and milestones.

Stage (1) – Preliminary Research

According to Stage 1 of the research, the research is well-planned and initiated through the PhD Gantt chart. It will be attempted to follow the schedule as much as possible based on the aims and objectives identified within the early stages. A systematic literature review based on five stages attempts to better synthesise and analyse the literature. The main areas investigated within the literature are including sustainability, SCM and DCM distinction, sustainable DCM, NPD, sustainable NPD, DCM and its linkage to NPD. As evident, the main deliverable of this stage would be the MPhil-PhD transfer.

Stage (2) – Research Methodology and Data Collection

This stage covers the study design, methodology development and data collection. Hence, it is required to select the most appropriate research methodology approach based on the conditions and facilities of the research. The interview questionnaire needs to be designed based on literature studies. Data collection will be based on case study investigations. The main deliverable of this stage would be the case study report.

Stage (3) – Case study Analysis and Framework Development

This stage includes the analysis of case studies and the critical discussions linking the study findings and the literature review. This is the key stage towards concluding the research results, summing up the research outputs from all the previous stages and comparing the case study results with the studies of previous authors. The researcher will be able to generate the final research framework and elaborate on the research limitations and future recommendations at the end of this stage.

Stage (4) – Final Thesis Preparation

The ultimate stage of the study is the final write-up indicating the procedures and details from the start to the end of the study. Within this stage, the researcher will also prepare for the submission of final RDA forms as well as the VIVA examination. A comprehensive research paper, including the whole thesis chapters, will be submitted to a relevant journal at this stage to present the research outputs.

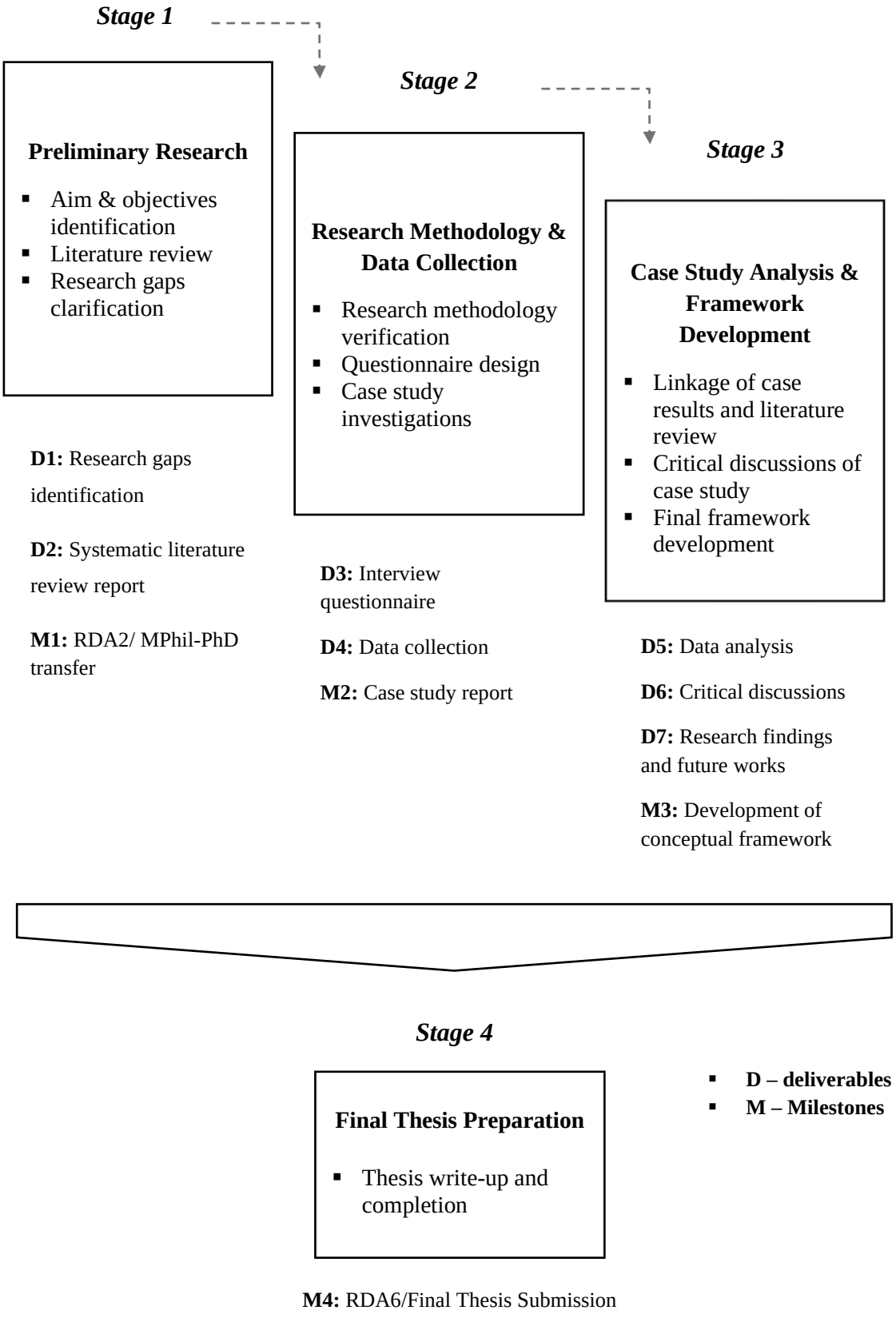

Figure 1.2 Research Plan

1.6 Contributions of the Research

Based on the research plan outlined above, this study makes use of existing information and data to make original contributions to knowledge. This includes a systematic review of literature, content analysis, data categorisation, identification of key themes and the final conceptual research framework. The key contributions can lay the groundwork for future research projects by interested scholars and practitioners.

1.7 Structure of the Thesis

This thesis is structured into six chapters as follows:

Chapter 1 provides background information regarding the main research concepts. It also highlights the initial motivation and the rationale behind the study. The specific research aim and objectives were clearly outlined, and finally, an overview of the research plan and structure was presented to the reader.

Chapter 2 conducts a critical study through a systematic literature review within the scope of our research concepts. Review of similar studies and published empirical findings play a vital role in making a proper foundation to identify the potential gaps and fulfilling them within the later stages of this study.

Chapter 3 describes the research methodology employed by the researcher to address the research objectives identified earlier. Using the research onion concept, the philosophical approach, research methods and the relative advantages of each method were explained.

Chapter 4 provides information regarding the company backgrounds and presents the gathered data from the case study investigations.

Chapter 5 analyses the data derived from case study investigations through cross-case analysis and makes a critical discussion of the research findings through content analysis.

Chapter 6 presents the generated conceptual research framework as the main research output based on the case study findings.

Chapter 7 summarises the research findings and reflects upon the extent to which the research objectives are fulfilled. The positive and negative outcomes of the research were elaborated using in-depth commentary on the results of the work. Recommendations for future research based on the limitations of this research were also presented to help rectify the identified problems by future researchers.

CHAPTER TWO: LITERATURE REVIEW

This chapter provides an overview of academic literature regarding the research concepts as well as their interrelationships. Utilising a systematic review method, the most relevant studies and key papers were extracted and further discussed to find the final research gaps. Figure 2.1 illustrates the different procedures in this chapter.

Figure 2.1 Flow of Literature Review Chapter

2.1 Systematic Literature Review Procedures

The researcher seeks to conduct a structured, multi-dimensional, robust and focused review process as a basis to establish findings, develop methods, and finally address gaps in a methodical manner (Moher et al., 2009). In a classic definition, a systematic review is defined as being responsible for "Integrating a number of different works on the same topic, summarising the common elements, contrasting the differences, and extending the work in some fashion" (Meredith, 1993). Therefore, a systematic review method was utilised to identify, synthesize and appraise the high-quality research findings while minimising the bias (Tranfield et al., 2003). Figure 2.2 indicates 5 steps for undertaking the systematic review as recommended by (Khan et al., 2003; Denyer and Tranfield, 2009). The following section will discuss how to formulate a question as a first step. The next steps will be followed in the subsequent sections accordingly.

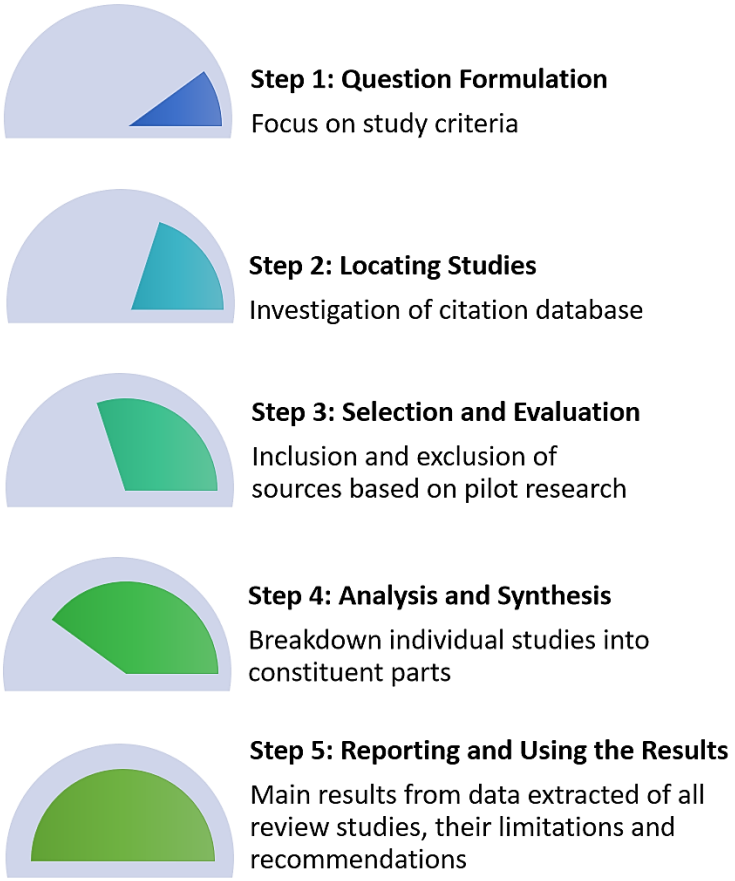

Figure 2.2 Systematic Review Steps (Khan et al., 2003)

2.1.1 Question Formulation Based on CIMO Logic

The initial research questions (RQ) are previously mentioned in section 1.4. However, according to Khan et al (2003), there is a need to formulate a set of literature review questions (LRQ) to help initiate the systematic review. Towards formulating these questions, CIMO logic will be followed as recommended by Denyer et al. (2008).

As Rousseau et al. (2008) stated, the systematic review highlights the "Comprehensive accumulation, transparent analysis and reflective interpretation of all empirical studies pertinent to a specific question". In management studies, it is not only necessary to understand what works, but also to ensure why, how and in what circumstances it occurs. The realist approach of Pawson (2006) requires the determination of context, mechanism and outcomes through comparison of mediations in different settings. This approach provides the opportunity to include different types of studies, as long as they provide some details about what works, why, where, and when. Denyer et al. (2008) further developed this method utilising the acronym CIMO (Context, Interventions, Mechanisms, Outcomes) to identify the relations and

circumstances between different works. This logic provides a mechanistic view by comparison of different perspectives that can be used to specify the four critical parts of a well-structured systematic review question (Denyer et al., 2008). This scoping study is prescribed to less experienced authors to produce a well-grounded scope of their field (Tranfield et al., 2003). Table 2.1 indicates the application of CIMO logic towards structuring the literature review questions. This contextual framework provides a proper foundation for the synthesis and report of key results from the systematic literature review.

Table 2.1 Applied CIMO Logic Structuring Review Questions (Denyer et al., 2008)

Component	Description	CIMO logic applied to research
Context (C)	Identified entities of interest (What conditions)	• Manufacturing industries • Entities engaged in NPD (Design, engineering, marketing) • Supply chain stakeholders, especially customers • Purchasing department • Marketing department • Society
Interventions (I)	Intervention of interest/ Solution (What intervention/solution)	• Efficient leadership style • Budgets for innovative market research and marketing • Sustainable attitudes • Customer engagement within NPD
Mechanisms (M)	Mechanisms to be adopted (How)	• Implementation of demand chain practices • Collaborative supply chain • Innovative marketing
Outcomes (O)	Primary and secondary outcomes	• Market responsive supply chain • Successful NPD projects • Business prosperity and profitability

As the aim of this research suggests, the researcher seeks to understand the interrelationships between DCM, NPD and sustainable practices. Moreover, as the research topic suggests, the influence of sustainability on the demand-driven chain and NPD success is under examination. Therefore, by applying the CIMO logic in Table 2.1 (Denyer et al., 2008), the main literature review questions can be described as "*Under what conditions (Context), does sustainability influence (Interventions) influence the performance of DCM and NPD performance? What mechanisms (Mechanism) operate in the influence of sustainable practices (Interventions) on DCM and NPD success (Outcome)?* In other words, it can be interpreted as to uncover the

conditions (when and where), explain the mechanisms (how) by which the concept of sustainability influences DCM and NPD, and theorise an explanation (why).

In order to fill research gaps, questions need to be defined in a clear and sensible manner. Given the multi-dimensional challenges within demand-driven supply chains and their contribution towards sustainability as well as the successful launching of new products, this systematic review seeks to address the following questions:

LRQ1. What are the dominant frameworks/theories currently employed within the SSCM, SDCM and SNPD domain?

LRQ2. How can these frameworks/theories impact the success of NPD projects within manufacturing industries?

LRQ3. What would be the limitations, strengths and future recommendations towards the influence of sustainability on DCM and NPD?

2.1.2 Locating Studies – Database and Resource Selection

This is the initial step within gathering the sources for systematic literature. To ensure that the study results have considered all the available evidence and information, comprehensive literature searches are required (Denyer and Tranfield, 2009). For this research, SCOPUS is selected as a search database despite the wide variety of other databases such as Web of Science, ScienceDirect, Google Scholar, etc. The reason for this selection was mainly due to the broad coverage of academic sources in SCOPUS (Thelwall, 2018). As an example, a SCOPUS search on “sustainable supply chain” produced 883 initial results from 2000 till the present, while the same search on Web of Science produced 509 results. Likewise, a search for “demand chain” produced 90 initial results on SCOPUS compared to 59 on Web of Science. Moreover, there are many debates regarding overall data quality in Google Scholar (Mongeon and Paul-Hus, 2016). This search is conducted based on five different categories of words (as search strings) within the main research concepts as shown in Table 2.2.

Table 2.2 Initial Search within SCOPUS

Search strings used in SCOPUS	Initial results (2000-2020)
"Demand chain" OR "demand-driven" AND "supply chain"	76
"Sustainable demand chain" OR "sustainab*" AND "demand chain"	1 (not on SCOPUS)
"Sustainable supply chain" OR "green supply chain" OR "sustainab*" AND "supply chain"	1766
"New product development" OR "NPD" OR "sustainable product development" OR "green product development"	1780
"Premium price" AND "green" OR "premium price" AND "eco-friendly" OR "premium price" AND "sustainab*" OR "price" AND "green" OR "sustainab*"	89
Total	3712

The initial search on SCOPUS started considering some filters. To improve the efficiency of research and to create the search strings, the Boolean logical operators (AND/OR/AND NOT) were used for all the possible combinations of the keywords. The search database applied filters such as article title, business, management and accounting disciplines and English language only between 2000-2020 as some of the inclusion protocols (Table 2.3). The selected research timeframe was due to the increasing research interests on the concept of sustainability and TBL in the early 2000s. Premium price has been included within the search strings, since it has been the most controversial aspect of green industries especially from the end-users' point of view. There are many debates in academia that are being updated from time to time regarding the influential level of premium price in customer buying behaviours (e.g., Drozdenko et al., 2011; Chekima et al., 2016; Guyader et al., 2017). Based on an experimental study, it was revealed that lowering the price gap between eco-friendly and traditional products through retail brands can highly influence consumers to buy greener (Guyader et al., 2017).

Following the application of all the filters, a total number of 3712 initial sources were originated from the entire database search – survey updated in May 2020. This large number is due to the wide range of research concepts that needs to be narrowed down within the screening steps. Besides, since the online databases only account for around 30% of the relevant data within any

field (Greenhalgh and Peacock, 2005), the authors also examined other sources from books, workshops, industrial reports, authentic websites in addition to the systematic review sources. However, 68% of the sample sources (51 out of 75) were published between 2010 and 2020, which shows the remarkable increase of the research significance within the last decade.

Table 2.3 Literature Review Inclusion Protocol

Criteria	Rationale
Period	2000-2020
Language	English
Availability	Full-text of article available online
Research discipline	Business, management and accounting
Study relevance criteria	Do articles correspond to the research aim and objectives? Do the articles help address the research gaps and answer the literature review questions?
Corresponding to CIMO Logic	To what extent, how, why and under what conditions do sustainable practices influence the success of DCM and NPD projects?
Publication type	Peer-reviewed journals or conference papers
Types of articles (theoretical, empirical, literature review or industrial reports)	The focus of this study is to evaluate and analyse various approaches within research concepts.

2.1.3 Selection and Evaluation of Studies

It has been recommended that the PRISMA flow diagram be used to illustrate the filtration process of study databases. The PRISMA flow diagram was created to assist researchers in improving the reporting of systematic reviews and meta-analyses (Moher et al., 2009). However, it should be noted that PRISMA is not necessarily a tool to evaluate the quality assessment of the systematic review (Moher et al., 2009).

After the initial search on SCOPUS, the titles, keywords and abstracts of all the papers were screened. This process is considered as a stage that provides an explicit selection criterion of papers to enable addressing the review question and maintaining the transparency of systematic reviews (Denyer and Tranfield, 2009). Afterwards, according to Table 2.3, the inclusion criteria were adopted to evaluate if the papers can address the required domain and ultimate purpose of the study. As a result, a total number of 201 articles were selected for full-text assessment based on literature review protocols. However, the main aim of this stage is to evaluate and find the papers for eligibility and to identify if they meet the main literature review questions derived from CIMO logic: "*To what extent, how, why and under what conditions do sustainable practices influence the success of DCM and NPD projects?".* Finally, 126 papers were excluded

and based on two screening processes, a total number of 75 sources were deemed appropriate to be included in the systematic review within the last 20 years. The PRISMA diagram and its relevant procedures are indicated in Figure 2.3.

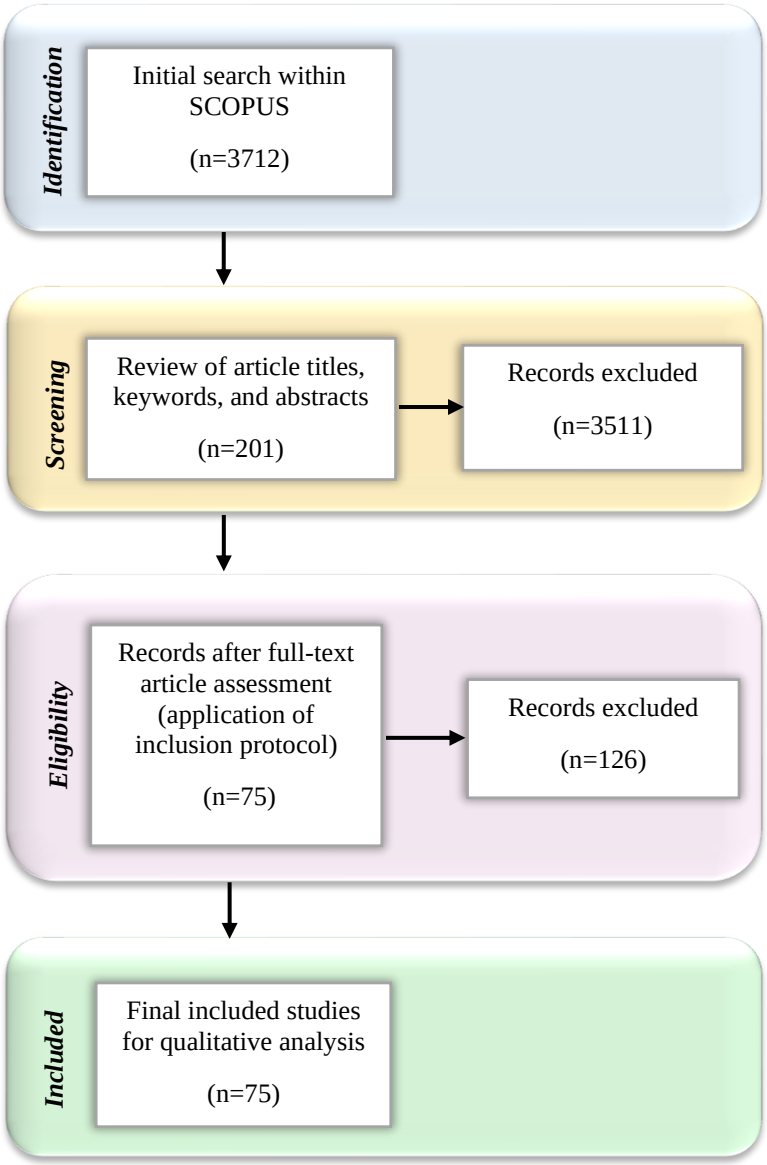

Figure 2.3 Selection and Evaluation of Database – PRISMA Flow Diagram (Adapted from Moher et al., 2009)

2.1.4 Literature Analysis and Synthesis

Data analysis and synthesis of the sources arise after gathering the relevant set of paper documents. This would be a key step within the systematic review since its main purpose is to make an integration between different individual research studies rather than investigating each of them in isolation. It would also enable the authors to develop arrangements towards a classified and inclusive summary demonstration of the study field (Denyer and Tranfield, 2009). In doing so, the researcher categorised the main study aspects into four factors including the year of publication, study design, focused paradigms and economic/industrial sector. Afterwards, the authors transferred and investigated a summary of each of the 75 sources (basically the abstract and conclusion) into a Microsoft Excel spreadsheet in order to extract the summary of each under the main categories as identified in Table 2.4. Finally, the entire article analysis and categorisation are illustrated in Table 2.5.

Table 2.4 Categories Utilised in Analysing Data in Systematic Review

Feature	Category
Description	Author Year of Publication Country of First Author's Affiliation Title of Journal/Conference/Book/Organisation
Focused Paradigm	Supply Chain Management Demand Chain Management New Product Development (NPD) Sustainability o General view o People o Planet o Profit
Article Classification + *Study Design*	Research Paper o Model construction o Model/framework/data testing o Market research o Empirical/scientific research Viewpoint o Authors' interpretation, e.g., journalistic pieces Technical Paper o Evaluation of technical products, processes or services Conceptual Paper o Hypothesis development Case study o Legal case o Hypothetical case Literature Review o General review o Historical examination Mixed Methods
Economic/ Industrial Sector	The sector that the paper seeks to investigate (if any).

Table 2.5 Article Analysis and Categorisation

Author	Year	Study Design	Focused Paradigm							Economic/ Industrial Sector
			Supply/demand chain	SSCM/ SDCM	NPD	Sustainability				
						General view	People	Planet	Profit	
Krishnan and Ulrich	2001	Conceptual paper	×		×					-
Childerhouse et al.	2002	Case study	×							Lighting company
Frohlich and Westbrook	2002	Research paper	×							UK Manufacturing and service companies
Heikkilä	2002	Case study	×							Nokia
Pujari et al.	2003	Research paper			×			×		British manufacturers
De Treville et al.	2004	Research paper	×							Pulp and paper company
Rainbird	2004	Research paper	×		×					McDonald's
Berchicci and Bodewes	2005	Literature review			×			×		-
Petersen et al.	2005	Research paper	×		×					US manufacturers
Ogawa and Piller	2006	Case study	×		×					Customer-based industries
Walters	2006	Research paper	×							Zara
Jüttner et al.	2007	Conceptual paper	×							-
Linton et al.	2007	Literature review	×	×		×				-
Tan and Tracey	2007	Research paper	×		×					US manufacturers
Van Hoek and Chapman	2007	Conceptual paper	×		×					Three companies
Carter and Rogers	2008	Conceptual paper	×	×		×				-
Charlebois	2008	Research paper	×							Canadian food industry
Seuring and Müller (a)	2008	Conceptual paper	×	×		×				-
Seuring and Müller (b)	2008	Research paper	×	×		×				Different organisations
Walters	2008	Research paper	×							Boeing
Badurdeen et al.	2009	Research paper	×	×				×		-
Hilletofth et al.	2009	Case study	×		×					Swedish appliance industry
Liao and Wen	2009	Research paper	×		×					Taiwanese bicycle manufacturer
Mu et al.	2009	Research paper			×					Chinese manufacturers
Tang and Zimmerman	2009	Case study	×		×					Boeing Dreamliner
Chien and Chen	2010	Research paper	×		×					Financial services
Crippa et al.	2010	Research paper	×		×					Italian electrical appliances
Gold et al.	2010	Literature review	×	×		×				-
Carter and Easton	2011	Literature review	×	×		×	×	×	×	-
Drozdenko et al.	2011	Conceptual paper	×		×			×	×	Green products
Gavronski et al.	2011	Research paper	×	×		×		×		Canadian manufacturers
Hilletofth and Eriksson	2011	Case study	×		×					Swedish appliance manufacturer
Agrawal	2012	Research paper	×							Automobile, consumer durables, and FMCG
Göçer et al.	2012	Mixed method	×	×		×		×		-
Hassini et al.	2012	Literature review	×	×						-

Table 2.5 Continued

Author	Year	Study Design	Focused Paradigm							Economic/ Industrial Sector
			Supply/ demand chain	SSCM/ SDCM	NPD	Sustainability				
						General view	People	Planet	Profit	
Walker and Jones	2012	Research paper	×	×		×	×	×		Multiple retailers
Zailani et al.	2012	Research paper	×	×		×	×	×	×	Malaysian manufacturing firms
Brockhaus et al.	2013	Research paper	×	×		×				US & Europe companies
Markham and Lee	2013	Research paper	×		×					453 worldwide companies
Beske and Seuring	2014	Research paper	×	×		×				-
Chong and Zhou	2014	Research paper	×							256 healthcare companies
Christopher and Ryals	2014	Conceptual paper	×							-
Gligor	2014	Conceptual paper	×							-
Gmelin and Seuring	2014	Conceptual paper			×			×		-
Machado et al.	2014	Conceptual paper			×	×				-
Ortas et al.	2014	Research paper	×	×		×	×	×	×	Diverse sample of 3900 companies
Santos and D'Antone	2014	Mixed method	×							-
Schaltegger and Burritt	2014	Conceptual paper	×	×		×				-
Vinayak and Kodali	2014	Research paper			×					Indian manufacturing industries
Martinich	2015	Viewpoint			×					-
Meixell and Luoma	2015	Literature review	×	×		×	×	×		-
Touboulic and Walker	2015	Literature review	×	×		×				-
Vural	2015	Research paper	×	×	×	×				-
Du et al.	2016	Research paper			×	×				Product Development & Management Association
Feng et al.	2016	Research paper	×		×					Chinese manufacturers
Katsikeas et al.	2016	Research paper	×		×	×		×		UK manufacturers
Chekima et al.	2016	Research paper	×					×		-
Mahmood and Kess	2016	Case study	×		×	×				Fashion industry
Mendes et al.	2016	Research paper	×		×					Beverage industry
Nafisi et al.	2016	Conceptual paper	×		×					Heavy automotive industry
Rocca et al.	2016	Case study	×		×					A longitudinal single case study
Bumblauskas et al.	2017	Literature review	×							-
Gao et al.	2017	Literature review	×	×		×				-
Nakamba et al.	2017	Literature review	×	×		×	×			SMEs
Scur and Barbosa	2017	Research paper	×	×	×	×		×		Brazilian home appliance industry
Stindt	2017	Research paper	×	×		×				-
Tolonen et al.	2017	Research paper	×		×					Hardware, software and service company
Kalish et al.	2018	Mixed method			×			×		69 LinkedIn individuals and 22 companies
Mores et al.	2018	Case study		×	×		×			Brazilian petrochemical industry
Ye and Lau	2018	Research paper	×							Chinese fashion apparel industry
Andalib Ardakani and Soltanmohammadi	2019	Research paper		×	×		×			91 participants within Iranian industries
Cooper	2019	Conceptual paper			×					-
Pinheiro	2019	Literature review			×			×		-
Redante	2019	Literature review	×		×			×		-
Sajjad et al.	2020	Research paper	×			×				23 New Zealand-based companies

2.1.5 Reporting and Using the Results

The following tables and charts present the evidence of statistical analysis of the extracted sources from Table 2.5.

- **Year of Publication**

As evident, the DCM and NPD concepts are not recent within the literature, and there are many classic sources from the early 2000s. However, sustainability-related concepts are more recent, especially the relationship between sustainability and the demand chain, which is a novel theme within the literature. Notably, only one paper exists as a very early conceptual effort towards an understanding of SDCM. This paper combines marketing and DCM perspectives with SSCM with the aim of sustainable value creation within the supply chain (Vural, 2015). Figure 2.4 classifies the selected literature sources based on the year of publication.

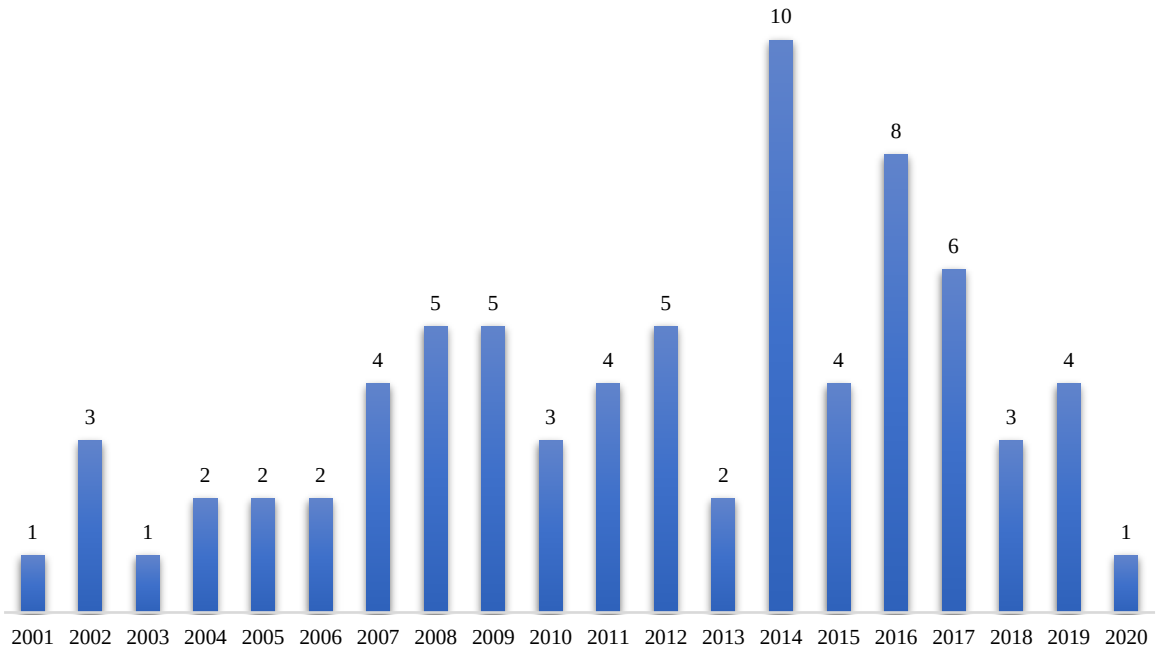

Figure 2.4 Number of Studies Included in Systematic Review During 2000-2020

- **Classification of Articles**

Several methodologies are utilised by the selected literature sources. Figure 2.5 illustrates the most utilised methodologies within the study concepts with the majority of research papers, conceptual papers and literature review with 49%, 19% and 16% respectively. The article analysis indicates that few articles were generated in the form of mixed methods and viewpoints. As discussed in Chapter Four, the nature and conditions of this research also necessitate generating a research paper within the form of framework/model development based on case study analysis.

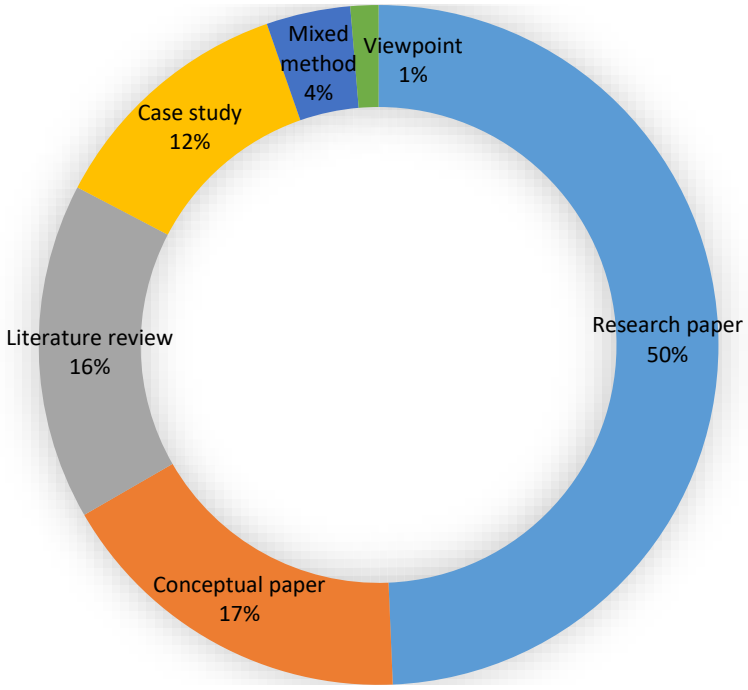

Figure 2.5 Classification of Study Types and Methodologies

- **First Authors' Affiliation**

Considering the geographic diffusion of the entire sources, authors from 19 countries have contributed to the whole resource documents from almost all the continents. The USA, UK, Germany and Brazil are counted for a large number of articles in the investigated field with 18%, 12% and 10% respectively. This indicates that developed countries with advanced economies such as the US, UK and Germany have generated more articles on this topic and account for approximately 40% of the total papers. Other countries such as Australia, Malaysia and Finland reached the lower steps. The diverse range of institutions' locations indicates a widespread interest regarding the main research concepts of this research.

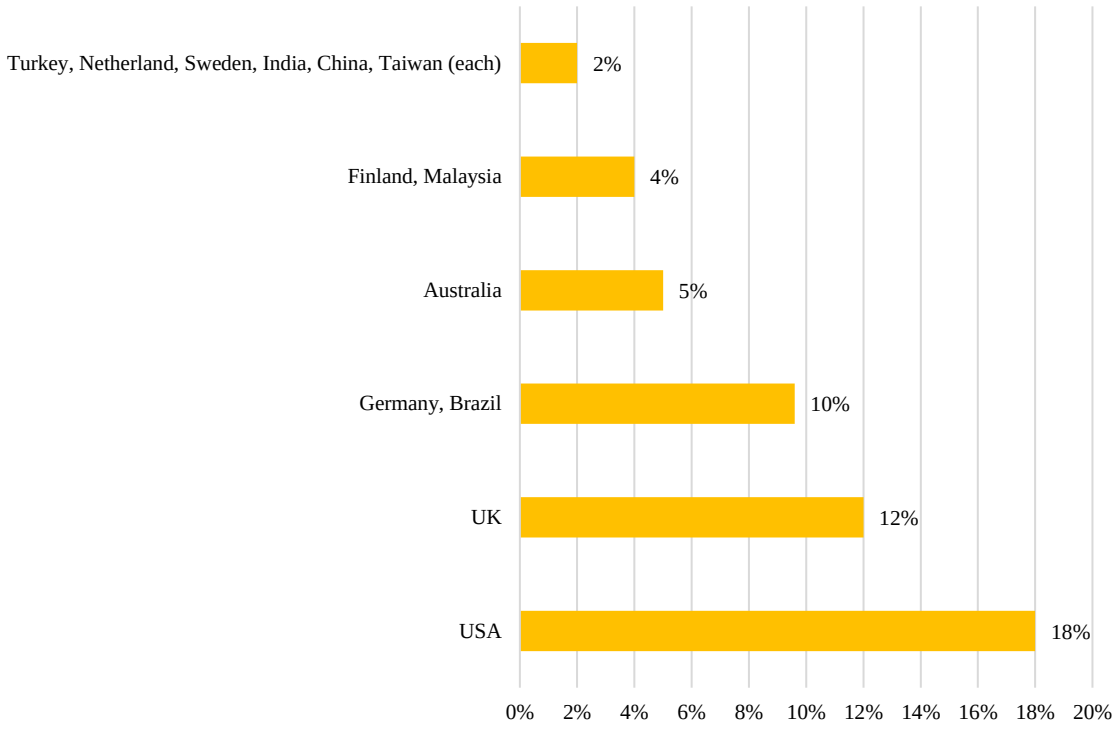

Figure 2.6 First Author's Institutions' Nationality

- **Top Article Sources**

The 75 sources included in this study were published in 31 different journals and conferences. This designates the broad inclusion of the study concepts and their high level of application within various domains of manufacturing industries, logistics, economy and environmental management fields. Table 2.6 presents the five leading journals within the study field. As obvious, the top journals with the highest shares towards source provision of this study include Journal of Cleaner Production, Journal of Operations Management, International Journal of Physical Distribution and Logistics Management, Supply Chain Management: an International Journal and International Journal of Production Economics that all represent high impact factors.

Table 2.6 Top Five Academic Journal Sources

Journal title	Number of papers	Percentage out of 75
Journal of Cleaner Production	7	9.3%
Journal of Operations Management	6	8%
International Journal of Physical Distribution and Logistics Management	6	8%
Supply Chain Management: an International Journal	6	8%
International Journal of Production Economics	4	5.3%

- **Focused Paradigms**

Researchers and practitioners are now considering customer experience and market segments as valuable sources of external knowledge while asking about their engagement in NPD processes from the early stages. Moreover, the applications of sustainability dimensions are widely discussed within NPD. Demand innovation is still in its infancy as a novel notion to be integrated with the supply chain idea. DCM is thought to address the synergies between marketing and SCM efforts, resulting in a higher competitive advantage. Besides, unlike sustainable supply chain (SSCM), sustainable demand chain (SDCM) is a novel concept and briefly studied within the literature. The reason for less consideration of the DCM concept in literature is probably because the demand chain is included as an integral part of the supply chain. Therefore, many conceptual frameworks exist for SSCM while none of them introduces any model, framework or strategies for the application of customer-based approaches towards the development and manufacturing of new products. This calls for further investigations to replace with the traditional supply chain structures and to clarify the rising theory on DCM within SSCM, especially through product development projects. In the next section, the report of the literature review will be presented and discussed in detail.

2.2 Differences between Supply and Demand Chain

Based on a classic definition, the supply chain is “A set of three or more entities directly involved in the upstream and downstream flows of products, services, finances and/or information from a source to a customer” (Mentzer et al., 2001). It is stated that the supply chain perspective mainly focuses on manufacturing efficiencies, logistics processes, supply-related processes and efficient use of assets (Hilletofth et al., 2009). Research studies have also

focused on designing a supply chain network to link and fulfil the demand patterns related to the overall function of the supply chain. However, it has been noticed that the power focus has been shifted from producers, manufacturers and retailers more towards buyers and end-users, which is currently known as the demand chain concept (Mahmood and Kess, 2016).

The notions of supply chain and demand chain, as well as their interconnections and impact on one another, have been the subject of much dispute. It is critical to comprehend the correct meaning of each notion to make an appropriate assessment of their interrelationships afterwards. SCM's definition is first presented by The International Centre for Competitive Excellence in 1994 as "… The integration of business processes from end-user through original suppliers that provide products, services and information and add value for customers" (Rainbird, 2004). The cost reduction and volume-driven strategy among the supply chains have been a classic method in business models to gain the competitive advantage among many companies such as retail supermarkets (Marks & Spencer and Sainsbury's in the UK) (Waller, 1998). It has been noted that upstream oriented supply chains based on mere cost-effectiveness insert many limitations on the markets, smaller retailers and even customers in the long term (Rainbird, 2004). To address the unidimensional, cost-focused and efficiency-focused supply chain concept based on increased profitability, the demand chain concept has been emerged progressively to emphasise business effectiveness.

Several literature documents have already highlighted the need for the alignment, integration, interaction, coordination and relationships between supply and demand chains (Rainbird, 2004; Jüttner et al., 2007; Hilletofth and Eriksson, 2011; Corsaro and Snehota, 2011; Santos and D'Antone, 2014). To comprehend the interactions between the two notions and to be able to come up with an integrated and unified approach, the concept of the value chain has been elaborated (Rainbird, 2004). This means that, despite all the debates regarding different interpretations and roles of supply and demand chain meanings, a company's overall value chain can be comprised of both concepts. Rainbird (2004) confirmed this integration and mutual interaction by stating that companies cannot sell what they cannot make and cannot make what they cannot sell (Rainbird, 2004). To optimise the relationship between supply and demand, business process models, including value catalyst and process fusion concepts have been suggested. According to Figure 2.7, this interaction involves a fusion of processes in what is called a "value catalyst". The whole model aims to create harmony and an effective alliance between the supply and demand chains while creating extra value to the firm utilising the catalytic effect. In this case, the most significant drivers for the organisation of such balance would be the owners and top managers of the firm, which have absolute authority from the top.

Hence, their active participation is essential. The author stated that different catalysts may be useful from time to time and the technology would be a powerful tool as it has a high potential linking supply and demand chain by minimising the limitations of time and location. Similar to the term "virtual enterprise", new technologies and new network partners can enhance the integration of the supply-demand chain (Rainbird, 2004).

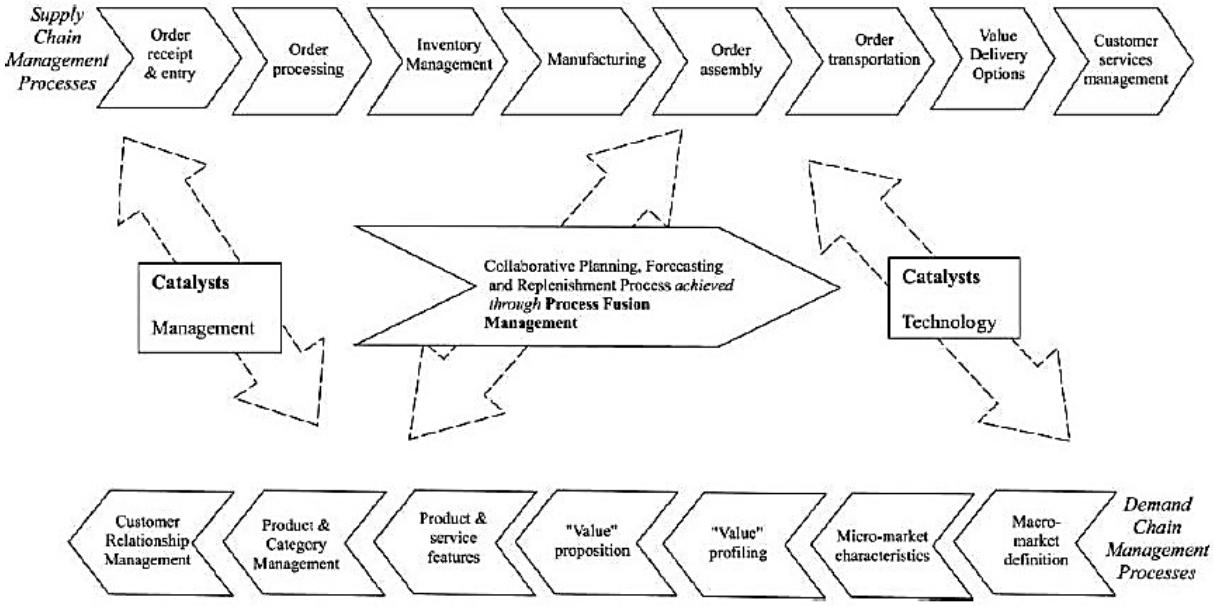

Figure 2.7 Process Fusion and Value Catalyst (Rainbird, 2004)

According to Holmström et al. (2001), two distinct linkages connect the demand-supply chain: the order penetration point (OPP) and the value offering point (VOP). These value tools aim at the value a supplier can offer to the customer and compared to the other value analysis tools such as value stream mapping, they concentrate on the connections within the supply chain (Kaipia et al., 2007). OPP is also known as customer order decoupling point (CODP) (Hoekstra and Romme, 1992) and refers to a stage in the production process in which customer orders are accepted by the manufacturer. VOP is the point where the supplier fulfils customer demand (De Treville et al., 2004) and includes three different alternative points; offer to purchase, offer to inventory management and offer to plan (Holmström et al., 2001; Hoover et al., 2002; Kaipia et al., 2007). Figure 2.8 illustrates the linkage of OPP and VOP accurately (Holmström et al., 1999).

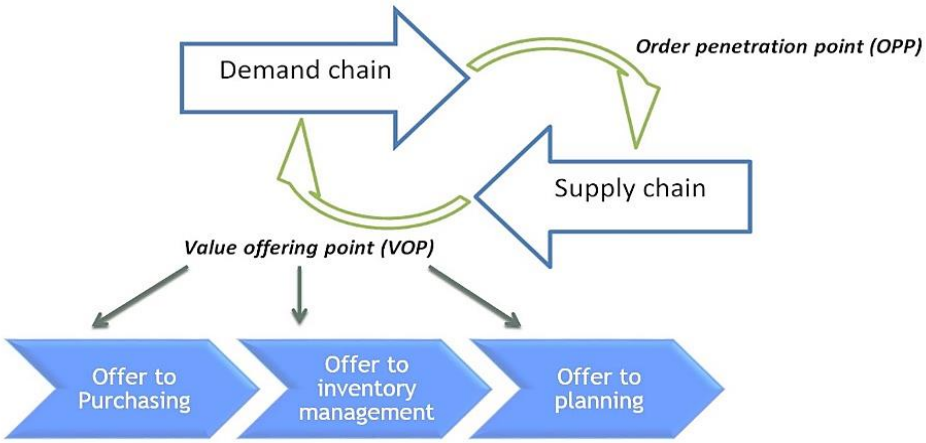

Figure 2.8 OPP and VOP linking supply and demand (Holmström et al., 1999).

Gligor et al. (2014) elaborated the concept of supply chain agility (SCA) and highlighted the need of integrating demand management into SCM procedures. This agility, he explained, refers to a production system that can adjust to rapid changes and meet variable customer demands at any time. The author created a supply chain agility paradigm, stating that demand-supply integration (DSI) is an essential measure of SCA (Gligor et al., 2014).

2.3 Demand Chain Management (DCM)

The concept of "Demand Chain" appears to offer a new approach to replace the traditional techniques of supply chain towards more compatibility with the growing power of end-users. This is in a situation where customer satisfaction plays a vital role in business survivability and profitability. There has been considerable growth in this term as an inspiring and significant part of the supply chain that focuses on the key business operations in NPD such as product design and development.

The first DCM research studies began when academics proposed that the first step in building a supply chain strategy is to evaluate the nature of demand for a firm's products, which were either functional or innovative in character. It was determined that functional products were fast-moving consumer items that were readily available in the market, having the capacity to fulfil customer demands and expectations, and were not prone to major changes over a specified period of time (Walters, 2006). In addition, research concentrated on creating a supply chain network capable of linking and fulfilling demand patterns, as well as the overall operation of the supply chain (Heikkilä, 2002). All functional products required an efficient SC network in one of the early models established, where the overall cost of manufacturing, transportation,

and stocks was minimised. (Walters, 2006). It was also demonstrated that competition has accelerated the pace of innovation through its discovery, implementation, introduction, and distribution into the marketplace. This has compelled many businesses to utilise continual innovation in their goods and services in order to deliver greater performance to their customers (Caputo et al., 2016). The recent shift in power supremacy from producers to end-users would be only the beginning of the transition from supply chain tactics to demand-driven ones (Mahmood and Kess, 2016). Bumblauskas et al. (2017) believed that the closer a company gets to the source of demand, the more probable it is to boost sales and profitability. End-users are typically not in direct touch with enterprises, and hence the contacts between the two are only enabled through contractors or business-to-business (B2B) context (Bumblauskas et al., 2017).

2.3.1 The History of Demand Chain Management

The evolution of the demand-driven supply chain (DDSC) was started with pull-based production systems such as TOYOTA's Kanban system in the 1950s. This was initiated by the generation of key demand-driven concepts such as just-in-time (JIT) production followed by electronic data interchange system (EDI) used for connection of transportation and financial service companies, barcodes, shipment records for cost-cutting and accuracy improvement further followed by point-of-sale (POS) during 1980 and 1990s (Ohno, 1988; Budd et al., 2012). Therefore, a new era began to arise within the transformation of traditional supply chain practices with the main purpose of inventory reduction and supply chain efficiency. As a result of globalisation enhancement in the late 2000s, challenges started to arise, putting businesses into a tight competition. Based on the upward demand variations and dynamic businesses, the SC strategy of "one size fits all" seemed to be inadequate. Therefore, researchers and authors began making a perspective shift from the supply chain towards the demand-based chain, rather than lean and agile supply design that have previously formed supply chain structures (Rainbird, 2004; Jüttner et al., 2007). Such developments became possible by tracking all the SC operations from upstream suppliers to downstream customers along with the smooth flow of products and information as well as lead-time reduction (Ye and Lau, 2018).

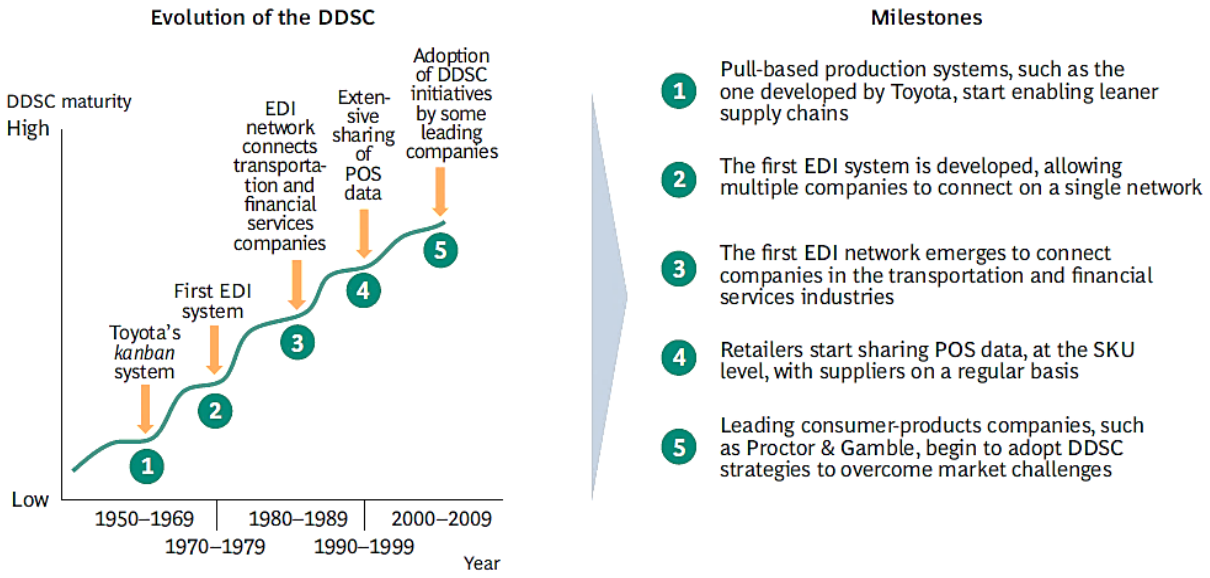

Figure 2.9 Evolution of DDSC and the Milestones (Budd et al., 2012)

Afterwards, during 2000-2010, the novel demand-driven supply chain strategies were adopted by some leading consumer-product companies such as Procter and Gamble and Walmart to tackle market challenges (Budd et al., 2012).

2.3.2 Demand Chain Definitions

DCM is generally defined as a specific approach for managing the supply chain (Frohlich and Westbrook, 2002). The concept of demand chain is classically described as, "… The whole manufacturing and distribution process may be seen as a sequence of events with but one end view: it exists to serve the ultimate consumer" (Brace, 1989). It is also referred to as "The complex web of business processes and activities that help firms to understand, manage, and ultimately create consumer demand" (Langabeer and Rose, 2002). Similarly, DCM is explained as "The management of supply production systems designed to promote higher customer satisfaction levels through electronic commerce that facilitates physical flow and information transfer, both forwards and backwards between suppliers, manufacturers and customers" (Williams et al., 2002). Boston Consulting Group utilises Demand-Driven Supply Chain (DDSC) instead of DCM. They describe it as "A system of coordinated technologies and processes that senses and reacts to real-time demand signals across a network of customers, suppliers, and employees" (Budd et al., 2012).

Vollmann and Cordon (1998) discussed that the principal driver of the demand chain is to accomplish the benefits of the virtual enterprise aiming to focus on cost reduction, customer support systems, best NPD and fast speed learning through demand chain partnerships.

According to Santos and D'Antone (2014), the DCM notion may be approached in two ways. One is more focused on the SCM approach, while the other is more related to the competitiveness aspects of SCM strategies. As the first approach states, demand chain could be defined as "A supply chain management approach that emphasises on market mediation to a greater than its role of ensuring the efficient physical supply of the product" (De Treville et al., 2004). Therefore, there is a need for alignment between customer satisfaction and supply chain efficiency. Considering the second approach, DCM is conceptualised as a harmonisation between the supply and demand processes within the outside and inside of the organisation margins to gain a higher competitive advantage. Hence, the primary one necessitates for the DCM implementation to comprise the organisational capabilities, demand-supply chain association and IT support (Santos and D'Antone, 2014). Demand processes might vary within different organisations, each focusing on specific operations aspects from product development, marketing, customer segmentation, distribution and logistics system to sales and price aspects (Childerhouse et al., 2002; Jüttner et al., 2007; Gattorna, 2015). Despite all the efforts in understanding the DCM concept, there is still a large gap between its concept and its applications as suggested by many researchers (Vural, 2015; Mahmood and Kess, 2016).

2.3.3 Demand Chain Management Interpretations

Based on the literature studies conducted based on the purposes of this research; two different perspectives towards the "Demand Chain" concept are highlighted:

A. This perspective stresses marketing approaches and tends to apply innovative marketing practices to prevent NPD risks and failures (Ogawa and Piller, 2006). The engagement of marketing in the interpretation of the demand chain concept is because marketing acts as a bridge and borderline between demand chain and traditional supply chain structures (Day, 1992). Likewise, DCM creates interactions between SCM and marketing taking into account the specific customer needs for designing the entire chain operations based on the creation of pull for end users, instead of purchasing and manufacturing-focused flow of typical supply chains by pushing products into the market (Hilletofth et al., 2009). In terms of marketing, companies such as Threadless, MUJI, Yamaha, BMW and 3M have started engaging user innovative ideas by involving potential customers within the very beginning of NPD processes such as design and manufacturing processes. These companies are utilising technology

platforms while making the customers committed for early purchasing (Ogawa and Piller, 2006).

Moreover, the integrated DCM approach seems to be essential for today's market competitiveness, where the customers are selective and demanding due to their real-time access to information (Hilletofth et al., 2009). Marketing has usually acted as a borderline between the company and the consumers (Day, 1992) and more profoundly, it concentrates on customer value creation in an external view, while the supply chain is internally focused on supply-related processes and efficient use of assets. In between, marketing is a concept that makes a linkage between these two elements (Jüttner et al., 2007; Hilletofth et al., 2009). Figure 2.10 shows this claim.

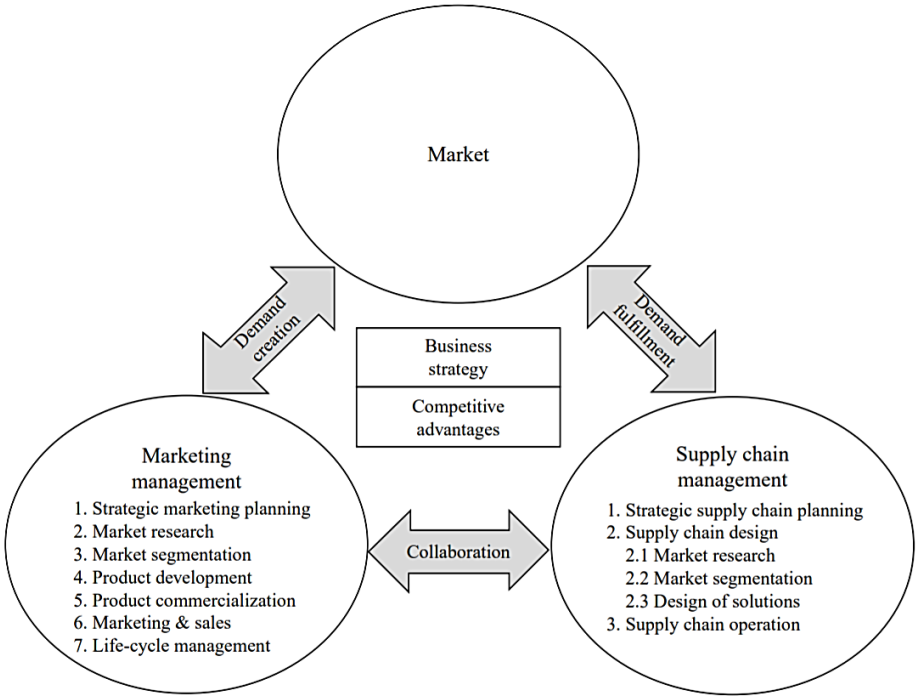

Figure 2.10 A Conceptual Framework for DCM (Hilletofth et al., 2009)

The innovative demand-driven chain emphasises marketing and creates pull for new products through a network of customers, suppliers and employees (Friscia et al., 2009), instead of pushing supply into the market from the traditional viewpoint of the supply chain (Emmett and Crocker, 2006). Similarly, it was highlighted that DCM is responsible for capturing the synergies between SCM and marketing by starting with the specific customer requirements and design the chain to fulfil them, rather than starting with the supplier/manufacturer perspective and moving forward (Hilletofth et al., 2009). It was stated that the DCM tends to evaluate and

understand the overall demand of the markets regarding the current and potential products of the company while concentrating on business effectiveness. However, SCM mostly focuses on manufacturing efficiencies and logistics processes (Hilletofth et al., 2009). Vural (2015) stressed that DCM is in contrast with the efficiency and production improvement view in SCM while preserving that effectiveness and customer orientation should be associated with supply chain tasks to gain competitive advantage and customer values.

Jüttner et al. (2007) facilitated a cross-functional study in addition to a co-development workshop to capture supply and demand integration. Based on the results, they introduced DCM as a model with three integrative elements considering the role of marketing within DCM and managing the working relationship within marketing and SCM. The approach is indicated in Table 2.7.

Table 2.7 The Roles of Marketing within DCM (Jüttner et al., 2007)

DCM Element	Role of Marketing
Process — Managing the integration between the demand and supply processes	• Facilitating the process integration by disseminating customer and market information • Considering the effect of marketing activities from an integrated process perspective • Fostering a demand rather than a supply-based integration of information needs.
Configuration — Managing the structure between the integrated processes and customer segments	• Linking external, customer-facing segmentation with internal segmentation of production, logistics and sourcing • Obtaining knowledge about changes in customer needs as a basis for structural adaptation requirements of the supply chain.
Social interactions — Managing the working relationship between marketing and SCM	• Exchanging information with SCM, e.g. providing timely information on defined customer segments; new customer/product opportunities; planned promotions; feedback on over/under service delivery and, seeking information on lead times, capacity and pipeline costs • Seeking collaboration with SCM by working towards a mutual understanding of the information exchanged and collective goals.

B. This viewpoint considers the application of technology and IT platforms as catalysts and facilitator tools towards the transformation of the supply chain to a demand-driven chain through enhanced knowledge flow and real-time information sharing within the chain. In other words, the impact of technologies in the manufacturing world is changing the supply chain structures.

In this respect, it is highlighted that the Internet has now solved many of the EDI shortcomings, such as high costs and lack of consistent standards in different regions. This is where the concept of e-supply chain provides companies with real-time information sharing, better coordination and product/service efficiency (Chong and Zhou, 2014). Despite the theoretical benefits of DCM, it would be hard to apply it in practice due to the lack of coordination between the entities along the supply chain (Frohlich and Westbrook, 2002). As a dimension of the e-supply chain, the adoption of web-based DCM integration is discussed particularly. This means that the company integrates its customers and suppliers through the web to coordinate them and better facilitate customer requirements. Web-based DCM integration can mitigate the difficulties of adoption of demand-driven chain and also enhance the service process and process innovation within the company. However, it can also bring challenges such as technological, technical, financial and competitive pressures which need to be addressed (Chong and Zhou, 2014).

This means that instead of traditional supply chains that are based on volume and cost optimisation, the new supply chains will be based on smaller quantities and this will gradually make mass customisation become a norm (Machado et al., 2020). In other words, by employing new technologies, the old paradigm of "economies of scale" is transforming into a term called "economies of scope" (Christopher and Ryals, 2014).

Boston Consulting Group referred to DCM as DDSC, which highly focuses on the application of IT platforms and increases the information flow to effectively track the ongoing material flow and reduce the supply chain lead-time (Budd et al., 2012). The significant point is the rapid information sharing that reduced from 4-8 days to Zero, through an IT-based chain. This means that by shifting from the traditional supply chain to an IT-based demand chain, the information is passed with no delay across the whole supply chain from retailer stores to raw material resources. This will benefit the raw-material suppliers, manufacturers, and in the majority of the cases retailers by reducing inventory, transportation costs, operations' planning time, warehousing costs, lost sales and working capital. It is claimed that DDSC has got the potential to enormously benefit end-users by improving customer sell-through and satisfaction (Budd et al., 2012). Despite the technological advancements and the potential for rapid information sharing, the DDSC is still in its infancy stages due to traditional mindsets, old infrastructures and operations.

Among the success factors of DDSC, establishing the right technology infrastructure is the one that facilitates fast data exchange and rapid information sharing. It also enables automation of key supply chain processes, strong processing capabilities and close coordination between IT and supply chain entities (Budd et al., 2012).

Boston Consulting Group made a deep insight through the demand chain concept and the gradual improvements in processing speed and computing power which enable rapid information sharing through a customer-centric approach (Budd et al., 2012). They consider DDSC with an IT vision and believed that the storage capabilities are now unlimited thanks to advances in technology and cloud-based systems. Some leading consumer-product companies such as Procter & Gamble and Walmart have started applying DDSC strategies to their planning processes such as using POS data, information sharing and partnering with their suppliers to improve their service levels, overcome market challenges and boost customer satisfaction Unexpected changes in market conditions are now getting traceable, and therefore, many costly and time-wasting issues such as inventory fluctuations and production schedule alterations could be avoidable. External storage capabilities which were once unavailable or costly, have now become unlimited with the aid of external platforms and cloud-based systems (Budd et al., 2012).

The smooth flow of information makes real-time visibility. It leads to improved supply chain performance by reducing the inventory levels throughout the whole system, costs reduction and forecasting improvement (Budd et al., 2012; Rai et al., 2006). As a result, all the supply chain stakeholders from suppliers to manufacturers, retailers and consumers will benefit from DDSC in different ways. Table 2.8 indicates the above claim in detail:

Table 2.8 DDSC and its Benefits to Supply Chain Stakeholders (Budd et al., 2012)

	Raw-material supplier	Manufacturer	Retailer	Consumer
Reducing inventory	✓	✓	✓	
Decreasing working capital	✓	✓	✓	
Improving forecasting accuracy	✓	✓	✓	
Reducing transportation costs	✓	✓		
Optimizing infrastructure	✓	✓	✓	
Decreasing order-expediting costs	✓	✓	✓	
Reducing other operating costs (such as handling and warehousing)	✓	✓	✓	
Reducing head count (such as planners and buyers)	✓	✓	✓	
Decreasing sales-planning and operations-planning time	✓	✓	✓	
Reducing lost sales		✓	✓	
Improving customer sell-through and satisfaction			✓	✓

✓ = strong benefit ✓ = partial benefit

2.3.4 Success Factors, Pillars and Paybacks of DCM

Companies must establish long-term implementation strategies to maintain potential markets and consumers, as well as to increase their prospects of attaining competitive advantage and profitability. Langabeer and Rose (2001) have expressed that the demand strategy depends upon the coordination between four factors; supply chain strategy (manufacturing, distribution and network optimisation), customer strategy (customers and markets), brand strategy (key product requirements and customisation needs), and sales and marketing strategy (awareness and demand). Hilletofth et al. (2009) believed that the successful adoption of the demand chain would be possible by the integration of marketing and SCM initiatives. Similarly, Jüttner et al. (2007) claimed that DCM success is not only based on customer-driven philosophy but also the strong adoption of marketing and supply chain strategies and their integration together. Mendes et al. (2016) proposed a DDSC maturity model to a multinational beverage company as a roadmap to lay out strategies and progress towards superior levels of maturity. Although, they suggest future researchers propose simplified processes to measure different components of DDSC in other industries as well.

According to Budd et al. (2012), DDSC is mainly based on four key pillars. Firstly, the demand and inventory levels need to be clear and transparent across the whole supply chain. Secondly, a strong infrastructure helps the supply chain entities to adjust and correspond to instant changes in supply and demand. Thirdly, coordination among the supply chain stakeholders enables them to operate more efficient and organised, and fourth is the optimisation of whole supply chain

performance which provides companies with cost reductions while enhancing customer service. Moreover, DDSC requires an internal collaboration within all the company departments including procurement, manufacturing, order fulfilment and sales to eliminate hidden supply chain costs and to consider the full impact of various actions (Budd et al., 2012).

As Hilletofth et al. (2009) expressed, the key benefits derived from the adoption of DCM include:

- Reduction of inventory level as a result of information accuracy on inventory levels
- Reduction of lead-time and better visibility of product demand
- Increase in sales level and customer responsiveness as a result of product availability and delivery accuracy
- Increase of SC responsiveness by working across different sale channels considering the production constraints

Ye and Lau (2018) proposed a conceptual framework for DCM supported by the alignment theory. They claimed that this framework can be used as a tool to explore the level of alignment of industrial firms with dynamic demand uncertainties. The framework helps to monitor the development process and continuously improve their internal capabilities towards adapting to the changes in their external market situation. Unlike the previous SSCM and DCM frameworks by previous authors, this framework considers both inter-organisation and intra-organisation scopes within the DCM framework including alignment with external market situation and alignment with internal DCM dimensions (market, SCM and organisation management). As obvious, there are three intra-organisation DCM scopes, including demand chain activities, supply chain activities and strategic management components. The framework adopted the strategic fit of the alignment theory as the supporting theory and the administration-integration-production-development (A-I-P-D) logic codes to be applied into supply and demand activities to gauge the aliment relationship between internal operations and external situations (Ye and Lau, 2018).

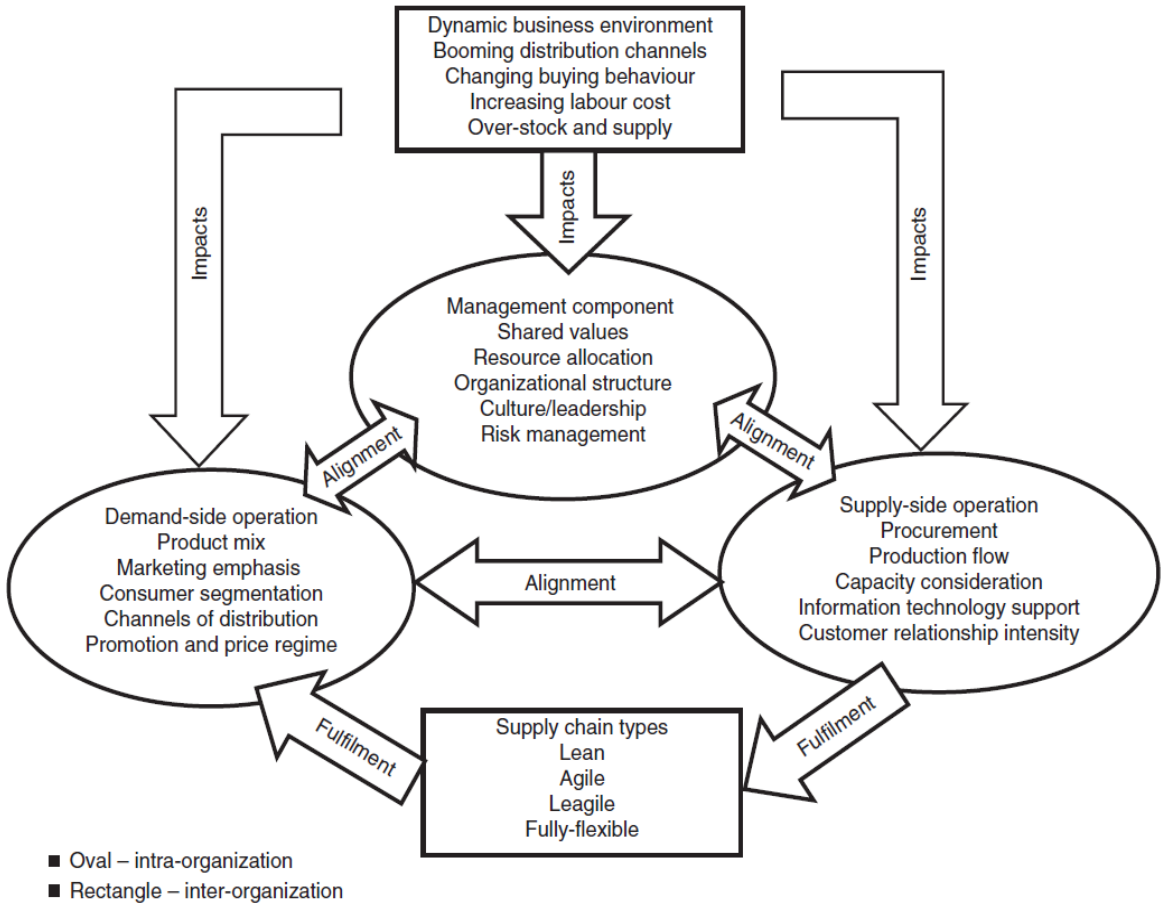

Figure 2.11 A Proposed DCM Conceptual Framework (Ye and Lau, 2018)

Liao and Wen (2009) presented a model for illustrating demand chain information and knowledge flow, which starts with obtaining data from customers (Figure 2.12). The authors believed that the knowledge of customers and market channels will create valuable assets for companies during the NPD stage. It is claimed that DCM includes customer satisfaction, engagement and customisation, which is achievable through the identification of customer needs. Such customer knowledge can be obtained through data mining to reflect their feedback regarding product and marketing knowledge to be presented to upstream suppliers and retailers. This model seems to be in line with both perspectives of DCM identified in this study presented in section 2.3.3 since it is focused on knowledge sharing within the supply chain entities especially with customers as well as the use of marketing channels and innovations towards finding target customers.

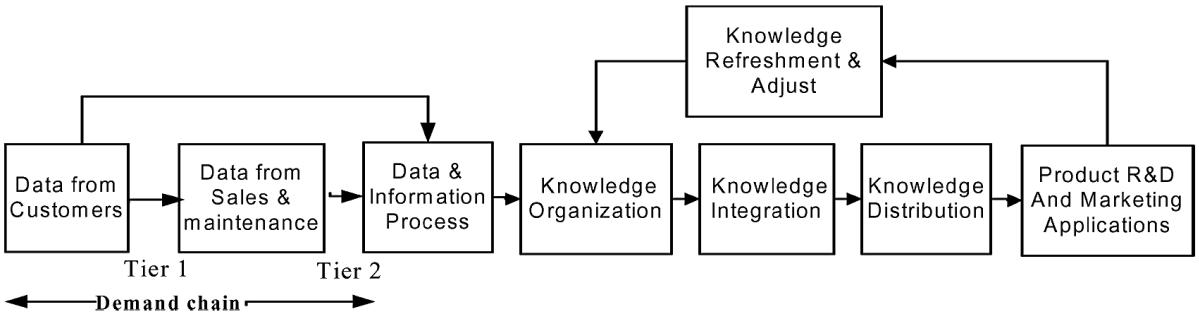

Figure 2.12 Demand Chain Information and Knowledge Flow (Liao and Wen, 2009)

Despite the endeavours during the last few decades to shift from forecast-driven to real-time demand signals, there is still a gap between the demand chain concept and its mass industrial applications. This might be due to several reasons. Firstly, the alignments between people and processes working at the demand-supply interfaces are still unclear. Secondly, the notion of "supply chain" is linear and disregards the complexities of new production systems (Santos and D'Antone, 2014). In other words, linear and traditional supply chains that sequentially provide information are not designed to solve the complex challenges of the supply chain within a customer-driven world that real-time changes need to be addressed. Thirdly, the enablers, drivers and consequences of implementing such alignment need to be investigated through multiple supply and demand departments of the company to reach the final goal that is delivering value to customers (Santos and D'Antone, 2014).

2.3.5 DCM Adoption of Industrial Cases

DCM has been applied as an SCM approach in world industries that emphasises market mediation to ensure efficient physical supply of the product. Retailers and companies with consumer products are nowadays leading the markets. However, other industries with complicated products and supply chain challenges have got the potential to adopt DCM as well. It has been discussed that DCM could be applied to a wide range of industries such as retail, consumer products, automotive, aerospace and defence due to its nature of end-to-end visibility and enhanced processes (Budd et al., 2012). For instance, the aerospace and defence industry has got logistical challenges requiring a high number of complex products at the right time, and due to costly inventory levels, these companies need to work closely with their suppliers to coordinate activities (Budd et al., 2012).

Servitisation is a concept that is linked to all aspects of a supply chain (supplier management, sourcing of new services) as well as sales (extended sales cycle, within-sale customisation, pricing approaches) and marketing (new customer offers) and that is why it requires a demand chain perspective. Likewise, Rolls-Royce Group (as plane engine manufacturer) introduced the idea of TotalCare transforming its business model from traditional supply chain thinking ("supplier of aerospace engines") to demand chain thinking ("power by the hour"). The TotalCare strategy allows Rolls-Royce customers to only pay per hour of flying time instead of buying an engine at a fixed price while offering services such as engine fixing and add-on services such as engine transportation, spare engine support, additional overhaul coverage and technical records management (Baines et al., 2009). Rolls Royce also utilises big data and advance analytics to gather large amounts of data on engine performance to plan maintenance and minimise disruption in advance. Moreover, through servitisation and the long service agreements with customers, Rolls Royce benefits from having access to products and components at the end of their life to recover, recycle and remanufacturing for use in new aerospace components (currently 95%) and this reduces their need for raw materials purchasing remarkably (Rolls-Royce, NA).

Likewise, many successful companies such as Zara (the Spanish fashion apparel) and Dell are now benefiting from the adoption of the DCM principles to their businesses to increase profitability and competitive advantage by the close association of supply and customer elements such as product availability, delivery accuracy and responsiveness (Walters, 2006). For instance, Zara is following a combination of both highlighted perspectives mentioned in this study. It adopts a robust market research programme that targets 17-22 years old customers who are following fashion trends having a limited budget (O'Marah, 2016). Moreover, it accelerates the products' time to market from the sketch of initial designs to store rack as quick as two weeks. On the other side, it utilises internet infrastructure to gather real-time information and provide fast market responsiveness to customers' changing demands. The personal digital assistant (PDA) devices are being used in Zara stores to send Inditex headquarters all the information regarding sales trends, customer impressions, reactions, ordering needs and feedback (O'Marah, 2016). In this case, a better match of supply and demand results in product availability, delivery accuracy and market responsiveness leading to increased profitability (O'Marah, 2016). Similarly, Google is working on the fleet of drones as delivery machines for consumer and medical goods purchased online, specifically to remote places with limited accessibility (KPMG International, 2016).

Authors have also suggested that it is essential for marketing departments to take into account other supply chain entities' information in their decision making and focus on the integration of supply chain processes (Walker et al., 2000). According to their findings, marketing will be resilient to alterations and hence, the whole supply chain needs to be involved in marketing activities, customer priority decisions and more significantly to deny marketing decisions if they are not in line with business profitability. In essence, they suggested that the relationship triangle of SCM, DCM and marketing can act as a business enhancement model which also creates superior customer value (Walker et al., 2000).

The demand chain transformation at Heineken Company is one of the classical examples that explains Heineken's strategy toward alteration of SCM strategies (Vollmann and Cordon, 1998). Firstly, after analysing the costs and internal performance data, Heineken decided to make some cost reductions along with reforming the company organisational structure as well as reducing the managerial layers and giving more power and responsibilities to the workforce. Secondly, following that the Heijn supermarket in the Netherlands (The largest customer of Heineken) declared a major profit loss on Heineken Beers, they committed Heineken to reduce the lead time of order distribution from three days to one day (now only six hours). Thirdly, using an external consultant, they implemented new computer system support with a new approach by fully outsourcing everything from computer systems and people. All these activities indicate that Heineken was in line with altering the demand chain by hearing the customer voices to provide better services and establish better relationships with them along with cost reduction in the entire supply chain.

McDonald's as a multinational corporation has been dominant in the world fast food industry by the integration of marketing, SCM and DCM techniques (Rainbird, 2004). Through the application of various management approaches such as fast speed production and delivery, high standards of staff training, process control, economies of scale, bargaining power, and development of demographic research; McDonald's was enabled to survive in the food retailing market despite its rivals' existence. From the marketing perspective, they have been implementing the four Ps of marketing. The "Price" factor has been reflected in their successful competitive advantage over their world rivals such as Burger King. The "Place" factor has been fulfilled through the high number of stores all around the world and the "Promotion" factor can be considered in Golden Arches, Ronald McDonald's and other market segments such as offering specific options for children. "Product" consistency seems to be a very important element in this case since it has well preserved its famous meals such as Big Mac through the years. However, according to an investigation of the franchises in mature geographic locations

such as Australia, it is discovered that McDonald's is in tight competition due to the reducing rate of eating out in Australia. This is because the principal reasons for Australians eating fast food are now changing from being convenient to having special occasions or breaking the routines. Moreover, as stated by a senior executive, McDonald's had faced competition issues by the new indirect rivals such as coffee shops and the other informal restaurants. Therefore, it needs to correspond with the new consumer values by expanding the menu variety and providing new solutions other than just promotional items, price reduction and cost efficiencies (Rainbird, 2004). One example of expanding menu varieties for McDonald's is that they are following the approach of "Glocalisation" (localisation + globalisation) (Mangan et al., 2012). This means that they provide different meals and drinks according to the desired taste of every world region. For instance, the seafood options are widely presented in the far east, while in Germany, they use potatoes in some of their sandwiches, or likewise in the UK, bacon is used in most of the sandwiches.

2.4 New Product Development (NPD)

The term 'Product Development' is classically defined as "The transformation of a market opportunity and a set of assumptions about product technology into a product available for sale" (Krishnan and Ulrich, 2001). However, the concept "development" refers not only to the innovative product specifications but also to the expanded product client services and life cycle. Utilising several methods, NPD evaluates and incorporates customer attributes and needs such as price, speed and reliability into the engineering characteristics of the product. A large number of new products do not succeed while entering the market and according to a study, the success rate of NPD in 2012 was potentially 67.5% in the US, 48.6% in Asia and 56.8% in Europe (Markham and Lee, 2013). According to a report on product development performance metrics and practices among 211 US businesses, 90% of the best performers, compared to only 44% of worst performers, have got a clear and well-defined plan guiding NPD projects from idea to launch (Cooper and Edgett, 2012).

According to Mintzberg (1989), organisations must be transformed from "machinery companies" where strategies are dominant to "innovative companies" where senior managers inspect to promote process developments with the participation of all manufacturing personnel to achieve the best results from NPD projects. This could be challenging since most businesses often consider short-term fiscal outcomes and tangible assets such as equipment and buildings rather than valuing intangible assets such as customer satisfaction which brings continuous success.

A research study examined product innovativeness from both technological and marketing perspectives. In other words, it highlighted that product innovativeness includes two dimensions of technological newness (TN) and market newness (MN) (Feng et al., 2016). NPD is related to many departments within manufacturing enterprises, while the main ones such as design, engineering and marketing departments should be included (Nafisi et al., 2016). The design department provides the key definition of the product that meets the requirements of the customer and the market expectation, which could be approved by the customer groups. The manufacturing activities belong to the engineering department that provides requirements of material purchasing, the distribution and the entire supply chain measures (Nafisi et al., 2016). The key activities and roles of the marketing departments are to identify and capture the customer requirements and the knowledge, the analysis of the markets and the opportunities and threats of new products within the market space. Hence, it could be suggested that market innovation has got key importance towards product innovation and product novelty (Vinayak and Kodali, 2014).

Figure 2.13 illustrates the interface between product, process and market innovations as the main three functions of NPD projects. Due to the high dependency between the functions, there is a need for collaborative work and efficient communication between them (Vinayak and Kodali, 2014). Researchers identified product innovation as a critical element to the success of the product which is highly related to sustainable business success, in turn, providing better business opportunities for growth, expansion and maturity within new areas (Cooper and Kleinschmidt, 1995). Similarly, process innovation refers to the aspect of using new innovative production and operations methods and using new technological advancements such as AM to improve their overall production processes (Machado et al., 2020). Market innovation is considered a newer approach that companies have been adopting to scale and utilise the target market. Likewise, Charlebois (2008) elaborated on five types of economic utilities in marketing and distribution channels that measure the potential of a product or service to meet customer satisfaction. This includes form (composition or appearance of products), type (product availability), place (product availability at preferred location), information (added value by giving useful product information) and possession (product usefulness). Market innovation will be further investigated in the next sections as an important factor considering demand chain role within product development processes that tend to engage the customers from the very early stages of the product design (Ogawa and Piller, 2006).

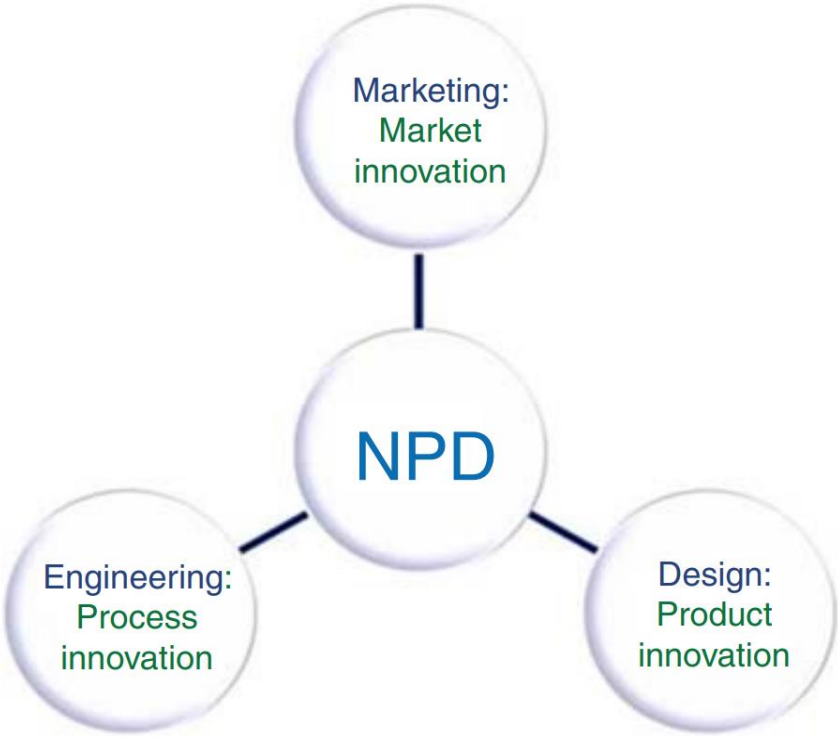

Figure 2.13 Product Design and Manufacturing System Design in the NPD Process (Vinayak and Kodali, 2014)

One of the NPD success drivers is identified as systems, methods, tactics and procedures that the firm employs for NPD management such as gating systems, agile development approaches and ideation methods (Cooper, 2019). In this regard, Cooper (2019) presented an Agile-Stage-Gate model as a systematic idea-to-launch methodology towards NPD success. This system acts as a roadmap towards driving new products from idea to launch and integrates the principles from agile project management into the Stage-Gate model. The system's main goal is to deal with uncertainties and ambiguity in the front-end and accelerate the NPD process by using iterations. The Agile Stage-Gate system has several benefits such as speed, dedicated teams, better communication within the team and regular customer feedbacks with strategic points. The model starts with great ideas, whereas the voice of customers (VoC) is identified as the most effective way towards the generation of new ideas within the earliest stages which helps to gain valuable feedback and early market validation from customers. The model continues with assessing technical feasibility, testing and product launch followed by the development, testing and final launch. As the term agile suggests, development projects must be founded on the principles of self-organising teams and close collaboration with customers. The sprints are the software development projects consisting of several iterations which are very short and usually 2-4 weeks. The goal of each sprint is to produce a working product to be

demonstrated to stakeholders (Cooper, 2019). The iterative (spiral) developments include build-test-obtain feedback and revise to present the results to customers to get the right product.

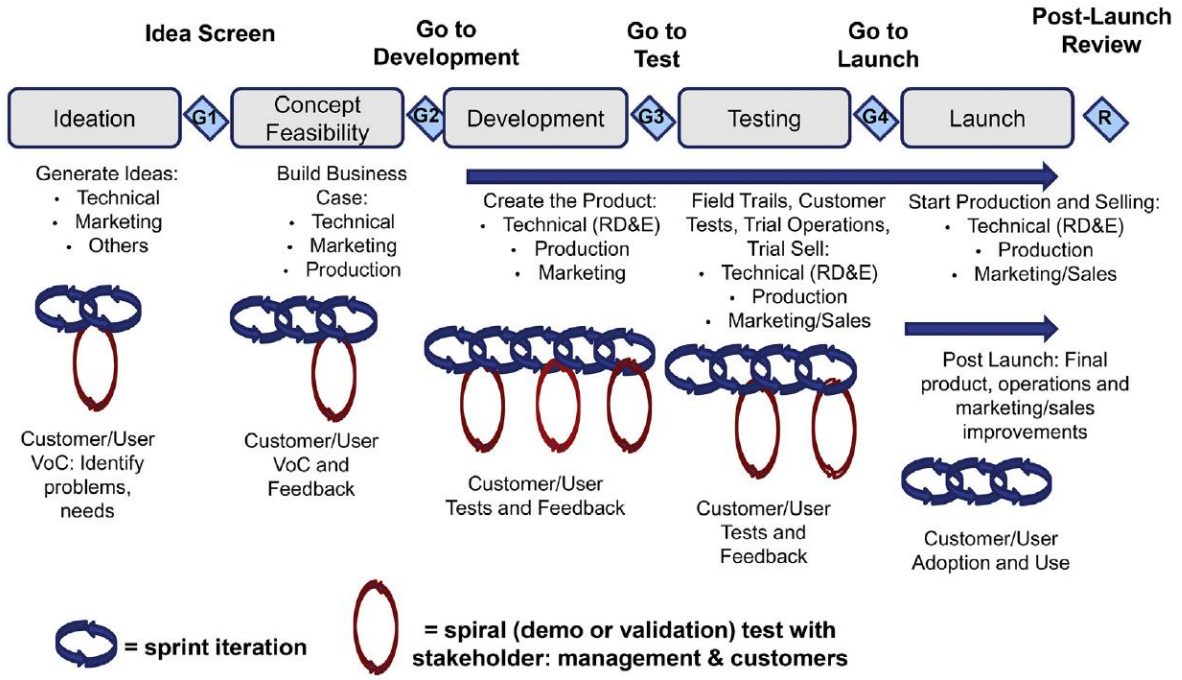

Figure 2.14 A Typical Five-Stage, Five-Gate System, with Agile Built into Each of the Stages—an Agile-Stage-Gate Hybrid Model (Cooper, 2019)

2.5 NPD Risks, Drivers and Success Factors

Effective communication and cooperation between different entities and NPD teams would be a beneficial factor for product success (Dougherty, 1992; Cooper and Kleinschmidt, 1995). Although, varied perceptions of innovation and varied mindsets of employees in large corporations appear to be a barrier and cause the failure of new product performance. Even, the association of NPD teams with environmental experts from external agents can often be problematic due to the uncertainty of green products. It has been claimed that understanding the uncertain success rates of environmental NPD might benefit from Dougherty's theoretical account of interpretative barriers. The absence of connectivity between technological and market potentials, according to Dougherty (1992), is the general barrier in large enterprises that leads to the commercial failure of new products. As a result, she specified three final factors working simultaneously, that can help firms to surmount those implications. These include, 1) active contribution of all the departments in the creation of the product and not merely the R&D group, 2) develop collaboration mechanisms between different departments to reach a similar understanding of the product and 3) develop a framework for practical action (Dougherty, 1992).

Three different factors are highlighted for the success of NPD projects by Chien and Chen (2010). This includes customer involvement, supplier involvement, and cross-functional integration (good decision making and effective teamwork between NPD and R&D). Moreover, it is claimed that product innovativeness exerts influence on the relationship between customer involvement (CI) and product performance success (Feng et al., 2016). In other words, to ensure NPD success through product innovations, companies need to cultivate a customer engagement culture to co-create value (Vural, 2015; Redante et al., 2019). As a result of customer involvement through co-creation; brand loyalty (Kruger et al., 2018), profitability and pro-environmental awareness (Singh and Giacosa, 2018) will be enhanced. According to Chien and Chen (2010), customer involvement in NPD brings implications for managers. To reduce NPD failure rates, managers need to encourage employees to work closely with customers and focus on two measures of technology and market newness in this regard. This also requires them to match their resources and capabilities to the NPD requirements. In this way, they could use the market opportunity and gain dominant performance within the new penetrated markets. After all, Chien and Chen (2010) believed that NPD performance mainly relies on two factors of process performance and financial performance.

According to the resource-based view (RBV) (resource-based theory), the sustainable competitive advantage of a company originates from its valued, rare, inimitable, non-substitutable resources (VRIN) and the distinctive way they are used through its core capabilities and potentials (Barney, 1991). In contrast to the industrial organisation paradigm, RBV believes that sustained competitive advantage can be obtained more simply by leveraging internal rather than external factors. The RBV model assigns a prominent role to resources in assisting organisations in achieving improved organisational performance and divides resources into four categories: tangible, intangible, heterogenous and immobile. VRIN is a framework to determine if resources are valuable, rare, difficult to duplicate, and non-substitutable. The long-term competitive advantages are the resources and competencies that respond yes to all of the questions (Barney, 1991). VRIN was later refined to VRIO by including the question, “Is a corporation structured to exploit these resources?”

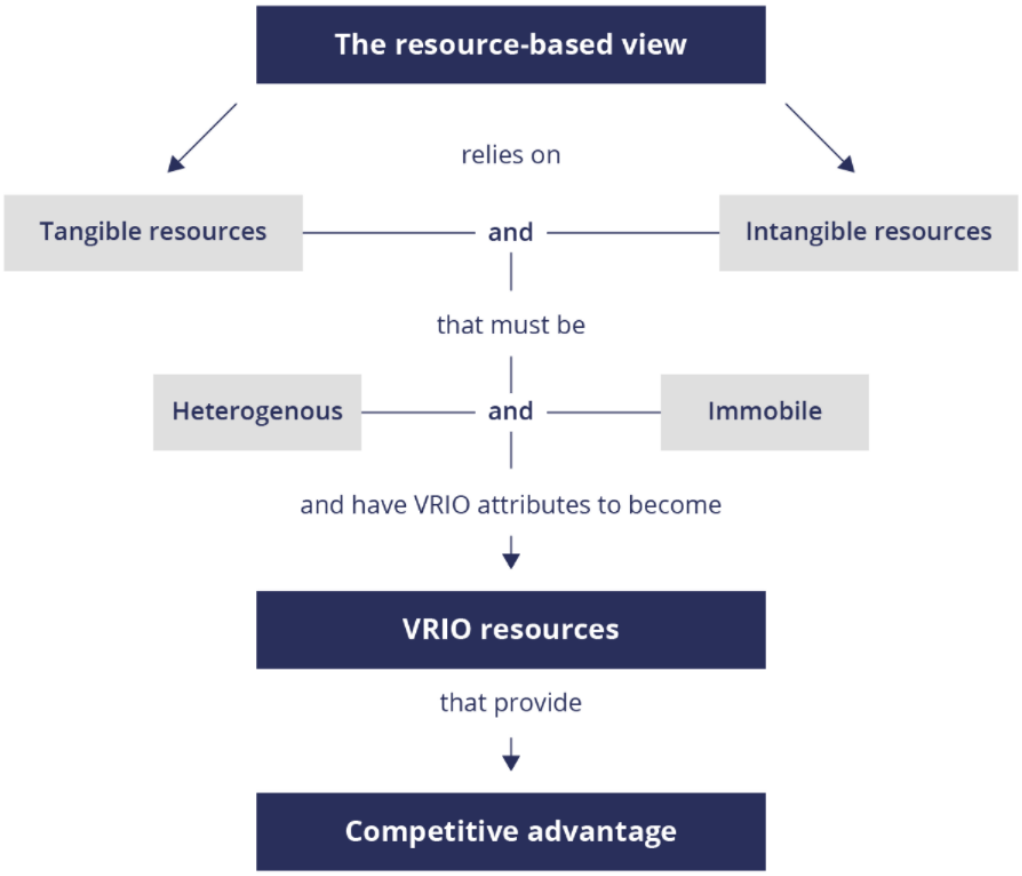

Figure 2.15 The RBV Model (Jurevicius, 2013)

A research study explored the factors that bring uncertainty to the process of NPD and cause struggles for companies for on-time delivery of products or projects (Martinich, 2015). The uncertainties are declared as resource capability, social or economic situations, market situations, technology changes, organisational changes, supply changes and regulatory changes (Martinich, 2015). Likewise, using a three-dimensional model based on a risk management approach and survey data conducted to Chinese businesses; the most significant risk parameters impacting on NPD performance includes technological, organisational and marketing risks (Mu et al., 2009). Future researchers have been suggested to find out the most effective risk reduction methods for NPD approaches within a comprehensive set of managerial schemes to other business contexts rather than Chinese businesses (Mu et al., 2009).

Along with the associated risks and threats of NPD, the case of Boeing 787 development, its supply chain transformation and further challenges were discussed (Horng and Bozdogan, 2007; Tang and Zimmermann, 2009; Kotha and Srikanth, 2013). In 2003, Boeing decided to create an aircraft (787 Dreamliner) by applying a value-creation strategy offering several

advantages both for the immediate customers (airlines) and end customers (passengers), such as cost-effectiveness, fuel efficiency and reduced noise pollution (Tang and Zimmerman, 2009). Apart from the material changes, Boeing applied some changes in supply chain structure and outsourcing, which brought them severe "supply, demand and management" risks. They shifted from the traditional supply chain system towards a new, unusual supply chain strategy that aimed to highly mitigate the development cost and time (Tang and Zimmerman, 2009).

Comparing the former and new supply chain, in the traditional one, subsystems were provided by several thousand suppliers and then Boeing was responsible for the final assembly within 30 days. Hence, Boeing acted like a typical key manufacturer which is responsible for the assembly of all the entire parts and subsystems provided by thousands of suppliers. Therefore, every single split in the supply chain system could cause long delays in the final production. The new 787 programme was based on a 3-tiered structure in which Boeing had a strategic partnership with only 50 tier-1 suppliers. Likewise, partners in tier-1 assembled different components and subsystems manufactured by tier-2 suppliers and ship entire sections to Boeing to assemble them only within three days. This alteration was made based on the assumption that their structural partner would have essential expertise. However, followed by major delays, this assumption proved to be invalid. Several factors, such as technology and supply related factors, caused long delays in the delivery of Dreamliner. These problems included engine interchangeability, security concerns of new computer networks, safety issues due to the usage of composite materials as well as 8% overweightness. On the other side, relying Boeing on its key suppliers for subassembly of the sections was risky. To address this issue, Boeing started to send hundreds of its key staff to its tier-1, tier-2 and even tier-3 suppliers' global sites to provide them consultation to solve the technical issues causing the delays in the 787's development (Tang and Zimmerman, 2009).

Regarding management risks, due to the transformation of the supply chain, it was essential for Boeing to establish a leadership team consisting of highly professional members in the risk management field to prevent the different risks associated with the new unconventional supply chain and to manage the problems resulted in delays. Regarding supply risks, tier-2 and tier-3 suppliers revealed a lack of technical know-how since they were not used to enter regular and updated information to the new planning system called Exostar. This caused Boeing and tier-1 suppliers to be unaware of the delivery delays and made them face struggles in making quick responses to the production delays. Regarding demand risks, following the announcement of delivery delays, many of the Boeing customers lost their trust in Boeing's aircraft development program and either started to cancel some of their Dreamliner orders or shifted from direct

purchasing to leasing contracts. Firstly, to enhance customer satisfaction, Boeing decided to supply some of its customers such as Virgin Atlantic with the new Boeing 737 or 747 instead of 787. Secondly, by sharing its progress information on the website, communication enhancement and conducting a publicity campaign for Dreamliner's technology promotion, Boeing attempted to work on its marketing strategies to revive its business image (Tang and Zimmerman, 2009).

NPD efficacy, NPD efficiency, and NPD productivity are three major components outlined by Machado et al. (2014) in the creation of NPD effectiveness. NPD efficacy refers to better product concepts with an appropriate potential market that are produced based on creativity and quality. NPD efficiency refers to shortening the development cycles and time-to-market using concurrent engineering. Also, R&D costs need to be minimised towards having an efficient NPD. NPD productivity refers to the collocation and functionality of the development project team. Ultimately, the value will be created for customers and the firm along with profitability, outstanding products, brand reputation and sustainable competitive advantage (Figure 2.16).

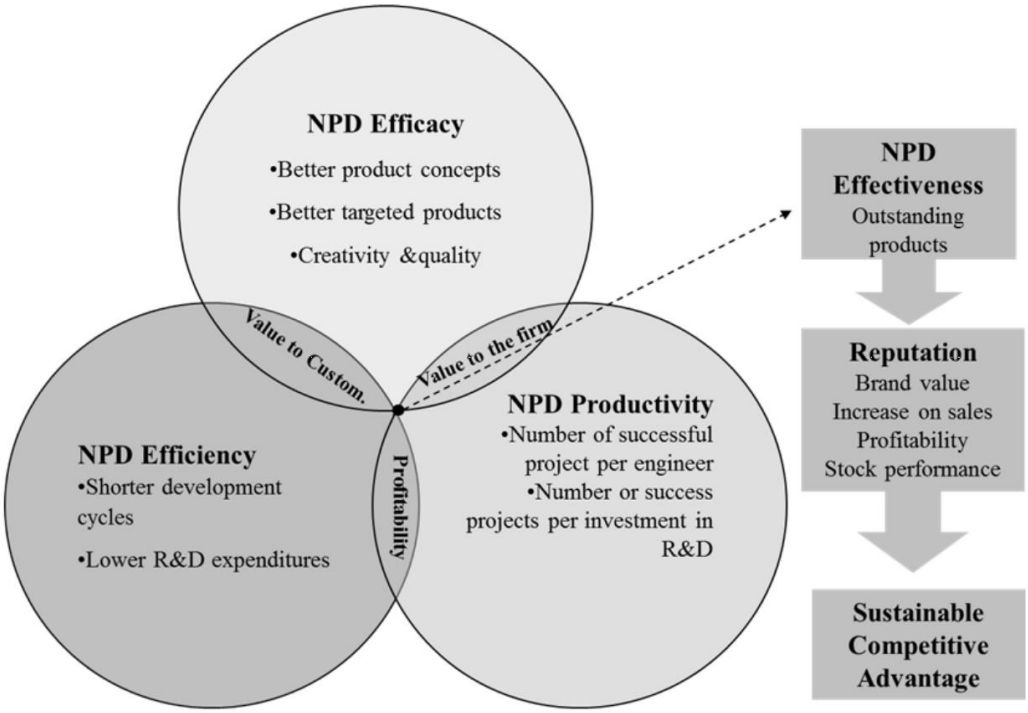

Figure 2.16 NPD Effectiveness (Machado et al., 2014)

The successful marketing of many products relies heavily on after-sales support. Manufacturing equipment, for example, needs after-sales services such as maintenance and repair for customers to get the most out of them. In the academic literature, some firms have begun to provide clients with an integrated product and service, referred to as a product-service system.

However, delivering such integrated services necessitates a new approach to NPD. This is because product design has an impact on after-sales service requirements, which must be taken into account during NPD. The link between NPD and service, on the other hand, has been largely disregarded by scholars. Six in-depth case studies at top organizations that offer a combined product-service offering were done to understand how service requirements are normally evaluated at the design stage, to close this gap. The findings reveal that service requirements are routinely evaluated during NPD by involving after-sales staff and using field service data to create design goals for organizations where after-sales is a substantial component of the business (Szwejczewski et al., 2015).

2.6 NPD and its Linkage to DCM

NPD is an element that can empower demand chain drivers and cause the fulfilment of market growing requirements. However, it is highlighted as an expensive and time-consuming practice (Sharifi et al., 2006). According to research, manufacturing enterprises continuously update their product offerings to satisfy the customer requirements, match the supply and demand, and remain highly competitive within the market (Crippa et al., 2010).

From a customer-centric point of view, to avoid costly product failures, companies are now transforming from their sophisticated traditional/conventional market research patterns and forecasting capabilities into novel methodologies such as “collective customer commitment”. This approach engages the potential customers in the innovation processes and asks for their commitment for early purchasing even before the final development and manufacturing processes (Ogawa and Piller, 2006). This commitment needs to be a mutual strategy adopted by the companies to reduce the NPD risks from the customer side and make them loyal and trusted customers. Collective customer commitment is a combination of postponement and mass customisation strategies while containing their features as well. This can be considered as a “configuration” element of the demand chain and its relation to marketing in terms of customer segmentation and interactions as external entities within the manufacturing company (Petersen et al., 2005). The authors also expressed that conducting regular surveys of potential customers following the introduction of new products can greatly reduce the likelihood of future failures (Ogawa and Piller, 2006).

Table 2.9 Options for Collective Customer Commitment Preventing NPD Risks (Ogawa and Piller, 2006)

Parameter	Alternatives	
Source of new product designs	Company ideas	Customer ideas
Connection with customers	Cooperate with external existing community (such as customer opinion platforms)	Build a community for cocreation of new products
Preselection of ideas	Company panel	Customer competition
Minimum order size	Predefined: Decisions are based on the development and manufacturing costs of the first production batch.	Predefined: Decisions are based on the development and manufacturing costs of the first production batch.
Commitment	Monetary: Customer has to pay at moment of preordering.	Good practice: Customer promises to buy product.
Incentives	None for participating customers	Special preorder prices for early customers and awards for user designers
Reorders	Determined by conventional planning and forecasting	Dependent on continuous commitment from community
Organization	Project- or competition-based process	Ongoing process
Relation to conventional product development and market research	Supplement the conventional process for developing radical new product concepts.	Replace the conventional process and serve as the underlying business model for entire company.

Depending on the desired level of customer involvement, there are several forms of collective customer commitment. All of them, however, have one common characteristic: full transparency of the entire development process from initial consumer ideas to final product introduction and commercialisation. This disclosure is in contrast to the traditional NPD practices that designers tend to keep the products in confidentiality out of their rival eyes and look for market demands which would even not exist. Increasing the information flow between consumers and the company is now facilitated thanks to IT advancements. Therefore, the entire product development process is automated towards collective customer commitment. Table 2.9 illustrates different parameters of collective customer commitment and further provides the possible options and alternatives, where the left column demands less interaction of customers, and the right one requires high interaction of them. It should be mentioned that there is always a need to balance the internal knowledge of the market and technical constraints and customer ideas. Therefore, there might be some product designs desired by customers which are then evaluated by the company as non-efficient, whether in terms of time, cost, quality or legal considerations. This marketing approach could be effective in two different situations; first in testing the innovative products where customers have little experience and hence the market research is unclear, and second for developing products with small and diverse market segments (Ogawa and Piller, 2006).

The application of collective customer commitment techniques to prevent NPD failures was investigated in several case companies (Ogawa and Piller, 2006). Fashion, cleaning, musical instruments, automobiles, chemical industries, and even real estate agents are among the sectors

and services represented by these businesses. Companies such as Adidas, BMW, Procter & Gamble and 3M have also adopted strategies to engage users' innovative ideas into their NPD systems through IT platforms. Table 2.10 indicates different collective customer commitment approaches already undertaken by some well-known global companies.

Table 2.10 Adoption of Customer Commitment Practices Preventing NPD Risks (Ogawa and Piller, 2006)

Company	Type of Company	Collective customer commitment practice towards NPD purposes	Type of product
Threadless	Fashion apparel – T-shirts with colorful graphics (American)	• Relying on customers, hobbyists and graphic designers • Customers evaluate the designs from zero to five scale in Threadless website from • Company produces between four to six new designs each week • Creators of the design are awarded 1000$ each • Company produces only the top scoring submissions and those designs that have received sufficient number of pre-orders from the interested customers	• T-shirts with colorful graphics • Ties • Polo T-shirts
Muji	Household/food/apparel (Japanese)	• Creates professional specs based on members' new designs on website (user-developed items) • Evaluates the feasibility of first production batch and the sales sustainability of the highest ranked ideas • After confirmation of minimum order quantity customers will be asked for pre-orders and company proceeds with manufacturing and distribution	• No-frills products – no brand name or label with 20-30% lower prices than other brand • A type of beanbag sofa with a special filling for more stability and taking less space than traditional sofas • A stylish portable lamp • Freedom-shelf: bookshelf with a hanging mechanism which is movable and does not damage the wall
Yamaha	Musical instruments (Japanese)	• Relying on customers and existing user community • Hobby musicians desired instruments to play without spending too much time for practicing • Design team came up with an electronic guitar that indicates song notes with small lights on fingerboard for the users to follow • Applied suggestions of customers for adding amplifiers and battery power • Minimum pre-orders received • Company sold the item 5 times more than the sales of this instrument category	• Electronic guitar with light indicators

Rocca et al. (2016) conducted a case study in the B2B context investigating the customer involvement within the NPD process and highlighted the vital role of the sales department in customer involvement, whereas marketing is usually seen as a borderline between the company and its customers. They combined the NPD process with customer involvement and proposed a novel scheme with a broader scope called new solution development (NSD). It is stated that the role of sales is particularly important within the early stages of NSD as it forms customer relationships resulting in commercial and technical success (Rocca et al., 2016).

Despite all the existing studies regarding NPD complications and uncertainties, a long-term NPD success might be possible by the collaboration of different supply chain companies within NPD processes (Moreno et al., 2011). Based on a theoretical model developed by Tan and Tracey (2007), manufacturing involvement, supplier involvement and customer involvement create an integrated NPD together that leads to financial performance success. Figure 2.17 framework presents the mentioned claim in detail:

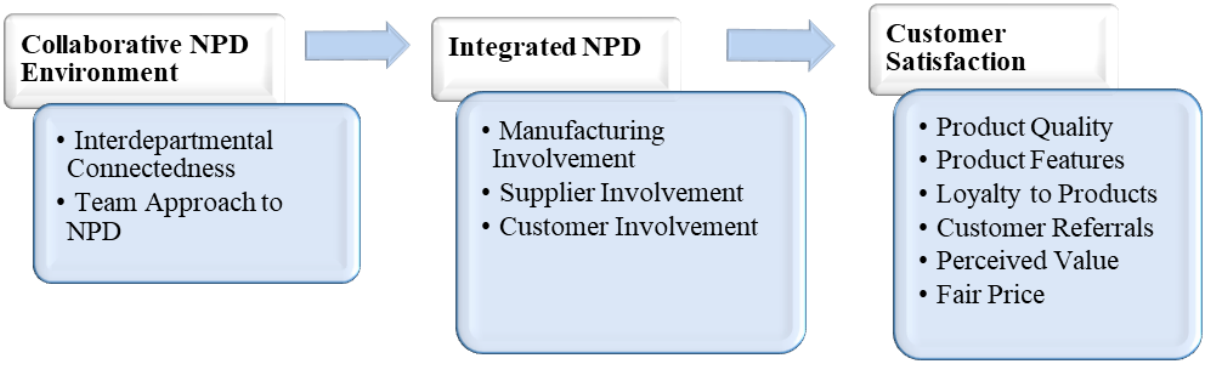

Figure 2.17 Identified Framework Linking NPD and Supply Chain (Tan and Tracey, 2007)

In the first stage, the term "Interdepartmental connectedness" is defined as capturing the degree to which an organisation's culture facilitates effective communication across functional areas (Sethi and Nicholson, 2001), whereas the contacts within the enterprise are considered by the open information sharing to bridge the borders between different parties and members of the firm. The middlebox contains three different functions that act as traditional roles with minimum engagement in the organisation's NPD processes. Hence, the increased involvement from the manufacturing staff, suppliers and customers are required towards creating better relationships between the independent and the dependent variable, which is the ultimate purpose of customer satisfaction with six established factors indicated in the last stage.

The linkage between NPD and SCM is investigated through a Swedish furniture company (Hilletofth and Eriksson, 2011). This company decided to transform its business strategy and focus on unique products with premium prices to become customer-oriented instead of focusing on mass production and low-cost competition with companies such as IKEA. Doing so, they defined some phases for their NPD success. One of their NPD success factors was market intelligence to identify the opportunities for obtaining a profound knowledge about customer demands and strategic market plan (SMP), instead of just focusing on technology innovations. As the priorities of different customers vary from each other, a market segmentation model was also needed. This included several customer segments based on their psychographics and desired design styles. Moreover, with the aid of market segments, new products could be developed to create a genuinely customer-desired company (Hilletofth and Eriksson, 2011).

Reitsma et al (2021) conducted a systematic literature review of 143 papers to explore the supply chain design during product development. They discovered that supply chain design

(SCD) correlates with nine product characteristics which increase the overall complexity of product development projects. These characteristics include product life cycle, modularity, criticality, variety, innovativeness, cost, quality, complexity, and physical properties. It is also indicated that the supplier selection criteria depend on product characteristics. For instance, to collaborate with a supplier on a highly innovative product, it is essential for companies to search for suppliers in broader aspects and outside their existing supply network (Mikkelsen and Johnsen, 2019).

Liao and Wen (2009) studied a world-leading bicycle manufacturing company using knowledge extraction methodology to create customer knowledge patterns to suggest solutions to the aforementioned case firm in terms of demand chain performance. As a result, they found out that the extracted data from customer views should be applied to the supply chain as an input to make an integration between demand chain and supply chain operations. This resource knowledge enhances product innovation capabilities, R&D and marketing strategies of the company along with handling product promotions and customer relationship management (Liao and Wen, 2009).

A study explored the factors that bring uncertainty to the process of NPD and cause struggles for companies for on-time delivery of products or projects (Martinich, 2015). In addition to the technical complications of product development, other NPD uncertainty factors are mentioned as STORRRM uncertainty terms including social/global economic conditions, technology changes, organisational changes, resource adequacy, requirements changes, regulatory changes and market conditions (Martinich, 2015). In addition to the NPD uncertainties, three risk factors are identified for the NPD process, including marketing, organisational and technological risks, which are very common as NPD components. These factors need to be identified, analysed and monitored by different tactics such as learning from customers, sourcing external knowledge and integrating internal knowledge (Mu et al., 2009).

Until recently, different conceptual models for the influence of customer contribution on the product/service innovation process and NPD performance have been presented (Wang et al., 2016; Feng et al., 2016). In between, the common point of all the models is the novel technological capabilities that provide effective communication between customers and the service/manufacturing companies. Moreover, market newness (Wang et al., 2016) and effective collaboration with suppliers (Feng et al., 2016) are considered as significant factors influencing the association between customer involvement and new product innovativeness.

Chien and Chen (2010) established a methodology that utilised a case study to determine how customer involvement, supplier involvement, and cross-functional integrations affect NPD success. They argued that the establishment of cross-functional teams is necessary for bringing together various departments to effectively collaborate with customers and suppliers as external stakeholders. Authors considered opinion boxes and customer interviews among the customer involvement practices, however, they believed there were several issues with their engagement. For instance, customer feedback and viewpoints are immature and do not contain professionalism and can cause conflicts with the company. Therefore, to gain solid, detailed, and unique information on customer needs, companies may consider widening their involvement approaches such as using customer surveys. The authors recommended future authors develop a model to understand the relationships between NPD projects and knowledge management, customer relationship management and as a result, the firm's performance (Chien and Chen, 2010).

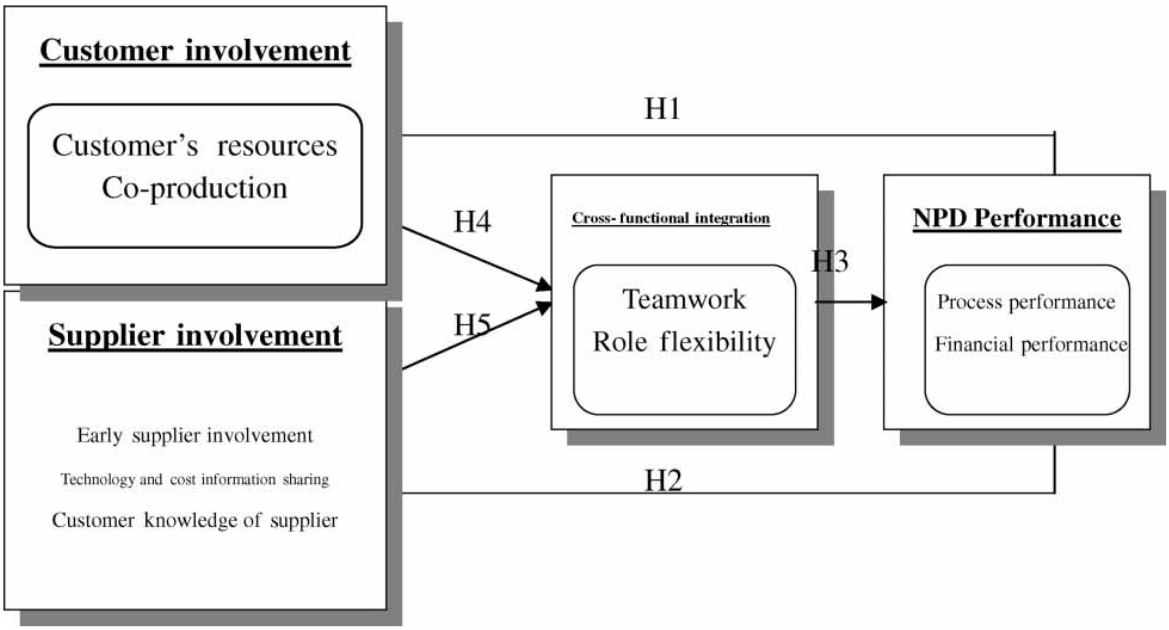

Figure 2.18 A framework of Supplier and Customer Involvement on NPD Success (Chien and Chen, 2010)

2.7 Sustainable Development and its Linkages to Supply Chains

In 1987, the Brundtland Commission (WCED) defined 'sustainable development' as a collaborative work between governments, industry and academia; and also explained it as "Seeking to meet the needs and aspirations of the present, without compromising the ability to meet those of the future". In general terms, sustainability refers to three interrelated areas known

as triple P (bottom line) of sustainability, including, people, planet and profits, or in other words, environmental stewardship, social equality and economic success (Fuad-Luke, 2009). This is also known as TBL of sustainability. The concept of sustainable product design (SPD) was formed in the late 1980s, and in 1992, the United Nations Commission on sustainable development (UNCSD) was established in Rio and considered business as a crucial concept that is integrated into many factors in environmental criteria from green procurement to after-sale services, recycling and the promotion of sustainable consumption. In 1995, the alliance of 120 international companies merged into the world business council for sustainable development (WBCSD) which was committed to the principles of economic growth and sustainable development. They described sustainable production and consumption as "Involving business, government, communities and households contributing to environmental quality through the efficient production and use of natural resources, the minimization of wastes and the optimization of products and services" (Fuad-Luke, 2009). From Walker's (2006) point of view, sustainable development aims to an undefinable and unachievable goal which worth targeting but does not ever reach an actual arrival point. Hence, it is far more an ideal insight rather than a feasible possibility. Walker (2006) suggested that sustainable development necessitates deeper social justice and upgrading the people lifestyle, especially in developing countries.

The complexities of sustainability applications in supply chains have been widely debated in academia and industry. Recently, manufacturing companies are making effort to integrate and commit different components of their supply chain networks into TBL. Also, within literature research studies, the authors have made several attempts to generate conceptual frameworks exploring the effective linkage between supply chain and environmental sustainability considering the supply chain operations from the strategic to operational levels of the company. This is formed by highlighting different sustainable solutions across supply chain entities such as sustainable logistics, sustainable procurement and SPD (Göçer et al., 2012; Stnidt, 2017). For instance, among the sustainable product design and manufacturing techniques, Industry 4.0 employs novel intelligent production systems to address market segments. Such practices tend to contribute not only to the optimisation of manufacturing processes and operations but also to the minimisation of environmental impacts and sustainability as secondary goals (Ford and Despeisse, 2016; Machado et al., 2020).

2.7.1 Overview of Sustainable Supply Chain Management (SSCM)

There are several definitions for the SSCM concept. According to Carter and Rogers (2008), SSCM is defined as "The strategic, transparent integration and achievement of an organisation's social, environmental, and economic goals in the systemic coordination of key inter-organisational business processes for improving the long-term economic performance of the individual company and its supply chains". Badurdeen et al. (2009) defined it as "Involvement of the planning and management of sourcing, procurement, conversion and logistics activities involved during pre-manufacturing, manufacturing, use and post-use stages through the life-cycle stages between companies by explicitly considering the social, environmental implications to achieve a shared vision". SSCM also seems to have common features with the recent circular economy (CE approach). CE is a novel economic model that is nowadays being replaced by the traditional and linear economy models (Pinheiro et al., 2019) and considers a closed-loop system where the manufactured products are considered from cradle to cradle instead of cradle to grave (McDonough and Braungart, 2010).

Based on the theory of natural-resource-based view (NRBV), the competitive advantage of a corporation is mainly determined by its interaction with the natural environment (Hart, 1995). Hence, supporting sustainable development imperatives provide the potential for differentiation and market dominance. According to the developed conceptual framework, there are three interconnected capabilities that firms can build including pollution prevention, product stewardship, and sustainable development (Hart, 1995). Each of these factors acts as a driver towards environmental protection. Pollution prevention capabilities help reduce emissions and waste. Product stewardship capabilities help reduce product life-cycle costs. Capabilities for sustainable development minimise the environmental impact as a result of a company's growth and development (Hart, 1995).

2.7.2 SSCM Drivers

Figure 2.19 shows the triggers for SSCM including government, customers and stakeholders. Two distinct strategies emerge from this framework. The first is supplier evaluation for risks and performance, which includes environmental and social standards. The second is the SCM for sustainable products which require supply chain life cycle criteria (Seuring and Müller, 2008a).

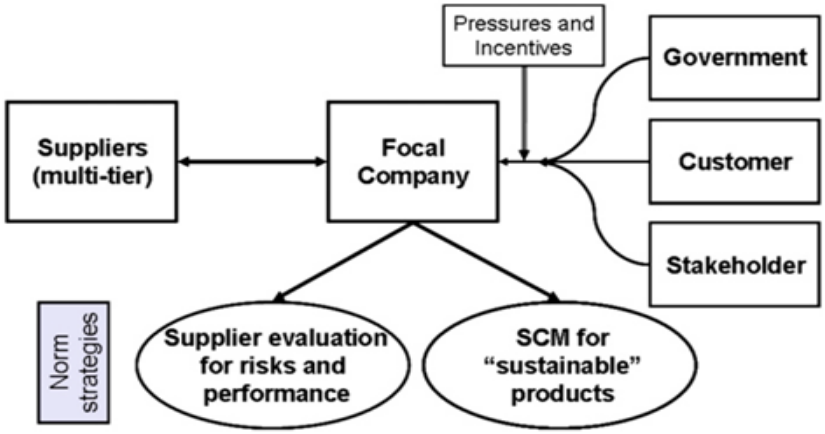

Figure 2.19 Triggers for Sustainable Supply Chain Management (SSCM) (Seuring and Müller, 2008a)

Market pressure is seen to play a significant role in shifting industrial behaviour toward more sustainable practices, and some corporations have established "suppliers' charter" outlining the environmental criteria they expect from their suppliers (Mackenzie et al., 1991). For instance, the government institutions and departments in Germany are required to purchase sustainable goods such as recycled papers, Wal-Mart Retailing Corporation in the US and B&Q in the UK are asking their suppliers for the development of eco-friendly products and adoption of environmental practices. One of the largest supermarkets in Denmark established its technical research programme in 1990 and set new environmental policies while prohibiting the use of PVC in product packaging and enforced its suppliers to utilise recyclable packaging materials (Mackenzie et al., 1991). Meixell and Luoma (2015) pointed out that stakeholder pressures can lead to sustainability awareness and adoption of sustainability goals, however, different stakeholders have dissimilar influences depending on the focused sustainability pillar.

2.7.3 Strategies for SSCM Transformations

The main aim of SSCM practices is highlighted as maximising financial profits as well as minimising the negative environmental impacts (Carter and Euston, 2011; Hassini et al., 2012). The application of SSCM implementation is still in its early stages of development (Grant et al., 2015), and this could be due to the lack of comprehensive agenda towards effective SSCM (Brockhaus et al., 2013). The common point of almost all the existing SSCM frameworks is the necessity of shifting the mindsets of managers and business leaders towards greening and its benefits. The adoption of SSCM would not only provide financial benefits to the companies but could also be fruitful for them in terms of economic savings in the long term. Indeed, implementation of eco-friendly strategies and operations requires allocation of extra budget for

R&D, purchasing new devices, materials, machines, transportation systems, technical know-how and also personnel training programmes. Moreover, the resilience of business leaders and senior managers in terms of supply chain transformation and adoption of novel and updated sustainable strategies is undeniable especially within the developing countries, companies running by owner-managers or elderly executives. Hence, transformation of organisational culture, transparency and risk mitigation strategies are suggested by many authors towards the adoption and success of SSCM (Abukhader and Jönson, 2004; Carter and Rogers, 2008; Seuring and Müller, 2008b; et al., 2012; Walker and Jones, 2012; Zailani, 2012; Beske and Seuring, 2014; Gao et al., 2017).

Researchers have suggested that enhancing company's sustainable supply chain performance (SSCP) can improve the company's capacity by reducing the material usage, energy, water resources and finding more co-efficient solutions (Ortas et al., 2014). SSCM is also considered as a catalyst of sustained inter-organisational competitive advantage since they are socially complex, causally ambiguous and historically grown and also hard to imitate by competitors (Gold et al., 2010). A framework of SSCM categories and practices is provided as an extension to previous studies to compare the SSCM to conventional (traditional) SCM practices (Beske and Seuring, 2014). There are three differentiating factors for SSCM including, triple bottom line, stakeholder management and life-cycle assessment (LCA). From the standards and certification aspects, both conventional SCM and SSCM utilise them. However, SSCM applies a particular set of standards corresponding to its sustainability goals (Beske and Seuring, 2014).

The strategies for adoption of SSCM are well-defined in Figure 2.19, which extends the supply chain operations reference (SCOR) model developed by the supply chain council (SCC) and adds the sustainability factor on top (Bernon, 2010). Risk mitigation in the upper level indicates that companies need to consider the whole supply chain to evaluate their business risk. Reputational risk is vital in this case, as companies may assume that they are performing well in their supply chain. However, if their upstream suppliers are executing their business in an unsustainable way, it may have an impact on their brand reputation as well. The next level is cost mitigation, where there are many cost-cutting opportunities by looking through the lens of sustainability within different supply chain stages such as waste minimisation, lightweight packaging, and efficient transportation. Building on risk and cost then leads to competitive advantage. For instance, Marks and Spencer has created a whole brand strategy towards sustainability called plan A, including a 100-point action plan across every entity of the business and throughout the whole supply chain with a £200m budget. This brand strategy undoubtedly provides them with a distinct competitive advantage over their competitors (Bernon, 2010).

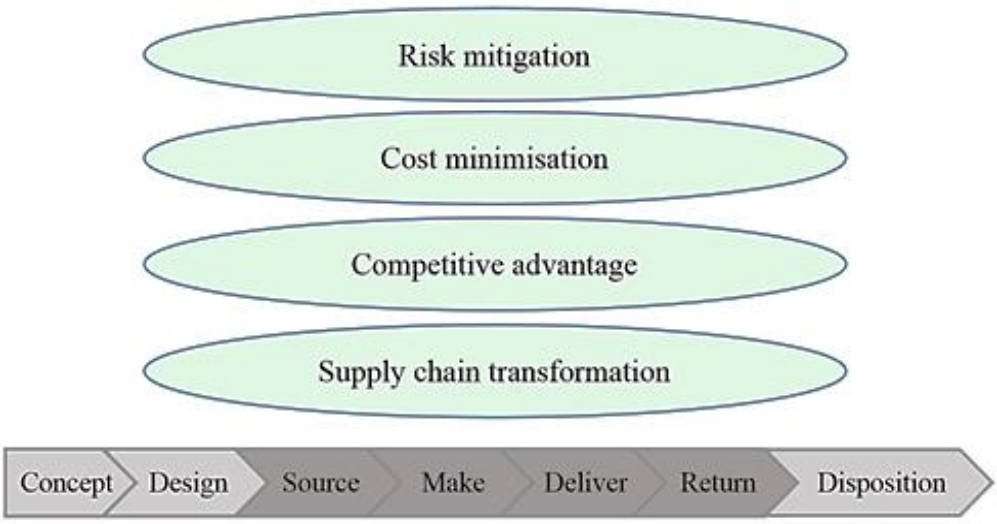

Figure 2.20 Strategic Approaches for SSCM (Bernon, 2010)

The last level in Figure 2.20 is supply chain transformation that can make radical changes in terms of sustainability. Supply chain transformation can be implemented in different ways. A practical example is sustainable logistics (contract logistics) (McKinnon et al., 2012). It is estimated that only 25% of the world networks are efficient, and this means most of the supply chain transportation systems and vehicles are running empty. Therefore, companies with identical products, close distribution centres and destination points can share their logistic networks and instead compete in their brand and stores. For instance, in the UK, Nestlé and United Biscuits are now sharing their vehicles to conserve costs and the environment, despite being competitors (Bernon, 2010). Nestlé has claimed that by doing this, it has reduced the running of empty vehicles by 270,000 kilometres per year since 2007 (Nestlé.com, NA). Figure 2.21 indicates the sustainable supply chain within different stages from the very beginning of raw material purchasing to recycling, meaning that the sustainable practices can benefit the manufacturing environments from the product cradle to grave and from operational to strategic level (Stindt, 2017; Göçer et al., 2012). However, “cradle to cradle” can be a more appropriate term to explain the new approach of a closed loop of full recycling of product generations (McDonough and Braungart, 2010). Scur and Barobosa (2017) evaluated green supply chain practices within a multiple industrial case study and found out that waste management is the most utilised technique, while green purchasing and LCA are less considered.

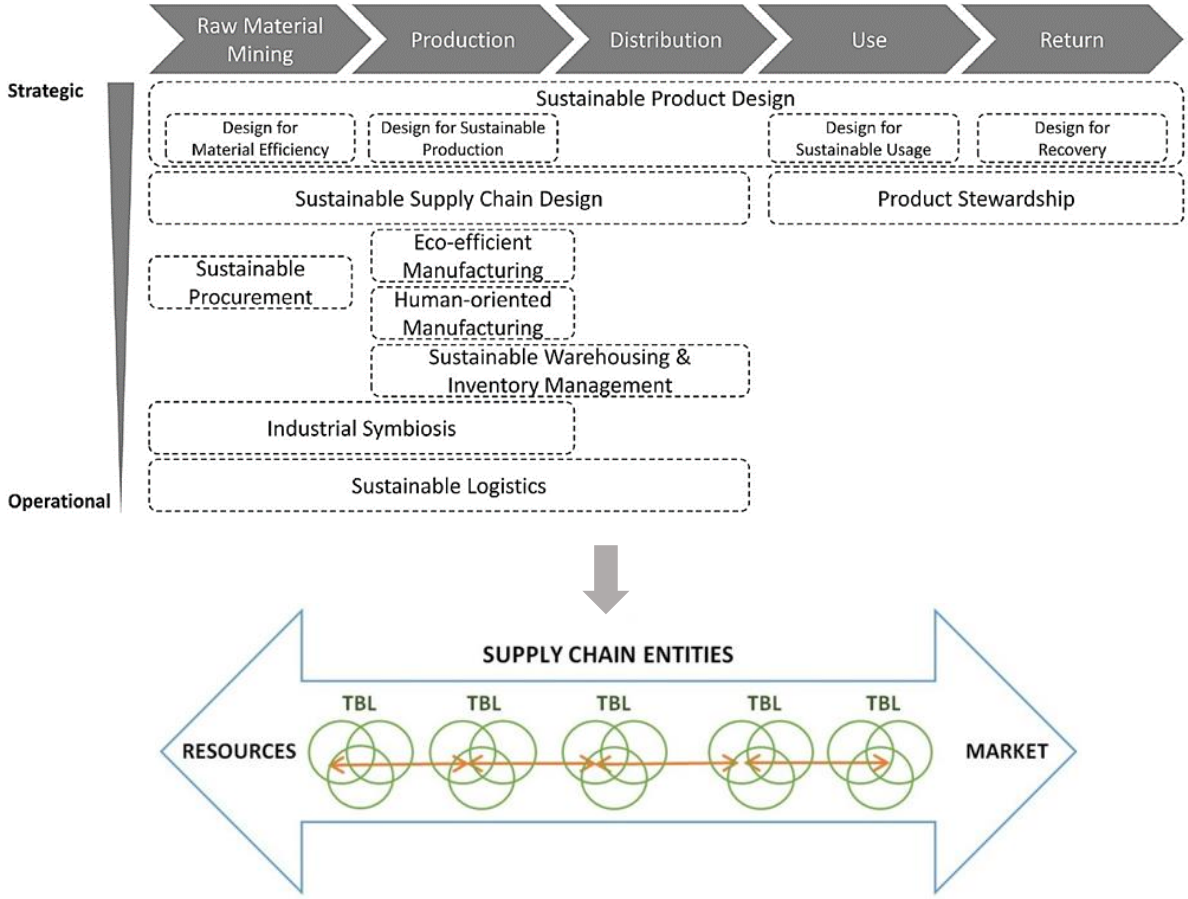

Figure 2.21 SSCM Concepts along the Value Chain (Göçer et al., 2012; Stindt, 2017)

Sustainable production and consumption are described as "Involving business, government, communities and households contributing to environmental quality through the efficient production and use of natural resources, the minimisation of wastes and the optimisation of products and services (Brundtland Commission, 1987)". Sustainable development, especially within global scales, necessitates deeper social justice and upgrading the people lifestyle, especially in developing countries (Walker, 2006). The remarkable growth of global trade has been facilitated in recent decades, thanks to regional trade agreements such as the European Union (EU) and Association of Southeast Asian Nations (ASEAN) (Mangan et al., 2012). For successful global trade, the term "glocalisation" is suggested to think globally and act locally. Several cases of global manufacturing businesses could be employed to revolutionize and transform the traditional supply chain patterns effectively and sustainably. McDonald's is a good example of this, since it offers both globally well-known products such as Coca-Cola and typical burgers, as well as adopting the local perspective of offering specific items to satisfy the desires of local people (Mangan et al., 2012).

Carter and Rogers (2008) recommended a theoretical framework for SSCM (Figure 2.22). The core concept of the framework is sustainability, including its three pillars with four supporting elements contributing to the SSCM. According to the authors, the TBL of sustainability provides the company with numerous benefits such as lower costs, shorter lead times, improved product quality, reduced disposal costs, improved working conditions and enhanced company's image leading to both supplier and customer satisfaction.

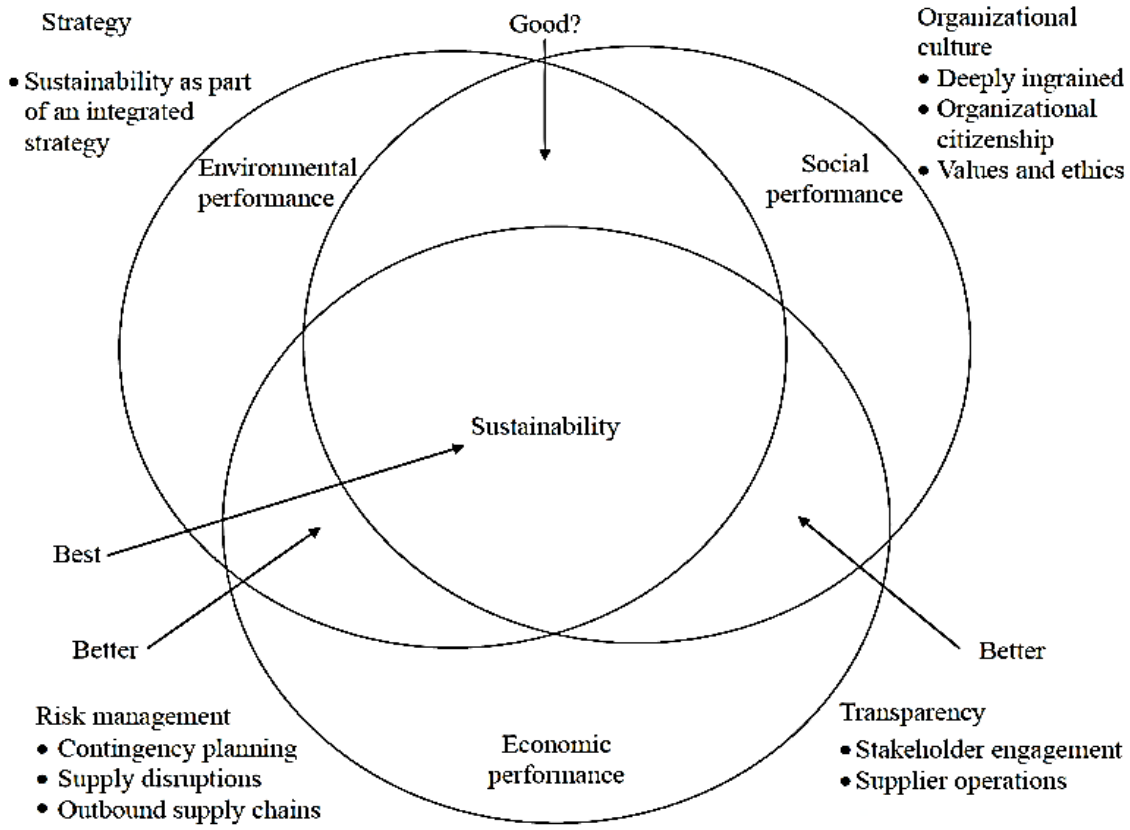

Figure 2.22 SSCM (Carter and Rogers, 2008)

For the effective implementation of sustainability within industrial organisations, codes of conduct (ethical codes) have been defined, comprising of four different parameters including labour practices, corporate governance, supplier practices, general morals and ethics (Fuad-Luke, 2009). For the codes of conduct to be effective, the full commitment from top management would be necessary to apply supply chain performance measurements and metrics and also redefine the company vision and mission considering TBL. In doing so, each firm needs to evaluate its sustainable initiatives with the aid of specific techniques such as environmental management system (EMS) and life cycle assessment (LCA). Despite the

applications of codes of conduct, according to a systematic review by Nakamba et al. (2017), it is believed that there is a need for the development of new tools to capture and measure the actual performance level of social sustainability within the firms. Apple Company as a world supply chain master (Aronow et al., 2016) is currently conducting the supplier auditing scheme by sending Apple auditor to lead every on-site audit, supported by expert local third-party auditors who are trained for using Apple's auditing protocols and codes of conduct (Grant et al., 2015). Moreover, there perform some annual audits for their tier-1 suppliers and further audits for suppliers with certain risk levels (Grant et al., 2015).

Sajjad et al. (2020) classified internal and external barriers to SSCM adoption based on results from interviews with 23 New Zealand-based enterprises. The most important internal barriers include cost issues, strategic and structural obstacles. The external barriers include supply-side issues, demand-side issues, government regulations or legislation as well as the lack of public awareness, cultural dimensions and proper standards.

A study by Mores et al. (2018) investigated the innovation process in the development of green plastic through the sustainable supply chain perspective. This innovation replaces naphtha (a non-renewable resource) with ethanol from sugarcane (a renewable one). The green plastic utilisation adds value to the final product as well as both upstream suppliers and downstream customers. The increase of sugarcane production enhanced the sustainability considerations by ethanol suppliers through the implementation of codes of conduct both in terms of social and environmental dimensions. The focal company also identified potential customers and created the "I'm green" logo for taking their attention.

A study was conducted by Andalib Ardakani and Soltanmohammadi (2019), including 91 industry experts to identify the interrelationships between SSCM, green product development and EMS. The study highlighted that the SSCM practices might result in a competitive advantage in the production process and product sales as well as boosting financial performance and economic growth.

In light of various frameworks and research studies regarding SSCM, Touboulic and Walker (2015) still believed that there is no equal consideration towards all the aspects of sustainability, and this shows the necessity to review and make a profound investigation into understanding the concept of SSCM including all its three pillars. Likewise, it is believed that unanticipated effects relating to negative social and environmental aspects are generally underestimated, according to the fact that sustainability trade-offs and tensions tend to mostly focus on economic criteria rather than sustainability pillars (Ye et al., 2020).

A recent study by Matos et al. (2020) made a critical review of unanticipated outcomes, trade-offs and tensions in sustainable operations and supply chain management (OSCM) identifying how these factors may hinder businesses towards more sustainable practices. The authors have classified trade-offs into land-use versus CO2 emissions reduction, financial versus environmental objectives, social versus environmental objectives, supply chain resilience versus sustainability, economic versus environmental versus social objectives altogether, product quality versus environmental concerns. Some of the tensions are named as procurement sustainability tensions, buyers' and suppliers' responses to tensions, innovations' cognitive requirements and price and flexibility pressures. Likewise, some of the unanticipated outcomes in the pathway towards sustainability are sorted into supply chain protectionism, price inflation, unintentional environmental impacts and opportunistic behaviours (Matos et al., 2020).

2.7.4 Sustainable Demand Chain as a Replacement

Sustainability applications would be further studied using the novel terminology of "sustainable demand chain management" as supply chain strategies gradually shifted from purchasing-based to customer-based (market-oriented) (Vural, 2015). Due to the uniqueness of this concept both within literature and academia, no clear definition is suggested for it yet. Santos and D'Antone (2014) have also made recommendations for future research studies towards the integration of marketing operations into business sustainability, which might be a great foundation for a better understanding of SDCM. However, it has been tricky to find many scholarly types of research regarding SDCM.

The first attempt towards the formation of this notion was formed by Vural (2015) which was followed by previous recommendations of literature for aligning sustainability operations with the downstream view of rapidly changing markets and customers as well as their sustainability expectations. The highlighted framework is indicated in Figure 2.22 which is inspired by previous studies emphasising customer orientation and DCM perspective (Santos and D'Antone, 2014). It has adopted its different components from the studies by (e.g., Walters, 2006; Seuring and Müller, 2008a).

The main aim of the framework is to create sustainable value propositions or value creation that results in competitive advantage (Vural, 2015). However, as Porter (2008) claimed, value is not the performance indicator determined by the supplier points of view, rather a concept that should be evaluated from the end-users and consumers' point of view. As claimed by Porter (1998), value is "The amount that a buyer is willing to pay for a market offering, and it is created by the distinct activities of an organisation which altogether form the value chain". Considering

the definition of "value" as the main aim of this framework and customers as stakeholders who evaluate the value, it makes sense that the model considers the customers as the most important stakeholders and members of the supply chain. It was stated that in typical sustainable supply chains, environmental and social criteria have to be defined and fulfilled by supply chain entities to meet customer needs and gain profitability (Seuring and Müller, 2008a). In this scenario, customers have no say in how the environmental and social components of sustainability are expressed. With an alteration from SSCM to SDCM, customers and their sustainability expectations will be the starting point of the chain (Vural, 2015). In other words, SDCM takes the customer perspective and transforms the traditional purchasing focused flow of the supply chain while taking its goals from the triple P of the business (Vural, 2015).

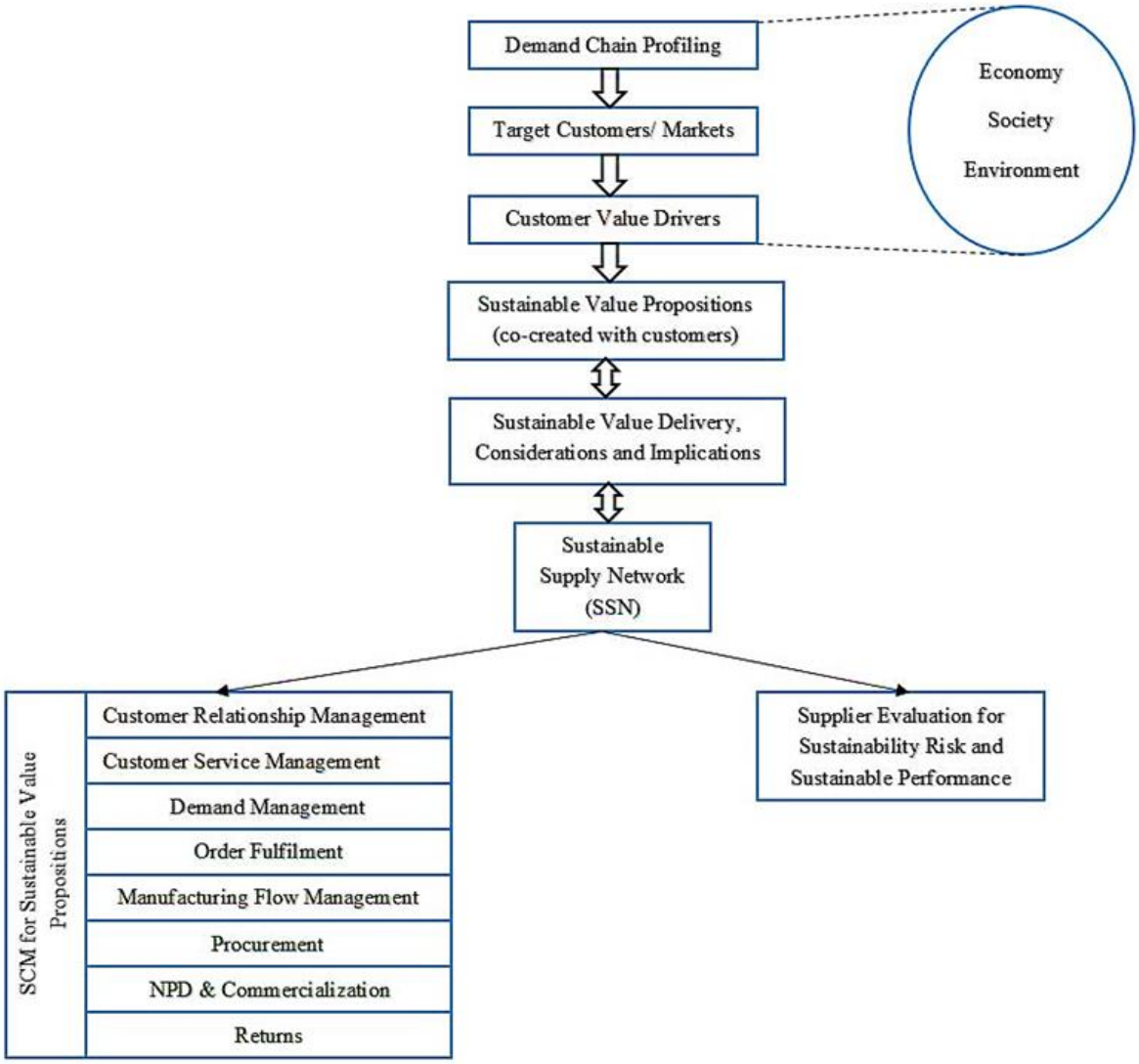

Figure 2.23 A Conceptual Framework for Sustainable Demand Chain Management (SDCM) (Vural, 2015)

The SDCM model starts with demand chain profiling and the information flow derived from the evaluation of business environments based on the TBL, their influences on the market's buying preferences and analysis of consumption patterns. Afterwards, the target customers, markets and their sizes need to be monitored and determined in terms of customers' sustainable value drivers or TBL of sustainability. Vural (2015) referred to this stage as a similar configuration dimension of the study by Jüttner et al. (2007), indicated in Table 2.7. The information derived from the analysis of market segments and customer perceptions will then be used as inputs towards the creation of sustainable value propositions. A sustainable value proposition includes monitoring and profiling the sustainability dimensions required by the customer as well as benefits and costs associated with sustainability. Afterwards, there is a need to consider the sustainable value delivery of the value propositions (Vural, 2015). The model highlights an integration between purchasing and marketing entities at the sustainable value delivery stage. Sustainable value delivery finally leads to the creation of a sustainable supply network (SSN). SSN is where multiple entities of the supply chain utilise multiple resources to gain sustainability principles within a value chain instead of a radical single firm-centric approach exerting power on the suppliers linearly and simplistically (Vural, 2015). As obvious from Figure 2.23, one of the supply network members is the NPD and commercialisation, being one of this study's pillars. As Vural (2015) stated, NPD and commercialisation also need to manage their processes and use the resources regarding sustainability information received from target markets with the purpose to fulfil the sustainable value propositions.

The framework is a first step in integrating market and customer information with SSCM practices, transforming the old vision of a sustainable supply chain into a customer-driven sustainable demand chain (Vural, 2015). This is the sole publication that provides a conceptual framework/model for SDCM, thus it would be a worthwhile endeavour to be used in this study.

By replacing the SDCM perspective with SSCM, sustainability will be integrated into activities beyond the main supply chain concepts such as involving customers in the management of by-products generated after the home or industrial use and product life extension (Linton et al., 2007). Moreover, in a typical SSCM, the three pillars of sustainability need to be defined and satisfied by all the stakeholders to survive within the supply chain (Seuring and Müller, 2008b), while in SDCM, these are the customers who define the implementation level of sustainability pillars. Hence, companies need to explore and analyse their target markets based on the demand chain criteria to develop value propositions according to their market intelligence operations (Walters, 2008).

SDCM is a concept that can further address the existing gaps regarding the integration of DCM and NPD concepts in parallel with the objectives of this research as suggested by many scholars as well (e.g. Liao and Wen, 2009; Chien and Chen, 2010).

2.8 Sustainable New Product Development (SNPD)

The key advantage of sustainability is the capacity to provide solutions for key business problems to be able to deliver better sustainable products and services or their combinations (Hansen et al., 2009). It has been described that the focus of innovative measures and practices leads to better sustainability-related opportunities (Schaltegger and Burritt, 2014). With the rapid changes of customer demands and advanced practices that have been applied within product-based manufacturing environments, many companies are now operating in less secure and more complex structures to facilitate these rapidly evolving changes within the manufacturing requirements. Organisations currently place a greater emphasis on short-term cost-effective production rather than long-term relationship development amongst the supply chain parties. Redante et al. (2019) highlighted that design thinking (DT) may boost stakeholder engagement in green product development projects (GPDP) if an appropriate background in terms of effective leadership, values and cultural aspects are established.

To achieve this, manufacturers need to enhance their operational abilities through adopting and linking the traditional manufacturing requirements such as lean and agility with wider business strategies including marketing, sales, technology adoption as well as product and process innovation measures within their environments (Pham and Thomas, 2011).

Based on a theoretical framework illustrated in Figure 2.24, three main critical incentives have been categorised that result in eco-friendly product development strategies and finally lead to product development effectiveness (Katsikeas et al., 2016). These incentives include top managers' commitment, corporate environmental support policies and environmental incentives. Senior managers, as dominant authorities in each organisation, have the ability to empower the employees to change their mindsets towards thinking greener. As Gavronski et al. (2011) suggested, managers' commitment, support and belief in CSR help them to communicate with employees to make them realise the firm's environmental roles and the strategies that are necessary for critical green activities. Moreover, according to Menguc et al. (2010), the more passionate managers are about environmental preservation, the more they may encourage their staff to adopt ethical and greening approaches.

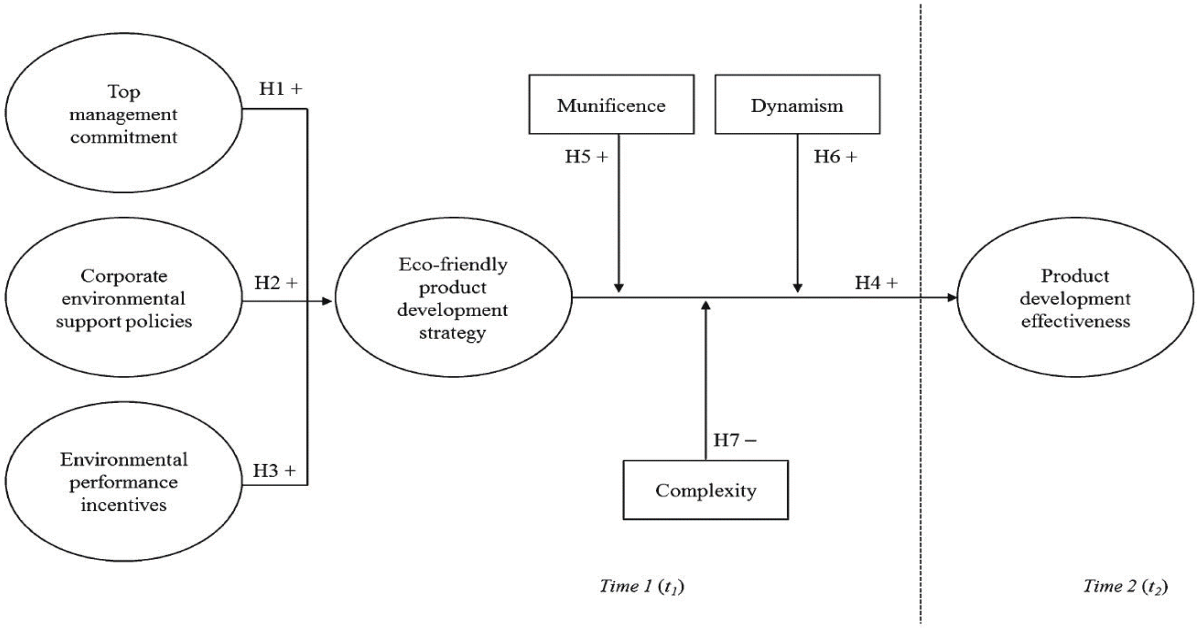

Figure 2.24 A Conceptual Model on Eco-friendly Product Development (Katsikeas et al., 2016)

According to the findings of a study by Pujari et al. (2003) indicated that UK manufacturers are shifting towards an environmental responsive paradigm at the product development level as most of them have established corporate environmental policies taking into account the environmental measures in NPD projects. It was also highlighted that the current focus is mostly on the reduction of the environmental impacts of conventional products. Therefore, a transition towards the development of eco-friendly products, re-engineering, cleantech concept and closed-loop of product consumption is suggested. It was mentioned that one of the advantages of environmental new product development (ENPD) over conventional NPD is its focus on customer satisfaction which also addresses the quality, functionality, costs, and product lifecycle from production point to disposal (Pujari et al., 2003).

Pinheiro et al. (2019) conducted a systematic review to find out the level of integration between NPD and CE. The three main drivers for NPD in CE were highlighted as legislation and regulations, internal company strategies and characteristics, and competitive factors (Pinheiro et al., 2019). Furthermore, the main barriers in the adoption of NPD in CE are related to consumers and society, technological aspects, financial aspects and metrics quantification (Pinheiro et al., 2019).

Finally, based on a mixed-method study, Kalish et al. (2018) highlighted that the most important reasons for companies to apply sustainability into their NPD projects include competitive advantage, market differentiation and product or service enhancement. This is while only a low percentage of companies pay credit to rules and regulations. Kalish et al. (2018) suggested some practical suggestions to companies and identified six different tools to integrate sustainability into NPD projects. These tools include NPD checklists, LCA tools, material screening tools, the Eco-design Strategy Wheel and supplier scorecards.

Utilising the existing theoretical models, Berchicci and Bodewes (2005) presented a model explaining the emerging risks and challenges towards the incorporation of environmental measures into product development (Figure 2.26). Understanding these implications may help us find an appropriate match between environmental issues and market demand. According to the authors, the success of NPD projects is determined by their nature and level of innovation. In this context, newness signifies products that are highly innovative and may encounter risk and uncertainty when entering the market. NPD teams will be dealing with three important factors when aiming to incorporate environmental concerns within NPD. These include different aspects of greening related to design specifications such as market demands, environmental attributes and product functionalities that make greening a complex procedure. From a market perspective, some aspects of product specifications that are important by a development team might not be important to consumers and they might have a neutral vision regarding the environmental aspects of the product they purchase. From a design viewpoint, environmental attributes refer to recyclability, recycled content, fuel efficiency, toxic content reduction and emission-related performance (Chen, cited by Berchicci and Bodewes, 2005). When focusing on these parameters, due to their misalignment with customer preferences, the chances of new product success can be remarkably reduced. Likewise, there might be an incompatibility between environmental attributes and traditional product attributes, or product functionalities such as safety and reliability.

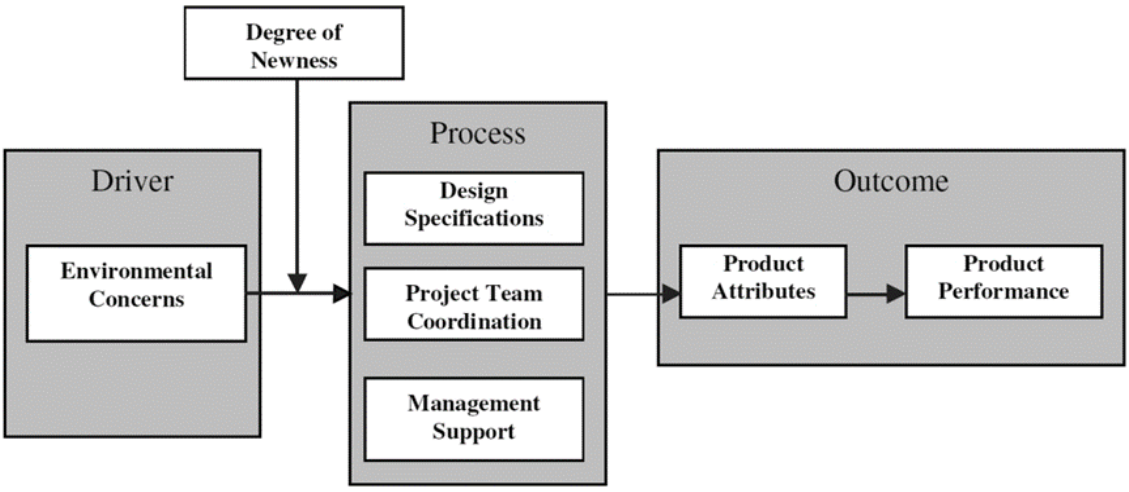

Figure 2.25 The Influence of Environmental Concerns on Product Performance (Berchicci and Bodewes, 2005)

According to the next conceptual framework in Figure 2.26, Du et al. (2016) believed that the sustainable orientation (SO) of a firm has a positive association and influence on NPD performance. In this model, customer focus (CF) acts as an intervening variable that mediates the relationship between SO as an independent and NPD performance as a dependent variable. They consider moderating roles of social media-driven inbound open innovation (SMOI) into the linkages of SO, CF and NPD and; categorising SMOI into SMOI-market and SMOI-tech. The idea behind the SMOI concept is to provide open innovation to change the traditional innovative practices and the way that companies search for external ideas and knowledge towards their NPD enhancement. SMOI activities such as social media or web 2.0 technologies are the inbound open innovation platforms that companies employ to facilitate their external research and gain knowledge outside their boundaries. SMOI activities can be among a broad range of social media platforms such as Blogs, Wikis, Ratings & Reviews, Flikr/Photobucket, Twitter, YouTube and Facebook. Companies such as Procter & Gamble, Unilever, Nike Adobe, Pepsi have been adopting SMOI practices within their NPD projects to gain knowledge on market trends, innovative concepts, new product features, product usability and market segments. Authors defined "SMOI-market" as the degree that a firm makes efforts to gather information regarding market segments and customer requirements. An example is Lego's social media-based innovation hub that gathers new product ideas from its customers and markets. On the contrary, "SMOI-tech" tends to gather technical and solution information from all the supply chain stakeholders (not merely customers) which are relevant to the final stages of NPD. Their main goal is to transform the gathered knowledge into new products with advanced technical features (Du et al., 2016).

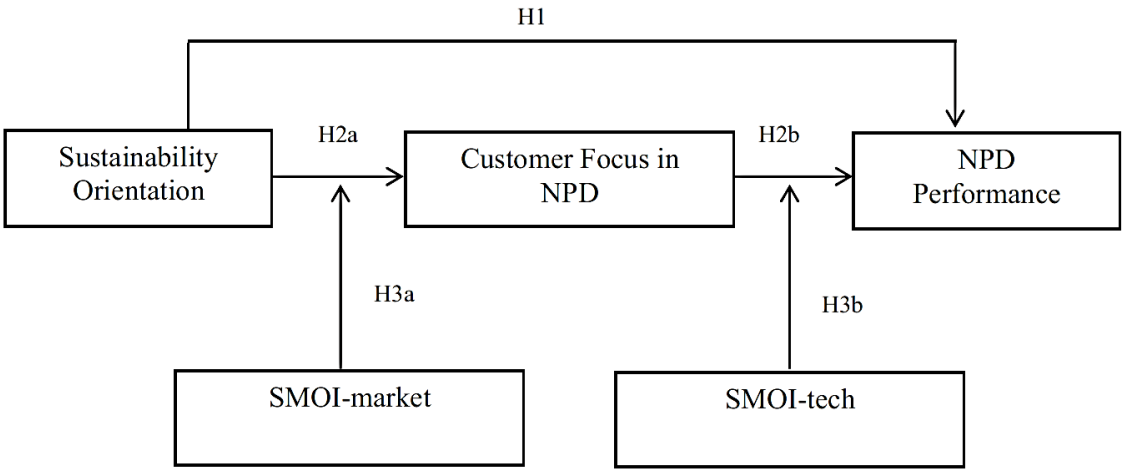

Figure 2.26 Conceptual framework Linking Sustainability and NPD Performance (Du et al., 2016)

2.8.1 Sustainable Practices within the Design stage of NPD

By adding sustainability function to the design aspect of NPD, the challenge of conventional design versus sustainable design needs to be discussed. Conventional design, in particular, industrial design, refers to particular sets of knowledge and skills that are being applied since the early 20th century to design products for large-scale distribution (Walker, 2006). It presents mass-produced products to mass markets, which often have a short life span. According to Walker (2006), sustainable development is a new journey of exploration with an uncertain route and unknown territory that industrialists, economists and politicians face complications in understanding and the way to associate it with long-established industrial and economic models. Due to this uncertainty, sustainable designers are not in a comfortable zone, since the existing conventional methods are unsustainable and being a sustainable designer is to be on an undefined ground. Besides, the modification of existing models is not an effective strategy, and changes towards sustainable culture take time and require incremental steps. Walker (2006) stated that due to a mismatch between sustainable principles and conventional design priorities as well as the differences between their characteristics, developing an effective association between these two requires new approaches. It was also suggested that traditional cultures can be an excellent reference for sustainable designers to take some inspiration into the diversity and richness of folk design. However, it would be a challenge for them to integrate the local and global to create products that are compatible with modern societies (Walker, 2006).

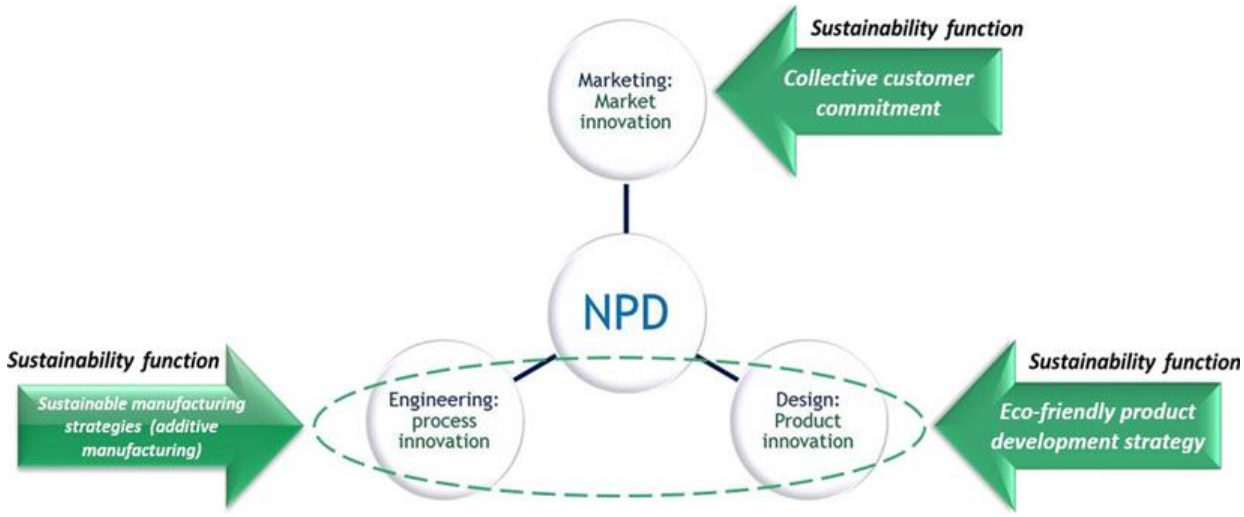

Figure 2.27 Adding Sustainable Function to NPD Components
(Adapted from Vinayak and Kodali, 2014)

Reviewing the history of sustainable (green) design, Fuad-Luke (2009) stated that the founders of the British arts and crafts movement (1850-1914) examined new methods to reduce the environmental damage associated with the mass production of new industries. Due to the shortage of material and energy supplies during the 1950s in Europe, some car manufacturers such as Fiat, Citroen and British Leyland introduced economical and fuel-efficient cars to the markets, while American Chevrolets, Cadillacs and Buicks were still producing heavyweight and gas-guzzling cars. By increasing the oil price in 1974, the energy crisis rose and encouraged scientists to study the life cycle of a product, its consequent energy supplies and finally come up with a new concept, as we know it as lifecycle analysis (LCA) today.

According to Stauffer (1997), a product can be only qualified as being environmentally friendly when its life cycle 'from cradle to grave' respects the requirements of the environment. Today many LCA and lifecycle inventory (LCI) packages can help designers assess the environmental impacts of the products from cradle to grave. LCA analyses the environmental impacts of the products in four major phases, including production; transport/ distribution/packaging; usage; disposal or end of life/design for disassembly or recycling. In recent years, product lifecycle management (PLM) has been allocated major attention in engineering management and production (Gmelin and Seuring, 2014). Hence, new concepts such as Design for environment (DfE), eco-efficiency, eco-design and EcoReDesign were developed by academic communities to describe specific types of green design (Fuad-Luke, 2009).

2.8.2 Sustainable Practices within Manufacturing stage of NPD

By adding sustainability into engineering aspects of manufacturing, novel manufacturing practices need to be considered. Mass customization (MC) as both manufacturing and marketing technique seeks to fulfil customer desires of specifically customised products which are also in parallel with demand satisfactions. For dealing with rapid market fluctuations and selective customers, robust IT platforms and technologies are required to assist organisations in the implementation of demand-driven approaches (Budd et al., 2012). These technology facilitators are different based on the company size, type of innovative marketing practices (postponement, mass customisation, collective customer commitment) and also the type of manufacturing practices they would utilise such as AM or digital manufacturing. IT infrastructures such as 3D scanning, modelling, and 3D printing are now helping MC operations to come into practice. Companies such as Shapeways are currently practising such developments providing customers with an online website to design and develop a wide range of their required products which will then be manufactured by 3D printers and delivered to them (Gandhi et al., 2014). By doing so, the distance between manufacturer and end-users will be minimised due to the elimination of supply chain entities in between, such as warehouses, distributors, retailers and shoppers. This approach fulfils both SNPD and DCM.

Industry 4.0 (also called as fourth industrial revolution) is coined by Germans in 2011 and aims to employ nine emerging technologies for flexible, efficient, high quality, low cost and sustainable manufacturing purposes. Such practices not only tend to contribute to the optimisation of manufacturing operations but are also in line with sustainability and minimising environmental impacts as their subsidiary objectives. Besides, Industry 4.0 can help NPD projects by shortening the distance between manufacturers and customers and increase profitability. AM (3D printing) is among one of the Industry 4.0 emerging technologies that is transforming the manufacturing operations from make-to-stock to make-to-order and mainly aims to minimise material waste, product weight, product inventories and logistic costs (Machado et al., 2020). However, there are several academic debates regarding sustainability challenges of AM adoption such as limited speed and reliability, high machine costs or limited recyclability of AM-produced goods (Ford and Depeisse, 2016).

2.8.3 Sustainable Practices within the Marketing stage of NPD

By adding sustainability function to the marketing aspect of NPD, conventional market research and the new innovative marketing practices need to be compared. In this regard, several marketing approaches such as postponement, or collective customer commitment are already discussed in section 2.6. The conventional market research towards NPD purposes is a

traditional and heavy form of market research for testing new product concepts, including "focused groups" which has several limitations (Ogawa and Piller, 2006). Firstly, the results of the test are based on a few numbers of consumers and do not indicate the feedbacks of broader populations. Secondly, people are not provided with the exact benefits of the products and are often being given only verbal explanations of concepts without knowing their unique features. Thirdly, the focused groups are not able to quantify the real customer purchasing, profitability and other information, and rather they only collect people attitudes regarding a new product. Due to the expensive and time-consuming nature of this concept, it would be more suitable for moving packaged goods rather than durable (heavy) goods (Ogawa and Piller, 2006). "Test marketing" can be beneficial as a market experiment stimulation conducted in a field laboratory comprising actual stores and real buying situations, where the customers do not know they are engaging on a market evaluation test (Business Dictionary, NA).

2.8.4 Premium Price of Eco-friendly Products

From the marketing perspective, one of the most frequent issues regarding green products is the high costs involved and the premium price that often cause product failures (Drozdenko et al., 2011). On the contrary to Drozdenko et al. (2011), Chekima et al. (2016) believed that the premium price does not play a vital role in customer green purchasing intentions. According to them, customers who are confronted with a green buying decision can tolerate 5-40% extra prices for green products. This can be beneficial for manufacturers and marketers as they can continue with sustainable practices such as recyclable packaging, re-manufacturing without much worrying about the premium price sensitivities (Chekima et al., 2016).

A logic for the premium price is the additional costs associated with green product manufacturing or growth. For instance, growing organic food products are more time-intensive than the ones that are grown using chemical methods and pesticides. Secondly, not only do the farmers need to be certified with organic certification standards, but also the manufacturers, retailers and distributors need it, and even if they go through other certifications, such as the fair trade, it will cost them more (Canavari and Olson, 2007; Jennifer, 2011). Thirdly, fair labour conditions as another aspect of sustainability are usually less considered in conventional products rather than the companies producing eco-friendly products, where it should be more valued in ethical production and costs more. Fourthly, the shipping costs would be much higher for the eco-friendly products especially for the smaller companies, as they need to ship smaller loads that cost more in the long-term period. Fifthly, the marketing of eco-friendly products needs an extra budget, especially for smaller companies with lower budgets. As the author stated, despite the green industry novelty, the use of such products is increasing day by day,

and this has caused slight reductions in the organic foods' prices in recent years (Canavari and Olson, 2007; Jennifer, 2011).

Moreover, one of the major reasons for the eco-friendly products' premium price is the low market demand, and the new concept of greening (Chekima et al., 2016). This usually leads manufacturers to produce cheaper products regardless of their life cycle, maintenance costs and environmental impacts. The eco-friendly industry is getting famous gradually. However, it is still an emerging industry that has not been placed in people's routine life and purchasing selections, especially in developing countries. The low market demand is related to the green purchasing intentions which depend upon six different factors including, environmental attitudes, eco-labelling, man-nature orientation, premium price, and demographics (education and gender) (Chekima et al., 2016).

Companies can follow different approaches to motivate customers towards green purchasing behaviours. It is mainly the task of marketing to change their environmental marketing practices by inspiring people through humanitarian orientation and make them reflect on cultural values. They need to regularly remind people of social responsibilities for the climate emergency. In this respect, cause-marketing is suggested to be adopted in addition to the routine marketing methods (Chekima et al., 2016). Besides, some countries have officially coined the eco-labelling schemes as trustworthy symbols attached to the products to provide consumers with independent information regarding the products they purchase, enhance their green product-related knowledge and help them change their consumption patterns towards getting more sustainable conscious (Erskine and Collins, 1997; Chekima et al., 2016).

2.9 Key Literature Studies

The main three pillars of this research are broadly elaborated within the body of literature. The frameworks which are presented previously explained the basics and main components of sustainability, DCM and NPD. Nevertheless, there are many other conceptual frameworks/models regarding the drivers and influential factors of research pillars that need to be considered towards achieving solid findings. Among 75 explored sources, 11 studies, including key conceptual frameworks, are categorised based on their major importance within the specified challenges of this study. The highlighted frameworks are selected based on their novelty, comprehensiveness and having included the main elements of this research. The key elements of these frameworks are classified in Table 2.11. The presented frameworks provide a foundation that can later the researcher towards summarising the gaps and key findings of the literature as well as case study criteria and specifically, the design of the interview questions.

Table 2.11 Key Literature Studies – DCM, NPD and Sustainable Practices

Concepts	Reference and Addressed Elements
Demand Chain Management (DCM)	*Jüttner et al. (2007)* o Roles of marketing within DCM o The working relationship between marketing and SCM o Roles of strategic management in DCM adoption *Hilletofth et al. (2009)* Interrelations between DCM, SCM and Marketing *Ye and Lau (2018)* Considering both inter-organisation and intra-organisation scopes within the DCM framework
New Product Development (NPD)	*Machado et al. (2014)* o NPD success o NPD efficacy o NPD efficiency o NPD productivity o NPD effectiveness o Brand reputation *Du et al. (2016)* Influences of Sustainability and social media on the NPD process The positive impact of a firm's sustainable orientation on its NPD performance
DCM and NPD Linkage	*Tan and Tracey (2007)* o Collaborative NPD environment o Manufacturing involvement o Supplier involvement o Customer involvement o Customer satisfaction *Liao and Wen (2009)* o Adding customer knowledge to NPD towards its success *Chien and Chen (2010)* o Customer involvement o Supplier involvement o Cross-functional department integration o NPD performance
Sustainable Demand Chain Management (SDCM)	*Vural (2015)* o Demand chain profiling o Sustainable value propositions o Sustainable value delivery o Sustainable supply networks o Supplier evaluation for sustainability risk and performance
Sustainable New Product Development (SNPD)	*Berchicci and Bodewes (2005)* o Determinants of NPD success o Environmental aspects of NPD (ENPD) o Organisational aspects influencing product performance *Katsikeas et al. (2016)* o Organisational inputs of eco-friendly product development strategies including top management commitment, corporate environmental policies and environmental performance incentives o The positive effect of eco-friendly product development strategy on product development effectiveness

2.10 Preliminary Conceptual Framework

The review of literature sought to investigate the study concepts to identify the existing gaps within this field. A preliminary framework is created to demonstrate the linkages between the study topics to summarise the important features of the literature (Figure 2.28). This framework establishes a state of thinking for the research and serves as a foundation for the interview questionnaire design and data collection stages. The framework starts with the triple-bottom-line of sustainability as a significant initiative of this research. However, the environmental element will be the main focus within this research, due to its significance in tackling the climate emergency. Sustainability factors further influence supply chain structure based on customer requirements, also acting as initiatives towards the success of NPD projects (Vural, 2015). As the literature suggests, IT applications (Budd et al, 2012) and innovative marketing approaches (Petersen et al., 2005; Ogawa and Piller, 2006; Jüttner et al., 2007 and Ye and Lau, 2017) act as effective tools that facilitate the ultimate goal of any supply chain and NPD project being customer satisfaction. The question will be, to what extent the final output (enhanced customer responsiveness) can be addressed.

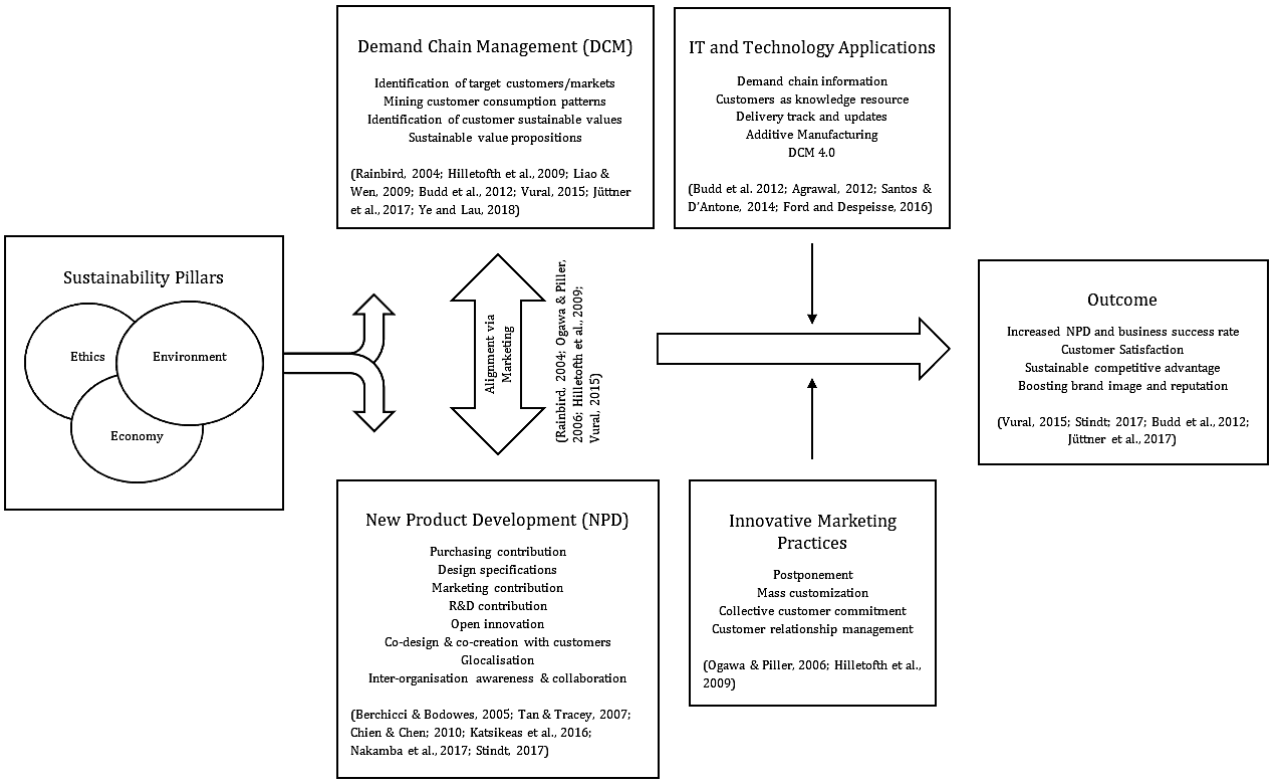

Figure 2.28 Preliminary Conceptual Framework: The Interrelationships of Sustainability, DCM and NPD

2.11 Literature Review Summary

The systematic review identified key definitions and existing methodologies regarding sustainability, DCM and NPD as well as the interrelationships among them. DCM was discussed as a new buzzword within the supply chain that promises towards the new transformation of supply chain structures. DCM practices aim to bring profound impacts and changes to the overall aspects of the SCM from redesigning the entire supply chain to the execution of NPD projects, where the success rate of newly launched products become critical. In this regard, marketing activities play a vital role in bridging the SCM and DCM practices. DCM was explored in two different perspectives, firstly the innovative marketing practices and secondly the application of IT platforms in the supply chain. The influences of sustainability on SCM and DCM was also discussed, and it was revealed that the current SDCM concept needs to be explored further. Furthermore, it was revealed that SDCM and SNPD concepts are very close to each other and have many points in common such as the customer demand for eco-friendly products within NPD. Therefore, their precise investigation is crucial for accurate results.

It was discussed that NPD projects are currently inseparable parts of the manufacturing companies and their networks. NPD risk factors as interconnected elements with customer responsiveness and demand chain are also investigated to find out how successful NPD projects contribute to the adoption of demand chain approaches. Moreover, sustainability practices need to be applied to the design, manufacturing and marketing entities of NPD to make SNPD/ENPD concepts true.

2.12 Literature Gaps and Future Steps

There has been a scarcity of scholarly resources examining the impact of sustainability on both NPD and DCM, highlighting the novel contribution of this study. It was also discovered that there is presently no clear definition or framework for DCM that takes into account the elements of NPD considering sustainability dimensions. Hence, the current practices within this area are limited among researchers and practitioners. The need behind the linkage of these three concepts is firstly the importance of climate emergency and the global move towards sustainable development. Secondly, the customer-oriented supply chains which are nowadays the key to business success and thirdly, the importance of NPD projects which are highly dependent upon customer involvement and satisfaction. Besides, the commercial success of sustainable products highly depends on customer willingness to pay for premium prices,

product quality, variety, and the possibility of customisation. In this context, the driving role of sustainability towards NPD and DCM need to be studied, as indicated among research questions. Likewise, the notions between the three concepts of this triangle need to be further investigated.

Moreover, the applications of technology infrastructures and Industry 4.0 as the fourth industrial revolution (such as AM practices) need to be investigated further within DCM and NPD considering the environmental benefits, costs and premium price associated (Liao and Wen, 2009). Besides, the security, costs and efficiency of IT platforms need to be elaborated from a DCM perspective within NPD contexts.

Likewise, the DCM contributions to business sustainability lack in the literature, therefore, their further investigation was suggested (eg. Santos and D'Antone, 2014; Vural, 2015). The combination of rising DCM concepts with SSCM has been hesitantly studied within the literature and hence, further holistic, empirical and theoretical proof has been put forward to be generated (Vural, 2015).

2.13 Chapter Two Summary

This chapter utilised a systematic review method to better identify and synthesis the relevant sources as a foundation for this research. In doing this, the five stages of the systematic review structure suggested by Khan et al. (2003) and Denyer and Tranfield (2009) are followed. Based on the CIMO logic, three main literature review questions were generated. Using the PRISMA diagram and inclusion/exclusion criteria, 75 final sources were selected. The sources were then categorised based on the concept, author, study context and publication year. Relevant statistics were also presented to classify and visualise the categorisations. The key selected sources were then studied as well as other supporting sources to gather information regarding study concepts. The next chapter will present the methodologies used for this research.

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter provides details of the research methodology deployed for this research. It presents a description of research philosophy, approach, design using the research onion concept developed by Saunders et al. (2012). Data collection and its procedures will be also elaborated as well as the data collection limitations. Finally, research quality and ethical considerations will be discussed.

Figure 3.1 Flow of Research Methodology Chapter

3.1 Research Methodology Definition

According to Kothari (2004), research is defined as "A systematic method to search for knowledge through an objective and systematic method of finding the solution to a problem concerning generalisation and the formulation of a theory". However, research methodology is referred to as solving the research problem systematically. It is claimed that the study of research methodology is a significant stage within any research, as it provides insight regarding the necessary materials, techniques, appropriate use of questionnaire, data collection methods, recording evidence and finally interpreting the data (Kothari, 2004). Within the literature, there are different classifications regarding the procedures of research methodology (e.g., Kothari, 2004; Blumberg et al., 2011; Saunders et al., 2012). The researcher within this thesis elaborates and uses the "Research Onion" concept introduced by Saunders et al. (2012) which has been of great interest to many academics to date (Figure 3.2).

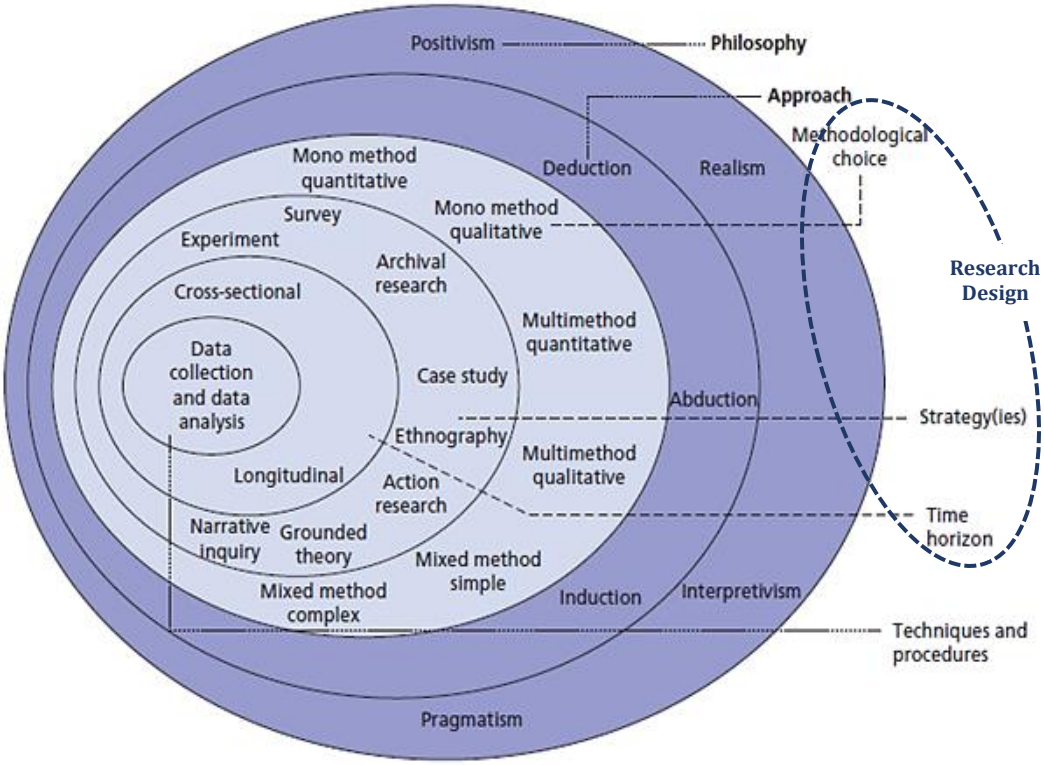

Figure 3.2 The Research Onion (Saunders et al., 2012)

3.2 Research Philosophy

As the outermost layer of the onion, the research philosophy indicates essential assumptions regarding how the researcher views the world. Research philosophy and research approach as the outer two layers of the onion are necessary for the researchers to choose the way towards answering research questions. These philosophical considerations also help the researchers to clarify the research design (Blumberg et al., 2011), strategies and methods (Anderson, 2013) within the later stages. There are two main research philosophies, including positivism and interpretivism (phenomenology) (Blumberg et al., 2011) as well as realism and pragmatism (Saunders et al., 2012).

Given the differences between the research philosophies indicated in Table 3.1, the research philosophy for this research would be *"Interpretivism"*. This is due to the researcher's attitude regarding subjective meaning and social phenomena. This research is value-bound, and the researcher is dependent on the data and maintains a subjective position. Moreover, the data collection technique would be based on case study investigations of four companies which is a small sample. Given the mentioned points, the adoption of interpretivism as a philosophical position is necessary for this research.

Table 3.1 Research Philosophies (Saunders et al., 2012)

Research Philosophy	Features	Strengths	Weaknesses
Interpretivism (phenomenology)	• Implies that the social world is perceived to be socially constructed and subjective, where it is given meaning by people. • Criticises the law-like generalisations to complex world issues	• In-depth qualitative investigations usually within small samples • Researcher interpretations are the key to knowledge contribution • Suitable for business and management studies especially in marketing, human resource management and organisational endeavour	• To enter the social world of research objects and understand their world from their point of view. • Difficulty in identifying right or wrong
Positivism	• Considers the researcher as an independent part of the research and an objective analyst. • Collecting data about an observable reality • Considers the social world as completely objective	• Structured data collection technique highly based on large samples • Suitable for law-like generalisations	• Lack of in-depth understanding of a context • The phenomenon is only judged by logic • Research is value-free
Realism	Nature and the social world exist independently of human thought and knowledge of their existence but can be interpreted through social conditioning	Nature and the social world exist independently of human thought and knowledge of their existence but can be interpreted through social conditioning	There could be different interpretations of reality due to diverse social conditions
Pragmatism	• Combines interpretivism and positivism perspectives • Believes in different ways of interpreting the world and multiple realities	Allows the use of mixed methods to answer the research questions.	It can be usually used by experienced researchers

3.3 Research Approach

The research approach is "A plan and procedure for research that span the steps from broad assumptions to detailed methods of data collection, analysis and interpretation" (Creswell, 2014). There are two main research approaches, including inductive and deductive approaches, and a combination of both called abductive as illustrated in Table 3.2 (Saunders et al., 2012; Blumberg et al., 2011). There is another Some authors classify research approaches as qualitative, quantitative and mixed methods (Kothari, 2004; Creswell, 2014). However, the latter ones are the broad terms that already include the first ones inside them. It is claimed that either approach can be advantageous towards the fruitful data for addressing the research gaps, and none of them has priority over the other one (Saunders et al., 2012). The research approach used for this thesis would be *"Inductive",* as the researcher has not used any existing theory to formulate the research questions and objectives. Despite the wealth of literature within the research concepts, the researcher is going to start with collecting data, exploring them and

finding common ideas, patterns and themes to see which issues to follow up with. This ultimately leads to conceptual framework development.

Table 3.2 Research Approaches (Saunders et al., 2012)

Research Approach	Features
Inductive	• Starts with research questions and observations often using qualitative research for data analysis and theory generation • Conclusions are more general as it is reached by generalising the evidence
Deductive	• Starts with a set of hypothesis or theories and then making observations to test the hypothesis, reach findings and consequently verify or falsify those theories that are mostly associated with quantitative research • Conclusions are more special as it is reached by applying logical rules to the evidence.
Abductive	• Abductive research starts with incomplete observations and continues to the closest possible explanation for it. • Theory generation or modification; incorporating existing theory where appropriate, to build new theory or modify existing theory.

3.4 Research Design

Research design including the third, fourth and fifth layer of "research onion" is classically defined as "The plan and structure of investigation so conceived as to obtain answers to research questions" (Kerlinger, 1986). Several authors have already classified the research design into different descriptors (Blumberg et al., 2011). However, the most crucial ones are research strategies, choices and time horizons (Saunders et al., 2012). To be precise, the research design is the general plan helping the researcher to answer the research questions specifying the sources of data collection, considering the limitations towards access to data, time, location, funds and ethical issues (Saunders et al., 2012). Before elaborating the research design descriptors, it was suggested to consider the "Research Purpose/Nature" or in other words, the type of study. This is categorised into three groups of exploratory, explanatory and descriptive studies as indicated in Table 3.3.

The nature of this research would be *"Exploratory"* since the purpose is to build a theory on the linkages of sustainability into a demand-driven chain considering the NPD projects. Another reason is that exploratory research is based on the discovery of ideas and qualitative data instead of the quantitative nature and collecting statistically accurate data which is usually the focus of descriptive and explanatory research.

Table 3.3 Research Design (Saunders et al., 2012)

Research Nature	Definition	Features
Exploratory	• Initial research into a hypothetical framework • A preliminary investigation on a relatively unknown field which aims to gain new insights	• Flexible • Expert surveys • Pilot surveys • Case studies • Secondary data (qualitative) • Useful if you want to clarify your understanding of a problem • Starts with a wide focus and gets narrowed
Explanatory	• An attempt to connect ideas to understand cause and effect • A study which is designed to indicate causality	• Manipulating one or more independent variable • Experiments
Descriptive	• To present a complete description of a phenomenon within its context • The causal relationship between variables	• Pre-planned and structured design • Secondary data (quantitative) • Surveys • Observational

3.4.1 Research Choices

This is a vital step within the research methodology chapter, as it discusses the data collection techniques and analysis procedures, the choice of qualitative, qualitative or mixed nature of the study. These can be expanded to data collection techniques (methods) as well as the data analysis procedures. Some authors use the generic term “research design” for these choices (Tashakkori and Teddlie, 1998). There are two main choices of qualitative and quantitative in general, where choosing any of them individually makes a “mono method” technique. However, mixing them into “multiple methods” (including multi-method and mixed method) is also possible (Saunders et al., 2012). It was mentioned that there is no general guideline towards the choice between the two and the final quality of study is not a matter of using qualitative or quantitative techniques, but the quality of research design and the way it is conducted (Blumberg et al., 2011). This is because both techniques have their strengths and weaknesses, and the aim should be to minimise the weaknesses and maximise the strengths (Smith, 1981). It was also stated that towards the purpose of exploratory studies, the qualitative technique is the most appropriate one since exploration is heavily dependent upon qualitative techniques (Blumberg et al., 2011).

Table 3.4 Research Choices (Saunders et al., 2012)

Research Choices	Features
Mono Method	Single data collection technique and corresponding analytical procedure
Multiple Methods	More than one data collection technique and analytical procedure
• Multimethod	More than one data collection technique used with associated analysis procedures (quantitative or qualitative)
• Mixed methods	A combination of qualitative and quantitative research

Towards this research, the *"Multimethod Qualitative Study"* was used, since, during the multiple case study investigations, the semi-structured interview was conducted as well as the use of documentary analysis in case of accessibility. The analysis of the collected data would also be qualitative (non-numerical). Therefore, a multimethod was adopted. The strengths of this technique are the deep observations through the case organisations as well as gaining first-handed information from the company employees. Moreover, it would be more likely to obtain unexpected information within the qualitative study, since it provides the researcher with more space for manoeuvre, for example, during the interviews and observations.

3.4.2 Research Strategy

There are different research strategies (also referred to as "research methods"), as shown in Table 3.5. None of the strategies is superior to any other, and the choice of research strategy needs to be guided by the philosophical position, research approach, research questions, objectives, environment, time and funds that the researcher has access to (Blumberg et al., 2011; Saunders et al., 2012).

The experiment and action research strategies are not applied to this research since they both need broader involvement from the researcher, the case study organisation and its employees, as well as more time and access to the facilities (Anderson, 2013). On the other side, the preference of case study over the survey is due to the necessity for an in-depth investigation and deriving wide-ranging data regarding several concepts of the study namely sustainability, DCM and NPD and many others that the researcher is not able to anticipate (Saunders et al., 2012). Another point is that in survey strategy, the researcher is dependent on others for adoption of information, and it can also be time-consuming to ensure the sample representativeness, suitable response rate and piloting the data collection instrument.

Ethnography is mostly associated with sociology and humanity research fields that require an extended period and participant observations, which is not practical for this research considering the technical dimensions of sustainability, DCM and NPD (Bell et al., 2018). Grounded theory is also suitable for humanity and soft issues that can be applied in case very little knowledge is existing in a field, and this is also in contrast with the field of this research (Saunders et al., 2012). Using the archival research strategy necessitates the researcher's access to administrative documents and records relevant to the research questions towards secondary data analysis. This can also be insufficient, since the archival sources of data are not collected originally according to the purpose of research, and therefore, the research objectives cannot be completely fulfilled (Saunders et al., 2012).

Table 3.5 Research Strategies (Saunders et al., 2012)

Research Strategy	Features	Strengths	Weaknesses
Experiment	Suitable for natural sciences and lab-based research	N/A	N/A
Survey	Suitable for deductive approach, exploratory and explanatory research nature	• Wide sampling and high responses • More control over the research process	• Time-consuming • Responses not guaranteed • Limited questions
Case Study	• Explore a topic within its context • Suitable for investigating an existing theory	• Boundaries between phenomenon and the context are not obvious • Can produce strong theoretical propositions	• Intensive and demanding • Access can be tricky
Action Research	Develop solutions for real organisational problems through a collaborative approach	Increase of participation and employee involvement in decision-making	Lack of participation leads to fail
Archival Research	Use of administrative records and documents as data sources.	Use of real data that are not generated for research purposes	• Possibility of incorrect and missing data • Possibility of refused access to data
Grounded Theory	A methodological approach developed from a set of data	Holistic approach and open-minded researcher towards analysis	The researcher may ignore literature, present raw data, and use inappropriate philosophical assumptions
Ethnography	Suitable to study groups	Study of the interactions between people in the same organisation, group or society	• Demanding • Need to develop some grounding
Narrative Enquiry	A story or personal account which interprets an event or events	Enables the research to compare the narratives of the narrators	Does not offer a well-developed set of analytical procedures

Given that case studies are frequently employed in exploratory research, the "case study" technique was chosen to meet the objectives of this study. The case study research strategy is chosen by the researcher not only because it allows the use of multiple methods of data collection (Creswell, 2013; Yin, 2014), but also because it facilitates the investigation of a

contemporary phenomenon (DCM, NPD and sustainability) within a real-life context (Manufacturing organisations). This consists of a thorough investigation to provide an interpretation of the phenomenon's context and dynamics. The use of case study as a research strategy allows for the investigation and development of an in-depth understanding of the issue through the use of cases as real examples.

According to Morris and Wood (1991), the case study strategy would be suitable if the researcher tends to gain a wide understanding of the research context and processes. Besides, it has got a huge potential to explain contemporary circumstances and find answers to questions such as why what and how (Yin, 2018). Considering the research questions (RQ), the questions starting with 'what and how' can be addressed using the case study strategy. Another preference for a multi-case strategy instead of a single case study is to eliminate the need to have a strong justification for that single choice. Moreover, single case studies are suggested when the case represents a critical test of existing theory, unique features or where the case can be studied in a longitudinal manner (Yin, 2018). It is also believed that multiple case studies can be valuable to illustrate the similarities and contrasts among different cases (Hartley, 2004). For this research, the multi-case strategy of four case studies was used based on convenience sampling and the respondents' knowledge regarding the study concepts.

3.4.3 Research Time Horizon

The fifth layer of the research onion is the time horizon (time dimension) that includes cross-sectional and longitudinal studies. Due to the time constraint for PhD studies, a "*Cross-Sectional"* study would be suitable within a limited amount of time for case study conduction. This represents a snapshot of one point in time that the researcher tends to describe the linkages between sustainability, DCM and NPD, through a case study strategy based on interviews and observations over a short period.

Table 3.6 Research Time Horizons (Saunders et al., 2012)

Time Horizon	Features	Strengths	Weaknesses
Cross-Sectional	Study of a phenomenon at a particular period	Suitable for time-constrained studies (academic studies)	Gaining limited data
Longitudinal	Continuous observations over an extended period	• Capacity to study changes and developments • Gaining a rich source of data	• Requires huge amount of time • Often expensive • Respondents may drop out over time

3.5 Data Collection and Analysis

The sixth and most inner layer of the research onion refers to the data collection and analysis being *"multi-method"* for this study. The data for this research was collected within the form of both primary and secondary sources of data. As discussed by Hox and Boeije (2005), primary sources are the first occurrence of a piece of work which are original and fresh data collected for a specific research goal using procedures that fit the research problem best. This is while the secondary data are the material created by other researchers made available for reuse by the general research community (Hox and Boeije, 2005). The primary sources of this research are the data derived from theses, conference proceedings, company reports and case study investigations including interviews and documentary analysis, while the secondary source is the journals and books. There are also a group of tertiary sources which are used in case of need such as catalogues, dictionaries, encyclopaedia, and bibliography. Figure 3.3 shows the entire research methodology process employed for this research.

Figure 3.3 Research Methodology Process

3.5.1 Triangulation

To maintain the integrity and credibility of the research findings, the process of triangulation needs to be explained in this section. Credibility refers to the degree to which a study is trustworthy, and validity is concerned with the extent to which a research properly represents or assesses the notion or concepts under investigation (Noble and Heale, 2019). To improve confidence of the research findings and ensure an in-depth and more unbiased set of findings, this study firstly employed the multiple case study design as discussed. Furthermore, employing multi-methods, as mentioned in the preceding section, is a type of triangulation in research that is regarded as minimising the weaknesses seen in single methods.

- The first research method was to use accessible documentation such as administrative records, business reports, guidelines, websites, archives, and public data, as well as relevant news in the media about specific product development, customer interactions, and/or

sustainable characteristics. The data from these sources were synchronised with the study scope and interview questions to be utilised in the data analysis phase.

- The second research method was conduct of interviews with company representatives of each case company (being four case companies in total) to determine their perceptions of demand-driven product development approaches considering environmental sustainability. The utilisation of several case companies and participants is a form of triangulation. Each participant contributes their own experiences and perspective to the research, adding new dimensions and the potential of shared experiences.

In this instance, some authors refer to research validity and reliability as logical tests. Research validity refers to the appropriateness of tools, processes, and data in qualitative research (Leung, 2015). It mainly includes three paradigms of construct validity, internal validity and external validity (Yin, 2018).

Construct validity is among the key factors towards a successful case study (Yin, 2018). This can be validated using multiple case studies and building an evidence chain. For this research, four case studies within different organisations are used as multiple sources of data. Moreover, the detailed research steps and procedures are explicit and well-documented. This helps the readers to see the flow and linkage between data and findings and also evaluate the issues from different perspectives.

Internal validity refers to the degree of certainty that the casual relationships being tested are trustworthy and not influenced by other factors (Yin, 2018). This is much depending upon the variable situation of respondents, especially during a longitudinal study. This was addressed through respondent validation by member checking. After the transcription of recorded data and the case study discussions, all the relevant company representatives were contacted to reflect on the accuracy of the account and check whether the data was correctly understood and interpreted.

External validity refers to the degree to which the research findings can be generalised to other situations or groups (Yin, 2018). It is suggested that an embedded multiple-case design accompanied by a cross-case analysis among the cases help to strengthen the external validity (Yan, 2018). This issue is also addressed by using a multiple case study approach. This helps the researcher to reach multiple sources of information and be able to analyse the data based on different angles and points of view within the same context.

Research reliability refers to the repeatability and reproduction of the research by any other independent researcher when using the same methodology (Bryman and Bell, 2011; Yin, 2018). In doing so, the researcher has kept an electronic database of the case study data for future reference. This includes all the data recordings as well as the transcriptions, documents and NVivo coding procedures. Minimising the bias is another key towards reliability (Yin, 2018), which is addressed through the study of organisations within different sectors, sizes and geographical locations.

Seale (1999) has also stressed that to ensure reliability in qualitative research, the trustworthiness of the study needs to be examined. The trustworthiness of this study was examined through peer review and continuous feedback from various resources. Parts of the thesis were submitted, peer-reviewed and published. Besides, the researcher participated in several international conferences having the chance to receive a wide range of comments and feedbacks from various researchers and practitioners around the world.

3.5.2 Documentary Evidence

Access to administrative records, documents and archives can be a valuable source towards the data analysis in qualitative research, since they are essential sources of evidence containing reliable information that can be provided by the case study companies. For this study, the researcher attempted to get access to documentaries such as company reports, guidelines, available statistics, websites and relevant web news in order to access data and provide evidence on business statistics, market performance, competitors, supply chains and NPD outcomes. All the gathered information and notes were organised into a legible report to be discussed with supervisors in terms of relevance and usefulness towards the data analysis. In the next chapter, the documentary evidence is provided at the beginning of collected data from each case study.

3.5.3 Interview Question Design

The data collection took the form of a semi-structured themed interview with top managers of the companies. This type of interview was designed to provide reliable and comparable qualitative data and allow participants the freedom to express their in-depth views, with little direction from the researcher. The design of the interview questions is mainly composed of open-ended questions. Ballou (2008) recommended using them to build a positive rapport and encourage the participation of the respondents. He also stated that the discussion of complex issues can provide an opportunity to explore the range of possible themes arising from a single issue.

3.5.4 Interview Questionnaire

The full interview questionnaire and relevant references are illustrated in Table 3.7. The case study interview is classified into six main questions seeking to explore the relevant subtopics. Before the main interview questions, the respondents were asked regarding their background and positions within the company.

The questionnaire design is based on the key points regarding the research concepts considering the key literature studies and frameworks. The questions at the start of the questionnaire are tailored to ensure that the correct individual is being questioned, also trying to direct respondents who have only a passing interest in the subject to a different set of questions. Questions flow smoothly from one to the next, and this is made easier as they are organised into subjects that follow a logical order, allowing respondents' opinions to be collected in a logical manner.

The questionnaire consists of six primary questions that cover all aspects of the study, including DCM, NPD, and sustainability. Furthermore, technology and IT have been prioritised since, according to literature, IT applications are the fundamental facilitator of the demand-driven chains (Budd et al., 2012). Marketing, as a link between a firm and its consumers, plays a critical role in facilitating demand chains and successful product launches (Jüttner et al., 2007, Hilletofth et al., 2009). Finally, firms should look at the economic and financial elements of adopting SDCM and SNPD as feasibility criteria.

Table 3.7 Case Study Interview Questionnaire

Question Area	Question Description	Relevance to Literature
Q1: General Background	*Kindly provide your background.* ➢ Relevant department of employment ➢ Job functions within the company ➢ Education background ➢ Overall work experience in this organisation ➢ Company background o Year of establishment o Company size o Previous and current products range o Total number of employees ➢ What does sustainability mean to your organisation? ➢ What motivates you to adopt sustainable strategies? ➢ How much are the government regulations and policies supportive of sustainability adoption? ➢ How much are the top managers/shareholders of the company supportive and committed towards sustainability pillars? ➢ How much does the company make an effort towards employee training towards increasing awareness and knowledge of sustainability?	*Brundtland Commission (1987)* *Menguc et al. (2010)* *Gavronski et al. (2011)*
Q2: NPD and the Influence of Sustainability	➢ What are the NPD risks, threats and success factors? ➢ Why is sustainability important within NPD? ➢ How does sustainability approaches impact on NPD process with examples of a specific product? ➢ What are the main/potential barriers, risks and threats towards SNPD adoption within your company? ➢ How do you address these barriers? ➢ Which departments are involved, and what role do they assume? ➢ How do you measure NPD success? ➢ How do you measure SNPD success? ➢ *To what extent is your company engaged in the implementation of following sustainable practices towards the success of NPD projects (as following)?*	*Berchicci & Bodowes (2005)* *Tan & Tracey (2007)* *Chien & Chen (2010)* *Vinayak & Kodali (2014)*

	○ Sustainable design (Constructions and eco-friendly products) ○ Manage the high costs and premium price of products ○ Sustainable marketing ○ Sustainable manufacturing (Environmental reduction practices such as additive manufacturing) ○ Suppliers environmental evaluation (green suppliers) ○ Sustainable logistics - raw material purchasing, product delivery and inter-organisations transportation (Zero-emission vehicles, CO2 emission calculation, sharing transportation with other companies etc.) ○ Reduction of environmental impacts through: • Recycling • Waste reduction • Certification of the environmental management system (EMS) • Workplace health and safety • Reduction of fossil fuel usage replacing by solar energy, geothermal energy etc.	*Ford and Despeisse (2016)* *Katsikeas et al. (2016)* *Nakamba et al. (2017)* *Stindt (2017)* *Machado et al. (2020)*
Q3: Demand Chain and the Influence of Sustainability	➢ How do you evaluate your company's relationship with your customers/end users? ➢ How much do you consider your customer preferences and demands? ➢ How much are you familiar with your customer's sustainable values and preferences? ➢ How do you manage differences in customer variable demands? ➢ If you have made changes in customer demands, what feedback have you received? ➢ What skills have you been able to develop within your organisation due to customer demand changes? ➢ What motivates you to adopt sustainability to fulfil customer preferences? ➢ Which departments are involved, and what role do they assume? ➢ Why are these departments involved and not the others? ➢ What are the main/potential barriers, risks and threats towards SDCM adoption within your company? ➢ How do you address these barriers? ➢ *To what extent is your company engaged in the adoption of sustainable pillars towards a demand-driven chain (as following)?* ○ Identification of sustainable customer values ○ Identification of target customer/markets ○ Mining customer consumption patterns	*Hilletofth et al. (2009)* *Liao & Wen (2009)* *Budd et al. (2012)* *Vural (2015)* *Jüttner et al. (2017)* *Ye and Lau (2018)*

	○ Customer service management (CSM) ○ Customer relationship management (CRM) (after-sales service and maintenance, technical know-how) ○ Supply chain redesign towards a demand-driven chain ○ Supply chain redesign towards a demand-driven chain	
Q4: Technology and Information Technology	➢ To what extent do you employ IT applications towards your product development projects? ➢ Do you use IT systems to coordinate your various supply chain entities? ➢ What IT systems do you use towards smoother relationships and more transparency with your customers/end-users? ➢ Which departments are involved in IT and technology-related tasks, and what role do they assume? ➢ Do you develop the IT systems yourself or do you use external resources? ➢ How do you choose your IT systems? ➢ What are the main/potential barriers, risks and threats towards IT applications within your company? ➢ How do you address these barriers? ➢ *To what extent are applications of technology and IT important regarding both customer satisfaction and success of NPD projects (as following)?* ○ Demand chain knowledge ○ Delivery track and updates [Kanban, electronic data interchange (EDI), POS, …] ○ Transparency of demand and inventory levels across the whole chain ○ Industry 4.0 applications such as additive manufacturing ○ Close coordination of IT and SC entities ○ Automation of key SC processes	*Budd et al. (2012)* *Agrawal (2012)* *Gandhi et al. (2014)* *Santos & D'Antone (2014)* *Ford and Despeisse (2016)* *Machado et al. (2020)*
Q5: Marketing	➢ What are the main marketing strategies for your company? ➢ Do you have several marketing strategies for different countries? ➢ How do you evaluate the relationship between marketing and NPD? ➢ To what extent do your customers take part in product development processes? ➢ How is your marketing department involved in the identification of customers' sustainable desires and other customised preferences? ➢ Do customer variable demands affect your NPD practices?	*Ogawa & Piller (2006)* *Hilletofth et al. (2009)* *Vural (2015)*

	➢ What are the main/potential barriers, risks and threats towards marketing approaches within your company? ➢ How do you address these barriers? ➢ *To what extent are sales and marketing practices/innovations important regarding both customer satisfaction and success of NPD projects (as following)?* • Postponement • Mass customisation • Collective customer commitment • Value propositions	
Q6: Economics	➢ How do you evaluate the sustainability investments payoff? ➢ What are the possible economic harms you assume for the implementation of sustainability? ➢ Do you evaluate the high costs of investments are barriers to sustainability adoption within your company? ➢ How do you evaluate and measure the economic impacts of your NPD and SNPD approaches? e.g. Sustainable logistics, reduction of environmental impacts, recycling, environmental certifications, etc. ➢ How do you evaluate and measure the economic impacts of considering customer preferences?	*Walker et al. (2000)* *Hilletofth et al. (2009)* *Carter & Euston (2011)* *Hassini et al. (2012)* *Budd et al. (2012)*

3.5.5 Sample Selection

The target population for the data collection during case study investigations would be four manufacturing companies referred to as Company A, B, C and D. All the companies are manufacturing organisations, three of them being in the UK and one based in the Middle East. Likewise, the British companies are small-medium enterprises (SMEs), and the fourth one is a large enterprise. The sampling logic is based on non-probability sampling, which specifies the probability of the cases to be included not being random based. Specifically, convenience sampling (availability sampling) is used since the mentioned companies were readily available to the researcher, for instance through known contacts that consent to undertake the research (Saunders et al., 2012). This sampling technique is widely used and despite its drawbacks such as bias, difficulty in replication, and limited generalisability, it can be effective in different ways. The initial advantage is the simplicity of sampling during the research process especially considering the complications during this research. Besides, unlike probability sampling, which requires a significant amount of time and funds to get primary data, convenience sampling is time and cost-effective. When compared to alternative approaches, convenience sampling data is easier to analyse, and it also can help with the generation of a hypothesis or framework (Blumberg et al., 2011).

To enhance the quality of convenience sampling and minimise selection bias, it has been attempted to control and assess the representativeness of the companies in order to get a sample that is a small-scale version of the population. Furthermore, diversity in case company selection has contributed to the strength of convenience sampling. The operations and products of the companies have been relevant to the aspects of research and the topic of this study. For instance, the core operations of Company A are based on sustainable principles. Likewise, all the companies are within the manufacturing sector, which allows investigating their product development approaches as well as supply chains. Company B and C belong to a monoculture, but Company A operates between the UK and South America, and Company D is from the Middle East with a different geographical region and background. The research findings are more generalisable when case studies from two distinct areas of the world are used. The reasoning behind varied business sizes is that they have a multicultural component which makes the study results more fascinating and comparable.

The researcher tends to reach as many as the respondents from each company, who are knowledgeable and responsible for the majority of company operations and can be responsive to the interview questions. Moreover, the researcher attempts to reach relevant respondents who

are dealing with sustainable practices within the company. However, this is usually not a routine established department within organisations.

3.5.6 Interview Process

As suggested by Saunders et al. (2012), there are different typologies regarding the types of research interviews. One typology categorises the interviews into standardised and non-standardised interviews (Healey, 1991; Healey and Rawlinson, 1993) while the other one differentiates them as structured, semi-structured and unstructured (in-depth interviews) (Blumberg et al., 2011; Saunders et al., 2012). Combining the two typologies, the structured interview belongs to the standardised group, while the semi-structured and unstructured interviews fall under the non-standardised group. The non-standardised group is often referred to as qualitative research interviews (King, 2004), due to its appropriateness towards qualitative and exploratory studies (Robson, 2002).

For this research, a *"semi-structured interview"* was deployed. This preference is due to a wide range of concepts that need to be uncovered within this research. To use a semi-structured interview, the researcher prepared a list of themes and open-ended questions to be addressed. However, the order of questions may be changed depending upon the conversation flow (Saunders et al., 2012). Likewise, additional questions may be required to explore different angles of the research given the nature of events within a specific organisation (Saunders et al., 2012). The main purpose of the researcher by choosing this type of interview is to identify the issues relevant to understanding the linkages between research variables namely sustainability, DCM, NPD; and gain insight into respondents' viewpoints and the way they interpret various phenomena. Besides, as a vital purpose of semi-structured interviews as claimed by Blumberg et al. (2011), the researcher's focus was to identify whether the respondent can confirm the insights and information the researcher already holds, and this requires the researcher to ask the respondents to reflect on their view in a cooperative atmosphere within the interview.

To facilitate more accuracy and to have the chance to save all the data without losing any useful information, conversations were audio-recorded upon respondents' permission as well as notetaking. Besides, an interview guide (memory list) helped the researcher to address all the issues (Blumberg et al., 2011). It also makes an integration within the results of the multiple case approach, by ensuring that all the questions were asked similarly. For this research, there has been no restriction regarding the facilities and conditions of the respondents. Therefore, all the interviews were done face to face.

3.5.7 Data Analysis Method

The interviews were audio-recoded, transcribed (verbatim transcription) and presented in a written format. Afterwards, the coding process starts with marking similar passages of text with a code label to categorise and combine the data to generate ideas and themes (Blumberg et al., 2011). In doing so, there are some computer-assisted tools to automate the coding such as NVivo, Atlas.ti, HyperRESEARCH or MAXQDA (Blumberg et al., 2011; Saunders et al., 2012; Yin, 2018). These are currently the typical software for qualitative data analysis. The researcher has attended a relevant course on NVivo 12© and has got access to this software authorised by the university. Therefore, it was decided to use this software for the interview analysis and visualisation of findings. Besides, NVivo 12© is widely used by researchers, and there are lots of information and learning tutorials available.

According to Saldaña (2011), there are three major types of coding for qualitative data, including descriptive, in Vivo and emotion coding. In Vivo coding uses the participant's language and emotion coding labels the emotions or experiences of the researcher/participants. In this research, descriptive coding was used, as it tends to assign labels to data and summarise them in a word or short phrase regardless of the participants own language or emotions which are not so accurate and might be misunderstood. It also uses the low inference codes, which are useful in summarising segments of data and provide the basis for later higher order coding (Punch, 2014). Based on their relevance, the codes were then grouped into categories. The codes and categories were then organised in a table to enable a "Cross-Case Analysis or Synthesis" to compare the case studies together. The cross-case analysis is a case study analysis technique when there are multiple-case studies. As Yin (2018) suggested, cross-case analysis is the ability of the researcher to discuss the contaminating differences between different cases as no two cases are equal. In this process, it is important to make an argumentative interpretation in a fair, strong and plausible manner based on the collected data (Yin, 2018).

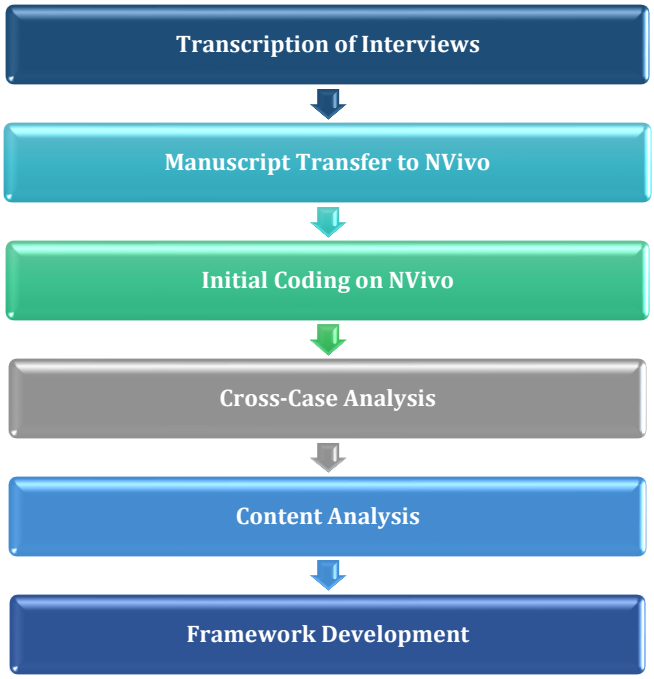

Figure 3.4 Data Analysis Process

To conclude with the data analysis findings and find a meaningful pattern between the data for further analysis, the *"Content Analysis"* approach was utilised for data analysis. Content analysis and thematic analysis share some common points in academic research studies and can be equalised in some stages. However, there is a debate in academia regarding the identification of boundaries between them (Vaismoradi et al., 2013). The thematic analysis seems to be an unconsidered method and does not appear to exist as a named method of analysis as the content analysis does. It is defined as "A method for identifying, analysing and reporting patterns within data" (Braun and Clarke, 2006). However, content analysis is a more general term and refers to a systematic coding and categorising approach utilised to analyse a large amount of textual data and find patterns, frequency, relationships and structure of communication (Gbrich, 2007). According to Table 3.8, the content analysis contains three stages including 1) preparation, 2) organising, and 3) reporting (Elo and Kyngäs, 2008) which are followed for the data analysis of this research.

Table 3.8 Phases of Content Analysis (Elo and Kyngäs, 2008)

Phase	Description of the process
1. Preparation	Being immersed in the data and obtaining the sense of a whole, selecting the unit of analysis, deciding on the analysis of manifest content or latent content.
2. Organising	Open coding and creating categories, grouping codes under higher-order headings, formulating a general description of the research topic through generating categories and subcategories as abstracting.
3. Reporting	Reporting the analysing process and the results through models, conceptual systems, conceptual map or categories, and a story line.

3.5.8 Data Collection and Analysis Limitations

The data collection and analysis of this study has its limitations like any other research study. 1) The limited time and scholarship for this research make an obligation for a cross-sectional study instead of a longitudinal study. However, this was compensated by keeping the contact with case study companies after the end of this thesis to be able to collaborate with them. This helps the researcher to apply the research results into practice as well as the companies to apply the recommendations and fulfil their industrial sustainability gaps; 2) The time limitation also did not allow the conduct of the questionnaire survey to a high number of companies to have a more comprehensive data; 3) Qualitative data collection and semi-structured interviews have their limitations since the honesty, credibility and unbiased data cannot be guaranteed. To tackle this, the researcher tried to make a connection with the respondents before the interviews to ensure them about the significance of the research, the need for getting the accurate data, as well as the data confidentiality; 4) During the coding procedures of the interview data, since the data are going to be condensed and categorised, the information is subject to interpretation biases as each description might give a different meaning to the researcher. However, this was tried to be addressed by investigating and asking extra questions during the interview to make the respondents' attitudes as clear as possible.

3.6 Research Ethics

- **Research ethics and consent forms –** Research ethics are considered an integral part of every research. Obtaining ethical approval confirms that the research will be conducted morally and responsibly. This means that the research design should be in a way so that the respondent does not experience any physical harm, discomfort, pain, embarrassment, or loss of privacy (Blumberg et al., 2011). To obtain the ethical approval for the case studies, three checklists were sent to the University Research Ethics Committee (UREC) including UREC

application form, participant information sheet and participant consent form (see Appendix C and D). All the forms were approved after a few amendments suggested by the UREC representatives (According to the UREC Reference No. UREC/16.5.5.11 available in PGR-Logbook). The participant information sheet was presented to the case study companies and the respondents to provide them with the details of the researcher and supervisor as well as the research confidentiality. Furthermore, the participant consent form was conducted to the participants to agree with the terms and conditions of the investigations. This was also to ensure them they could withdraw from the research process at any time should they wish. To add value to research participants and help them comprehend the interrelationships between research concepts and their organisation, the case study questions were presented to them before the interview.

- **Anonymity –** Research participants were assured that their names and company names will be kept anonymous. The researcher also ensured them that the individuals and their associated companies will not be identifiable when reading the research findings if required.
- **Data security –** Collected data (including recorded interviews and transcriptions) were transferred into the computer through password-protected files. Any hand-written notes during the study were kept in a secure place. All the collected information was securely saved until the finish of the publications, and once the publications are completed, all the data will be fully deleted.

3.7 Chapter Three Summary

In this chapter, the Research Onion model established by Saunders et al. (2012) was utilised to determine the best approach for this study. This led to the creation of the research philosophy, methods, and design. Finally, research validity, reliability and ethical approval were explained. The transcribed data from the four case study investigations will be presented in the next chapter.

CHAPTER FOUR: DATA COLLECTION

Based on the methodology explained in the previous chapter, this chapter presents all the gathered data from the case study investigations of four manufacturing organisations. The interviews with the company senior members are transcribed and presented as direct quotes. This chapter represents the preliminary data for content analysis within the next chapter. Available documentaries will be also used to extract further information regarding the company background and range of products and operations.

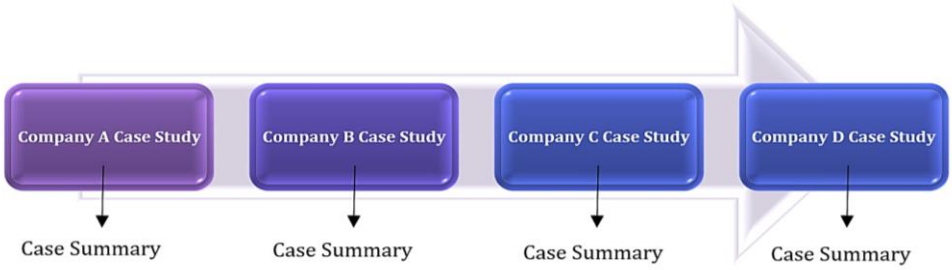

Figure 4.1 Flow of Case Study and Data Collection Chapter

The selection and investigation of the following companies can assist the researcher in shedding light on the influence of sustainability on DCM in the manufacturing sector in a variety of ways. Firstly, three of the selected organisations are small and medium-sized enterprises (SMEs), which, according to statistics, account for 99.9% of the company population in the UK (Gov.uk, 2019). In Europe, SMEs contribute to 60-70% of industrial pollution (OECD, 2018). Furthermore, the fourth organisation is a large enterprise that manufactures a variety of chemical and petroleum-based goods that are potentially detrimental to the environment. This corporation has a significant market share in its region and is continuously coping with the effects of economic sanctions and commercial pressures within the country. In this situation, the company's journey towards implementing environmental sustainability and becoming demand-driven would be challenging and necessitates special consideration. On the other hand, considering sectors in different parts of the world is a plus that can assist researchers and practitioners in developing an inclusive global environmental policy. The Paris Agreement has been a positive step forward in the fight against global warming; however, to preserve the entire planet from climate emergency, all companies and global regions must work together consistently under a standardised strategic plan.

4.1 Case Study A

- **Demographics:**
  - Company A is an SME start-up that is established in 2017 from the heart of laboratories in Imperial College London, based in the UK. It is an independent company in partnership with Imperial College aiming to develop replicable and scalable technological solutions to one of the most important world's environmental issues. Company A has 18 employees and 3 advisory board members, based in both the K and South America (Ecuador). It is a multi-award-winning company focusing on reducing the pollution of the ocean and river ecosystems. They are working on the development of disruptive technologies (devices) to extract synthetic waste and plastics (high-density and low-density plastics) from rivers and oceans. It also collects data from the systems and provides information to the government regarding the plastic pollution problems to help them come up with solutions. These contaminations are caused to human activities such as land-use changes, harsh agriculture and poor waste management. This company is currently operating its technology in Ecuador which has a serious plastic contamination issue, especially in areas such as the Galápagos isles, which are very significant ecologically (Bolinabooms.com, 2021). Ecuador is also the home country of the CEO, which makes the business more relevant and applicable.
- **Problem:**
  - Humans have generated roughly 8.3 billion tonnes of plastic to date, with just 9% of this being recycled. According to the Ellen MacArthur Foundation (World Economic Forum, 2016), an estimated 150 million tonnes of plastic have polluted ocean ecosystems as a result of this ravenous hunger for plastic and the consequent unregulated waste stream, with an additional 12 million tonnes entering the marine environment each year. Plastic pieces, especially microplastics, are now so common in water ecosystems and the ocean that, if current trends continue, by 2050, this plastic trash may weigh more than all the fish in the sea.

  - Despite the urgency and magnitude of the problem, present methods for collecting plastic from rivers and seas are inadequate. Manual plastic removal with nets remains the backbone in rivers, although it is inefficient (only 1% collected) and economically unviable in the industrialised world.

- In 2018, enhanced efforts by organisations throughout the world raised enormous awareness about this issue, resulting in higher levels of action. Unfortunately, the results of the contaminated rivers in the developing economies, without waste management systems, are far from the cause of the problem.

- Plastic production has increased drastically over the past 50 years, from 15 million tonnes in 1964 to 31 million tonnes in 2014 (World Economic Forum, 2016).

- Without major intervention, plastic pollution is expected to treble by 2030, threatening the survival of the seas and human civilisation.

- According to available data, only 20 nations are responsible for 80% of all global marine pollution, with the top five countries accounting for more than half of the total. Although the bulk of the responsibility for these five may be tenting, the plastic pollution produced is mainly a result of the consumption they create, but also of Western use, with the West exporting its plastic trash to Asia.

- Plastics can take hundreds to thousands of years to break up under ocean conditions. This usually results in finer particulate matter through ultraviolet (UV) and mechanical degradation. Hence, the combination of macro and micro plastic pollution creates many risks for marine life and the whole ecosystem, and they even pose a more destructive danger after decomposing into microplastics. Heavy metals, plasticisers, and other poisons may be transported through the plastic. Once consumed, these poisons seep into the body, polluting the whole food chain.

- **Solution – Developed Products:**
  - Three different systems have been created by this company for removing plastic from various water bodies, Azure, Cobalt and Ultramarine (Figure 4.2). They work in diverse settings to avoid the insertion of macro and micro plastics into the phytoplankton growth regions of coastal areas and to regenerate plastics in the ocean. Plankton is described as anything impossible to swim against a current, while phytoplankton is a plankton subtype. The position of phytoplankton is essential to marine life, and especially to the feeding habits of most marine creatures. Once plastics are collected, they are sorted and transformed into flakes for recycling.

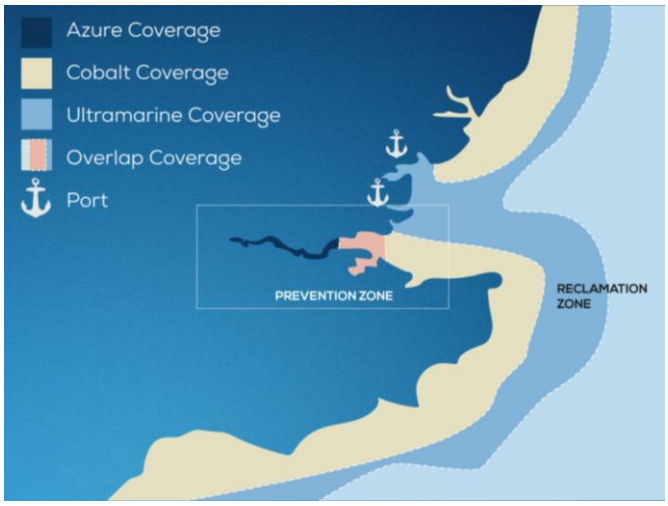

Figure 4.2 Technology Streams for extracting Macro and Micro Plastics at Company A

- The Azure model has been developed to prevent plastic trash from reaching marine habitats in rivers - technology readiness level (TRL) 6. This is currently their most developed system which combines physical recovery, power generation as well as gathering of essential data for decision-making and improving waste management systems around the world. The equipment can gather up to 80 tonnes of plastic from every river each day. Only up to 7 tonnes per day can be used by current technologies. In combination with the newest recycling technology, this would be a genuine changeover, along with collaborations with a UK company producing advanced recycling technology. The Cobalt - TRL 4 (Bench Scale Research), and Ultramarine systems - TRL 2 (Invention and Research) are using static infrastructures and transport systems to collect plastic particles and microplastics from key sites throughout the shore and across the sea while preserving marine life. These technologies may decrease the cost of removing plastic pollution by up to 97.5% per kilogramme of traditional methods. Figure 4.3 indicates the TRL levels of Company A.

- These methods are also meant to offer statistics on the plastic they remove to help the government learn on circular economic measures that might reduce pollution from water streams efficiently. Plastic extraction technologies have been created to supply data on the plastic that they extract, which is then used to pre-sort the different materials extracted with the Azur system for endeavours such as recycling, energy waste, upcycling and to inform public policy. This can help governments generate evidence-based public policies on circular economy to help keep plastic waste out of water sources which is why this project is being implemented under an alliance with the local provincial government.

According to them, *"We are going to change the world and we are going to do it using technology and data"* (Garces, 2020).

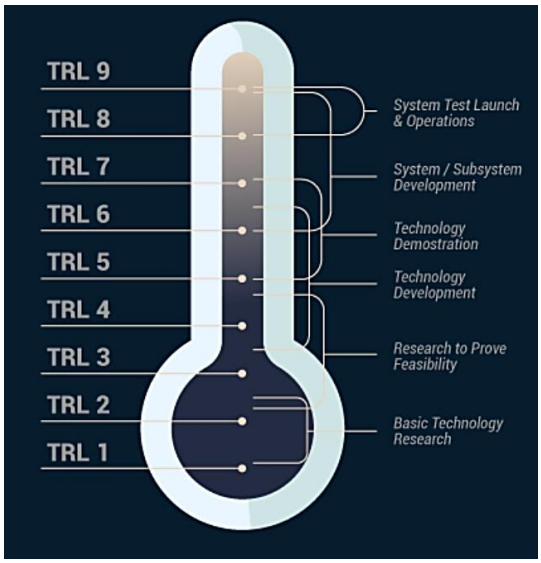

Figure 4.3 Company A's TRL Level

- **Supply Chain and Competitors:**
  - There is a growing number of organisations across the globe that have taken on the task of cleaning up the water ecosystems and re-entering the extracted plastics to the supply chains. This indicates the profitability and productivity of circular economy application in the plastic industry both in economical and ethical aspects. Within the ocean clean-up industry, Company A currently has four main rivals in Europe, three of which are located in the Netherlands and one in Italy. As the Chief Operating Officer of the company noted, there is also a strong Chinese competitor. One of the Dutch competitors is however more concentrated on supporting major brands seeking to reduce their plastic footprint. In a mix of material changes and shifts in business models, this company helps businesses develop and accelerate their sustainability objectives (Aquatechtrade.com, 2020; Sps-ich.com, NA).
  - This company does not have manufacturing facilities itself, and its partner manufacturing companies are based in Germany, Italy, the USA and Ecuador.
  - Ecuadorian government and municipalities are Company A's key customers since the company's present goal are to meet the nation's environmental needs.

- Community engagement is a vital part of the company activities. Environmental awareness, education, and behaviour are three components of a communication and outreach strategy to involve the community, government, and the general public in developing better local policymaking and industrial change. The campaign that the company has formed will focus on millennials of the Ecuadorian community, the government, and the general public through social media with data-backed communication. Visual information architecture (IA) is the tool that helps them gather data and translate it into meaningful insights and messaging.
- Company A is a for-profit organisation; however, it has established an NGO collaborating with an external company towards providing recycling facilities to the vulnerable local communities who collect and sell trash for their living. In this way, they also concentrate on CSR aspects by supporting the community not only to collect the trash but also to recycle and transform them into usable products.

- **Business Statistics – Performance and Revenues:**
  - The total addressable market (TAM) is expected to be around £3 Trillion in 2019, with a compound annual growth rate of 15% projected to continue until 2025.
  - The model Azure has 95% served available market (SAM), which is based on conservative estimates of plastic mass intake from the most contaminated rivers, as well as the potential cost of plastic recycled after recovery.
  - In developing economies where it is now not financially feasible, this technology allows recycling facilities to be installed. Return on investment (ROI) for the installation and operation of Azure technology as well as recycling facilities is expected to be three years.

4.1.1 Company A: Respondents' Background and Sustainability Interpretation

- Respondent 1 (R1): The CEO and the co-founder of the company. His education background includes a PhD in innovation ecosystems from the School of Design Engineering of the Imperial College London. Besides his professional achievements, he also has the honour of gaining several awards such as the inventor of the year in South America, from IT technological review in 2018 as well as the Ambassador of the environment and bio-economy from Ecuadorian Ministry of Environment. As he stated, his role is to develop the strategy of the company, to understand the actual state and future path of the company. This

includes both financial and technical aspects of the business. Hence, he has got a leadership role to make all the business entities collaborate and move towards the corporate directions.

- Respondent 2 (R2): Chief operating officer responsible for marketing, risk management and commercial deals. His educational background is in mechanical engineering.
- Respondent 3 (R3): Chief technical officer who is dealing with R&D, engineering and technical aspect of product development, monitoring the prototypes at the site or the testing labs as well as identifying wastes. Her academic background is in chemistry and fashion design, and she has 17 years of expertise in the areas of NPD, manufacturing, and project management.
- Respondent 4 (R4): Among the advisory board of the company who has got more than 30 years of academic and business background. He has operated in mechanical and design domains. His defined role in the company is defined to verify the performance of technical aspects.

To begin with, Company A's respondents' interpretations of sustainability were as follows:

> *R1: "We need to understand the environmental and social impacts when we make a design. As we are involved in the environmental area, we need to be very careful in the way we operate. It is not only providing options but also becoming a company that really believes in that and the way we design the products".*
>
> *R2: "Sustainability reminds me of reducing the impact in operations and that basically means every impact in terms of social or environmental aspects".*
>
> *R3: "It [sustainability] is all about balance in anything. It can be the balance and consistency in communication with consumers or the balance in using the resources".*
>
> *R4: "Sustainability is multi-faceted. It is about responsible operations within a holistic sense, and it is more around people and planet".*

They were asked about the motivations that drive this company towards sustainable activities:

> *R1: "From one side, it is an internal effort [the sustainability motivations], trying to have an approach which is respectful to the environment, and I think it is also a trend when you see the new start-ups coming that all try to be more conscious about what they do. But perhaps being part of a cluster of clean-tech start-ups, I think what we see around us might be different from what is outside the bubble of the cluster clean-tech. But just the fact that you have a start-up company, new companies in this area behave in a similar way in terms of protecting the environment, showing a global trend. That perhaps shows it is a growing trend, profitable idea and something that is appreciated by the public".*

R2: "All of us work to make all the operations, business models and decisions sustainable. The main driver of sustainability adoption is firstly reducing the environmental impact. We are aware of the impact of our product on every aspect of supply and demand chain. So, we measure that impact and try to lower it. The second part would be the social impact. As per our business model, we work with local communities. Our focus is to make the local community understand how their behaviours and reactions affect the rivers, so we take care of the social impact in this way. We want them to take a look at the rivers and to understand that every negative action they make is harming the environment".

R3: "Firstly, we make technology for the green market, which is reducing the plastic waste. But we have not classed the product as a sustainable product, because sustainability is a very different thing. You need a robust product lifecycle to show that it is sustainable. So, I am not claiming that we make sustainable products. The only prize [of sustainability adoption] is making that positive impact in terms of helping to restore the health of the rivers and the oceans. That is what drives us, to see the everyday impact of this. The rivers and oceans make up the bulk of this planet and they are so polluted in this country which is a problem for everyone. To make a solution for this actual problem is the main driver for us. This is not consumer demand, because there is no traditional customer for this product".

R4: "I think it's a societal driver. In the communities I interact with, there is a significant proportion of people who want a cleaner environment, who want a better community. I think there is a huge worldwide societal driver for more environmentally responsible actions. I don't know what the proportions are, but I would estimate that 70%-80% of people would like things to be more environmentally benign. Of course, the question is who pays for that and put the effort in? If I'm right that more people want things to be environmentally benign, then that is going to impact upon the political organisations and government representing those people, and then that is going to result in policy from government level and then that could be an industrial response. Of course, there is nothing to stop the industry from taking its actions. Some industries are more financially significant than the government like some major Chinese, north American European corporations. They have even more budget than small countries. These entities can themselves have a huge impact if they choose to leverage their capabilities that way and this can be due to multiple reasons such as leadership, response to government and tackling old-fashioned marketing approaches".

Company A is working with both UK and Ecuadorian government. Their funds and resources are supplied by the UK, while they sell the products to Ecuadorian municipalities. Hence, they deal with two governments in different roles. They were asked about the roles of both governments, their policies and support towards their business approaches:

R1: "Access to funds is extremely important for small companies. The decision of the UK government for boosting these entrepreneurial activities allow companies like us to grow. So, in a way, we become conscious about where the opportunities are to access the funding to develop things. So, because the UK government, in this case, has funding for that, it drives companies towards that. So, it is very important even from a political point

of view to develop these opportunities in an organised and synchronised way, as you will find a pile of companies start doing that. The Ecuadorian government is not caring much, and there is too much defence from us. However, to make it attractive for them, we needed to have a great strategy in terms of marketing. We knew that our services and products need to be attractive to the public in general. We invested in communications, access to mass media and free press, so it makes our propositions something attractive to the government. So, the main driver is not the environmental protection for them, but the government wants something cool to get positive opinions, especially from the young population of the country. We actually developed the company in the UK because the resources for developing those technologies are here. If we were based in Ecuador, we couldn't have those resources, but we know they have the needs. Being an international company is a mixed approach bringing us advantages to use the resources in the UK and sell in Ecuador".

R2: "In developing countries, there is not much support from local government for companies as they don't take the lead. But we hope in the future the government will at least ease the tax for the companies working on sustainability".

R4: "There is a rule of thumb that technology tends to be 5 years older than government policies. Some politicians are not at top of the latest science and technologies. I see politics and government as always being behind, they cannot know what's coming. There are some exceptions. The famous one is the European Union's directors for example related to what happened related to the Volkswagen emission scandal. So, it's not just government, there are many stakeholders involved. One person or one organisation can make a difference. One person's idea can result in a small industry which can then result in a new market opportunity. That industry can influence to set some standards, influence policy and government which goes back to the society. History has shown that one person or one entity can make a difference. Of course, things can be top-down from the government (we have different types of governments), but I don't dismiss the influence of a single person".

Employee awareness and training were mentioned as something that is being considered from the recruitment stage proactively. Besides, their exclusive collaboration with educational institutions provides a good source of knowledge and training when necessary:

R1: "When we recruit people, we try to select people who already know about the vision of the company, to be able to understand the problem (plastic pollution) and passionate about solving it. So, we recruit people whose main motivation for joining us is to make contributions to the environment. However, if an employee is willing to have a course on sustainability, we motivate them by paying 50% of the fees, for example. In general, it is not something that we need to motivate, but we hire motivated people from the beginning, and they are automatically driven towards that".

R2: "We are still a start-up; we are 4 years old now and still small, and we are working with public funding from the UK. Now we are operating using the grant that we have from the University of Santa Barbara in the USA. As we have come out of Imperial College London labs, we also have a lot of support from universities in the UK. So, we manage the training and support

through our links with universities, and we have a really good network of contacts over there".

4.1.2 Company A: Sustainability Influence on NPD Success

The risks of developing new products in light of environmental dimensions are explained as:

R1: "I guess it depends pretty much on the size of the company, so different constraints and limitations depending on how small or big the company is. For our small company, one of the challenges is always to operate as effectively as possible, because we have fewer resources. We do a lot of research beforehand to get information from potential customers and we make decisions based on that. Because the main constraint is resources and that's the main aspect. We also have a benefit as we are flexible, and we can make changes easily due to less bureaucracy (comparing to large companies). So, if we are able to find information about customers and develop products with limited resources, we have more chances to succeed".

Regarding the departments engaged in product development activities:

R1: "Half of our company is focused on NPD, as we develop technology and we commercialise. The UK operations are based on NPD. How does NPD success get measured? We use a technology readiness level (TRL) table, and that shows the level of development of technology when you start from zero (design stage). So, the company use that to operate. In the UK we go from level zero to five (five is a prototype for the intended environment), six to nine in mass scale which is being used in Ecuador (commercial operations)".

He was asked about how they measure the success of new products when entering the market and he asserted that:

R1: "For small companies like us, we want to achieve profits, so we need to reach the possibility of passing the breakeven point and start generating profits for the company, so that's one important thing. The other one is the scalability of the product, so one thing is to start selling something, and the other is how fast and efficient this product can grow and gain the market opportunity, so this is very important and depends on the design of the product. The third one is sustainable design, so how is the product designed with minimum impacts on the environment. So, this is a core part of the success of the product we produce. So, the final product needs to be profitable, scalable and sustainably designed".

Likewise, regarding the success measure of SNPD projects:

R1: "For the success measure of SNPD, we focus on minimising impacts, for example in terms of selecting materials or the source of energy. So, when we have these in the deep culture of the company, it becomes something natural to think about. For instance, we think about the sources of energy needed for devices, we have solar and hydrokinetic options, and we don't even think about fossil fuels alternative even as the last option, so the company already has these as part of the DNA, so that is extremely important on how we do things".

R3: "We use a stage-gate process and TRL method [to measure the NPD success]. As long as you pass in each stage, it is moving on, but obviously, as the company grows, those processes become a bit more complex. For certain

projects, you need to understand the feasibility of projects in more detail. The stage-gate process is useful if you need to get different stakeholders to sign off things and to showcase the project. With this process, you normally have various departments to sign off and you have to give a presentation to everyone. In this way, everyone becomes aware of the upcoming challenges, and the progress being made. I have seen both the pros and cons with it, but I think everyone needs to find the right balance between their product and their company considering the risks associated. For high investment projects, I would definitely follow the stage-gate model, and this is how I manage it personally".

R4: "Sustainability cannot be based on quick assessments. You should look if it is benign for society and locality. I think most assessments need to go to the whole planet and then zoom down to business interactions, ask difficult questions like, Is this really worthwhile? Is this doing everything that people are demanding? or unlike the media reality checks. We got some tools in the world of eco-sustainability. But those tools are used in isolation. The tools such as LCA can only give you polling decisions because they are just looking at one thing. But we need to look at the other aspects as well. LCA is not the answer to everything. The circular economy philosophy is a useful construct that may be helpful in some situations but is not the answer to life".

High costs of sustainable products and their premium prices are explained as something that needs to be covered by the potential markets and customer demand:

R1: "I think it depends on the type of customers. I suppose that is completely different from companies that are producing in a B2C model, but in our case, I can say there is a possibility [to cover the costs]. I can give you an example of an agreement that we signed with a chocolate company (B2B model). The chocolate company is developing a new product, but the branding is about protecting the oceans. They want to have compostable packaging, and they want to donate some parts of the profits to our NGO as well, and there is a market for that. Sustainability is becoming something for higher markets, let's say for middle, upper-middle or higher class of societies in Europe, perhaps not so much in other societies such as Latin America yet. But it's something that is going to improve".

Regarding assessing sustainability dimensions of suppliers, he claimed that:

R1: "We look for companies who are environmentally conscious as we are. To be honest, we don't ask for certificates, maybe we should (for ISO etc.). We more assess the company on their attitudes and values. When you go and visit a company, you can see clearly if they are environmentally conscious or not. However, we don't have so many choices, so maybe we are not as good as we are in other things. Sometimes it is also a matter of speed, so we don't have the chance for unlimited resources. So, we don't assess that much, but it is perhaps an opportunity for improvement in the future".

Company A is using AM at the prototype stages of product development as an innovative approach:

> *R1: "We don't have any manufacturing department, but we have a partner that is producing what we design, and this is to leverage the costs. That's more common nowadays with start-up companies, so instead of you manufacturing yourself, you use new techniques such as 3D printing or laser cutting to make prototypes, and then you partner with large companies so they can manufacture what you designed. Using 3D printing depends on the volume. We are not a company that aims to sell a massive number of products, but each of our products cost a high amount (between half to £1million). So, it is difficult to use 3D printing for the production of the final products. So, for prototyping for product development, we use 3D printing and laser cuts. The partner manufacturing companies are based in Germany (for recycling), Italy (recycling), the US (construction of one of the components) and another one in Ecuador".*

> *R3: "We have used 3D printing in the production of our prototypes. It is suitable if it is used for rapid prototyping. 3D printings always seem nice but have never been representative enough for what we need to have for testing. If you are trying to test something and your 3D printed material doesn't have that strength, then it is not suitable, and I don't think 3D components are durable enough. So, for using this method you need to make sure if it is suitable for your testing and what you are trying to achieve. If you are going to produce something on a material basis, you need to use the right material and you can't use 3D printing. Selecting the right manufacturing method for your prototype depends on the product and the technical challenges you are trying to overcome".*

Application of sustainable practices into NPD projects can be one of the initiatives towards becoming greener and responsive to the environment. This can be applied in many aspects of the project, from green raw materials to waste management and sustainable logistics. Logistic activities and minimising the impacts of using vehicles were commented as:

> *R1: "We are assessing that. We are now looking for a company that is capable to partner with us (with electric trucks) to minimise the impact. For us, it is so important to perceive and take care of these details, because being a company doing environmental services, if we don't consider these tiny details, the image of the company will be affected. So, I suppose this is harder for us, as we need to take care of every detail about the environment".*

Similar to the eco-friendly functionality of their products, they also provide recycling services within the product life cycle:

> *R1: "Normally, the devices get reused, reprocessed and re-manufactured. When we design our products, we think about how to make something which is able to be re-used somewhere else. So, after the operation time of a device which is usually 3-5 years after the contract gets finished, we take the machine from the ocean/river. Moreover, we don't have any EMS or health and safety certificate in place".*

R2: "We recycle the large parts including aluminium parts. We design for recycling, and this has no costs or financial benefits for us".

R3: "We have developed this product with modularity for it to be compatible with different sites and locations and we are also regularly extending its lifespan. Its components have a long lifespan, so we should be able to repair the parts when they need to. We should be able to keep using that system for a long period of time. We have thought about that, but we have never completed a more detailed product lifecycle to get the full sustainability prospect. The goal is to use the system in different sites, but we are still a young company, and still testing our business model".

4.1.3 Company A: Influence of Sustainability on Demand-driven Chain Success

Company A relationship with municipalities/government as its main customer is crucial and needs lots of effort and negotiations. Regarding this, the company representative stated that:

R1: "Interacting with customers need lots of work. Because our customer is the government, we need to understand what they want. Because they want good public opinions, so we need to attract them. Once you understand what product you need to have, you need to build the strategy of selling, because it's not a mass-market product. There are different strategies on how you sell it to the government, so what is the sort of legal agreement that you need to make, is this a public or private alliance, is it a strategic alliance. So, you have to understand that is it's not a normal trade-off and there are some legal aspects in the business model you need to consider, and that requires a lot of time and effort. You need to work with lawyers, financial teams and do continuous work with them to develop the business model. There is no specific department for after-sales, CSM or CRM, but the whole operations in Ecuador are related to commercialisation and sales".

R2: "In Ecuador, as a developing country, we also intend to introduce the local community to new income sources. In some parts of the country, the income is less than five dollars a day. We try to make all the local communities involved and think of developing business models within recycling or circular economy concepts. Currently, due to COVID-19, we cannot organise any events or campaigns for this purpose. The access to the internet is also very poor here, so we are planning to start working with the local community in the following months for instance, by organising sustainability workshops and giving them tools to work in small teams".

Their customers are not involved in NPD within the design stages. However, they comment on the prototypes and ask for prototype refining if required:

R1: "We don't have collaborations with our customers basically. When we understand the need of the market, we do a lot of prototypes, and we show the prototypes to the customers with a speech presentation, then we get a lot of feedback followed by refining until the production of the final product. So, it is not like inviting them to be part of the design, but more like trying to sell the products".

Addressing customer demands and expectations as key points in demand-driven chains were elaborated as:

> *R2: "Right now, I don't think they have any expectations yet. This has been difficult because talking about sustainability and environmental impact is difficult in Ecuador since we have loads of other problems to deal with. We have extreme poverty, COVID-19, etc. The politicians don't talk a lot about sustainability in general. They have recently started to think about that, and we are trying to teach them about how we can start working on it together. Information, data, all the photos and videos that we gather and present to them [government, as a customer] make them interested. This helps them show off to people that we are working, and we take care of the rivers. So, they mostly use it for advertising purposes".*

> *R3: "In this case, it is important to have a clear upfront understanding about what the customer wants, what are they trying to achieve, and what are the required time, cost and other key parameters. Based on my experience, our customers have mostly got technical, cost and timing requirements. However, their expectations need to be realistic either from private customers or the government. For instance, if they want to clear the entire rivers in Ecuador in two years, obviously that is a very different expectation, unrealistic and unachievable. So, our company is not able to achieve that, and we can't commit to something that we can never deliver".*

Regarding the notions of customer buying behaviours and supply-demand for sustainable products, the chief technical officer also asserted that:

> *R3: "I think it [implementation of sustainability] is going to get longer than we all expect. Manufacturers are telling consumers what they want, whereas consumers are not saying what they want. People are now used to convenience and cheap products, and some people cannot afford it even in developed countries. With the current consumerism, that model changes. Until the consumers change their way, I don't think that change will not happen. I think the consumer doesn't realise how much power they have to make that change. I personally don't pay for organic foods, but I have changed my shopping habits in terms of other things. I buy things that cost a bit more, so they last longer and can be also repaired. I have never bought fast fashion and I have stopped shopping on Amazon as well. This is convenient but you need to think about the destruction of the high-street businesses and the people losing their jobs. There are currently sustainable business models where people return their furniture and appliances to the shops for recycling. For instance, IKEA has done that. In Europe, they have implemented a system to repair the electronics, and this should be the aim of all manufacturers. I would like to see more companies willing to take back their waste. The government needs to step in and drive sustainability, where the customers can't drive it enough. They can introduce different policies to push it along quicker".*

> *R4: "Buying choice is not only about how much money you've got but also how much time you've got (so how much time you choose to apply in a buying choice). I do see changes in people's buying behaviours. People recognise that if they spend their money on goods not made in their locality, it's not going to help their local industry/community. They observe that cause and effect in their life, but whether it's a strong enough influencer to alter behaviour is another*

matter. So, I think there is awareness but whether it alters behaviour, I don't have the answer. And sometimes the changes in buying behaviour are short term and that's why it can be good to have local and national government interventions in order to help develop the policies to end up with a more substantive societal response. The challenge with eco-sustainability is that it is enormous. For years and years, I have taught to do the little things like removing the charger on the wall (such a tiny intervention). Even if everybody does it, it doesn't make much difference, but it changes the way we think. So, one of the things I like is big renewables which are having significant net benefits".

The current challenges of Company A within the customer relationship context includes lack of government (customer) awareness about sustainability as well as the language differences as a barrier towards effective communication:

R2: "Sustainability in developing countries is not the key focus for politicians. In this country [Ecuador] if they have the budget for public investment, they prefer to make parks, highways or infrastructure projects because that's what people see and give politicians vote for. So, sustainability is not what they can get a lot of votes from it. We work really hard every day, to persuade people to look at the problem. There are only little discussions on environmental pollution. We try to make this awareness so that everyone can see it, but this cannot be limited to photos and videos on social media".

R3: "I think the technical team needs to get more involved in the customer discussions. At the moment we are not involved, because they [the customers] are based in Ecuador, they speak in Spanish and that is a barrier that we need to overcome".

The notions around future sustainable trends and the role of consumers as end-users within supply chains are discussed as:

R3: "Customers must take the lead in pushing forward sustainability. They also need to accept the costs associated with it, since the manufacturer will never give it to you upfront. To make a product sustainable is going to cost companies more money and if the people are not asking for it, then you are never going to drive that change through. So, this is the customer that needs to be always demanding that change. Afterwards, it is depending upon the innovation or technical team to act and make that product sustainable or make something to be re-used or recyclable. It will be nice to see that change, but until the consumer asks for it, the manufacturer will not change".

R4: "The company technologies are exciting and interesting and of the moment and if the technologies can be developed in scale, people can see them. This technology will extract harmful materials from the rivers, leading to improvements in river quality, river life and fishing. It will improve the fishing community prospects so one can see the cycle of benefits…ultimately of course. So hopefully people will also change their behaviours, organise themselves and no/less rubbish will be dumped into rivers and then there won't be a need for these kinds of technologies. But of course, by that time this company will come up with new technologies for other applications to solve other historical challenges".

4.1.4 Company A: IT Influence on NPD and Customer Relationships

Development of IT platforms was mentioned as something unnecessary, due to the world access to web-based and cloud-based platforms nowadays:

> *R1: "There is no need for us to develop an IT platform for our SC coordination. Nowadays, there are a lot of options in the market for communications (even for bigger companies). In the case of logistics specifically, because we don't have a lot of products to manufacture as there are only a few batches, it is more like direct communication with our suppliers. For internal company purposes, we use cloud-based platforms such as Dropbox which is really good for sending information. For some of the confidential things, we try to provide access to the people who are working on them (not everything to everyone) to avoid these spillages. We ask them to have an encrypted password and secure systems. They need to understand information security, mostly in product development. Regarding our contact with our customer (government), they are very old-fashioned in that".*

> *R2: "In the development of our products we try to look at actual systems or services that already exist in this industry. We have a strong focus on innovations there. We also use SAS (Statistical Analysis System) for data management and statistical analysis".*

The current technical challenge of Company A is the lack of sufficient funding for extensive prototype testing, considering that the devices need to be tested in different environmental conditions:

> *R3: "The challenges we are facing from a technical perspective is the budget, we never have enough money. I guess our main technical challenge is getting an external site where we can test the technology in a safe way. Obviously, we need a river that is polluted. Considering that rivers have different levels of pollutions and for instance, the river pollutions here is different from Ecuador, having a test site with specific conditions would be great. Testing in labs and based on simulations can't be indicative to full extent".*

4.1.5 Company A: Marketing Influence on Linkage on NPD and Customers

At this stage, the researcher attempted to find out the way the company employ marketing strategies towards its relationship with customers; before, during and after the NPD projects, as well as finding potential markets for new products and marketing strategies towards product launches. Company A utilises a wide range of marketing strategies and tools, especially on a national scale:

> *R1: "We use targeted market strategies with the Ecuadorian government (as our customer). We need to invest a lot in marketing activities, mostly in the media and press. Also, when I travel to Ecuador, I do a lot of interviews with local media channels so that people understand what we do, and therefore, the government wants to operate with us".*

Marketing approaches were elaborated as:

> *R1: "Regarding collective customer commitment, we don't manufacture upfront. So, either they pay upfront some of the costs, or we have a contract, so without that, we wouldn't start manufacturing. We use modularity, not mass customisation. So, we make modular systems that we can make some small tweaks to make it work in different environments. We don't tend to completely customise them. We tend to design the systems in different subparts, so one of the subparts can be changed depending on the customer needs (not the entire one), so you can make changes to customise some of the aspects of the product".*

He discussed the approaches to attract the Ecuadorian government to do business with them:

> *R1: "I can give you an example. I know another company in Europe that was trying to do a similar thing like us. But they didn't succeed, because the look of the company was too serious. They didn't care about having a media presence, even they weren't sure about where they want to deploy their products in the whole world, and they didn't succeed. In our case, we had other options, but we chose one country, some municipalities and local governments. We also raised the media attention and therefore, they wanted to work with us. It's not only about the product itself, but also about the narratives, how you make it something cool and attractive that they would like to have it".*

The barriers of marketing activities and the competitors' power are mentioned as:

> *R1: "It's really easy. From one side because we are doing it for the public interest, we use local media a lot. We try to be effective and become public by using local media like television, radio, local newspapers and media channels. This year we started using social media as well. To be honest, it's not something so expensive compared to how it was in the past. So, the social media campaign is so cheap".*

> *R2: "Some of the competitors are more funded than us and that is their power. They are mainly located in Netherlands and China. We have different approaches to our competitors, and this is the main difference. We think our business model and equipment are more scalable and we can also scale the products quicker than them".*

4.1.6 Company A: Economic Aspects of Sustainability, DCM and NPD Practices

The main economic target of every business is its profitability. Hence, every project is initiated based on its economic feasibility and profitability in the long term. As an initiation, it would be great to talk about the profitability opportunities to incentivise it for businesses, especially SMEs with greater impact on the environment as well as greater sensitivity about their budgets and resources. The profitability and economic harms of Company D, as a manufacturer of sustainable devices were discussed as:

> *R1: "Being honest, we don't measure the pay-off, because it's part of what we do. I suppose other companies (when doing the transition), measure their effort of sustainability, but we see that quite a lot as greenwashing, so in our case, it's not something we analyse, as it is part of the DNA of the company. We don't have indicators to track if this is going to be paying off or not*

because that is embedded in the company. So, it's much easier for us, perhaps comparing to other companies that don't have it (sustainability) embedded in their company, they need to have interventions externally. It is definitely profitable; we exist because there's a market need for what we do. I don't see any economic harms as it is embedded, so we don't even measure or track if it fits the cash flow of the company".

R2: "In terms of selling the equipment, COVID-19 has had a bad impact on our economy, so I hope this year we can start negotiations on new contracts as we see there is a reactivation of the economy".

R4: "In today's society, the economy is one of the aspects which enables people to function. The economy is also part of sustainability but to me, it's not the most important thing. People's self-worth and value are more important to me than finance. So, I don't think finance is the ultimate driver [of sustainability], but I see people as the ultimate driver of sustainability. You need to look at the consequences of your actions and see whether there is a net benefit. I have put a lot in there to see if it has a future for both business and the people involved, wherever they are within the organisation, or even within all the stakeholders of the organisations".

Moreover, the company utilises an innovative "build-operate-transfer (BOT)" contract with customers:

R2: "On the business model side, we tend to be really innovative. We are working to sell this as a service, and not merely equipment. We are trying to build equipment and just charge for its operation, and this is an innovative process called build-operate-transfer (BOT) (take it as a service). We are not selling the equipment or assets, we are selling the service for stopping the plastic with our equipment and after we finish the contract, we can leave the assets with them, so we teach them how to use them as well. That's the way we have found it more scalable to reduce the environmental impacts. To communicate with customers effectively, we also move with the market trends".

R4: "I believe this model is properly capable of profitable enterprise. To me, I see profitability more associated with leadership throughout the business model. So, I personally think that the co-founders can drive that company into sustained profit, that's in their very essence, they have the drive and ambition. The device looks expensive today. But that's based upon prototypes. There's a rule of thumb that between a prototype and a production model you are looking at a 90% reduction in costs. So, considering the value engineering, cost reduction, local supply chains and redesigns, the cost will dramatically reduce with a bit of effective engineering".

The high costs of investments towards sustainable products were mentioned as something natural to deal with, having no threat:

R1: "We don't have design changes to improve the products, and the products are being designed with all the ideas in mind, so it's not something that is creating additional costs, because of its design nature. I guess for companies that don't have it embedded in the culture, it might be harder than for us because we hire people with that mentality and knowing the reality. So, I don't see any cost threat in that".

R3: "We are implementing specific tests to measure the technology performance, understand the benefits of it and how it leads to our financial benefits. We are currently developing those tests so that we can prove our technology performance in our first test site, and hopefully, we can convert it to our financial benefits".

4.1.7 Summary of Case Study A

Company A is a start-up which takes its core missions from sustainability pillars, especially environmental aspects. As its representative mentioned, sustainability is in the DNA of their company. The CEO himself is the ambassador of the environment in his home country, and this can show the alignment of the sustainable objectives they have in that country. NPD and product design are the main functions of Company A. Therefore, they only employ passionate and highly knowledgeable staff to reach their goals. Their products' functionality is mainly towards the separation of millions of tonnes of plastic items that enter water habitats annually. Plastic items can cause death for marine species as well as the destruction of ecosystems. Having their key focus on developing devices to save nature and serve sustainability is something that automatically makes their business distinctive. However, they continue to label their product as a "sustainable product", because the whole lifecycle of the product from raw material extraction to final disposal must be sustainable, which has yet to be achieved. The importance of sustainability for this company is not limited to this, and by the establishment of an NGO, they also provide recycling devices to the vulnerable locals who collect trash for a living.

Technological practices such as AM is used by Company A for their prototypes, and they mainly find it suitable for rapid prototyping and not for the final product as it needs to fit the material specifications of the devices considering the environmental conditions of water ecosystems. This company is keen to move with the market trends in choosing IT systems either for communication with stakeholders, internal company interactions or NPD projects. Government is the main customer of Company A and therefore, they need lots of initiatives, strategies and legal agreements when it comes to being customer-driven. Their marketing approaches are at the national scale, and because their government is looking to attract public attention, Company A is deploying several marketing tools. Investments on environmental or social sustainability are surely costly for them, however, by close collaboration with both Ecuadorian (as a customer) and UK government (as resource provider), they will see a positive return on investment (ROI) and will be able to achieve their business goals.

4.2 Case Study B

- **Demographics:**
  - Company B is an SME based in Liverpool, UK with 22 employees. It was founded in 1994 and it is the leading manufacturer of reference materials for applied markets including the petroleum and petrochemical sectors.

- **Solution – Developed Products**:
  - This company has got a wide range of products and applications from calibration standards to certified reference materials (CRMs) and laboratory testing equipment. Their premium quality reference materials include density, flash point, liquid colour, refractive index, TAN/TBN and viscosity standards. Their products and service apply to multiple industries such as petrochemical, food and beverage, environmental, pharmaceutical, medical, adhesives, electronics, paints and coatings, automobile and aviation. They also produce a small number of petroleum-based products. They believe that attention to customer service, technical support and prompt delivery is key to business success. Company B motto is *"To ensure the customer's trust that we will deliver high-quality products in the fastest possible time to your laboratory".*
  - For marketing purposes, the company representatives actively attend tradeshows and conferences (Industrial and academic) which are mostly held in the EU, Dubai, and North America.

- **Supply Chain and Competitors:**
  - The company has around 8 major competitors in the UK all being SMEs as well as some large enterprises.
  - Their products are utilised in many sectors globally and they are served both directly from their headquarters in UK and through designated global distribution networks. Their main clients are OEMs (original equipment manufacturers) located all around the world, and they sell to end-users in testing laboratories. Moreover, the company directly serves end-users through its distribution partners in over a hundred countries.

- **Business Statistics – Performance and Revenues:**
  - Following international standards ISO 17025 and ISO 17034 Paragon Scientific Limited has dual accreditation status as a UK Accreditation Service (UKAS). As a certified laboratory, their products adhere strictly to an international test method protocol and, most significantly, their ability to do so has been officially recognised.
  - The company revenues are $5m.

4.2.1 Company B: Respondents' Background and Sustainability Interpretation

The respondent from Company B was the managing director with a Bachelors in E-business who has been working there since 2011. He was initially recruited as general manager, then promoted to director and currently working as managing director. He oversees company strategy, ensuring that all departments have enough resources, and making critical decisions on daily and strategic issues.

To start with the interview questions, his attitudes about sustainability concept were asked and recorded as:

> *"More from a profit point of view and based on my position, I would think: Do we have a sustainable business? But generally, I would think about the environmental impacts of our business, products and activities which are completely two different points with profitability. This is fairly new to be honest, in terms of every decision we make in this regard. About ethics, green initiative project, we are reviewing all the materials we have in process and packaging".*

The motivation behind the adoption of sustainable practices was the second question to find out his main incentives and sustainability drivers:

> *"From a business perspective, revenue/profit generation is the first motivation. On the other hand, our customers (mostly large organisations) have started to send us supplier questionnaires and surveys. They usually ask if we have ISO standards such as ISO 14001. So, we know that they are going to start that driving as a prerequisite to purchasing at some point in the future as more businesses started to think about sustainability and environmental practices and this acts as a driver towards doing so. We tend to prepare ourselves, gaining necessary accreditations at one point as well as focusing on our environmental impacts. This has been elaborated a lot in media and news during last year, so more people are becoming more conscious, and we are also thinking about what we can do to improve our activities accordingly. There could be opportunities with investments on sustainability, and that is how I am looking at it".*

The correspondence of government regulations and policies as a supporting factor for the company was elaborated as:

> *"I am not aware of any policies, and we have not received any notifications or funding from government or any other organisations about any available support towards sustainability. I was approached two years ago by an organisation that was working on green initiatives providing some funding. We went through that process, but we run out of time to be able to see if we are entitled to funding (as it was time-limited). You can sometimes get part funding for accreditation (40% contribution towards the costs) from one of the external parties I know which is indirectly relevant to the government. There might be some support and initiatives available from the government, but we are not aware of it to be able to utilise them".*

As an internal factor, the support and understanding of shareholders/senior managers have great influences on the whole systems' approach towards sustainable development. Company B representative stated that:

> *"I, as a key decision-maker in this company have to come up with a strategic plan including green initiatives, present it to the CEO and owners to make justifications on the costs and reasons, so I will be driving it from the top and then expect to get buy-in from all the senior stakeholders. At the moment no clear direction and decision are confirming that we are going to adopt these practices to be able to define a business case together to justify the expenditures, gaining a good position in the marketplace compared to our competitors, considering the consciousness from buyers regarding sustainable products. I have no idea if the owner/shareholders see the bigger picture of long-term profitability, so I think we need to make a business case and justifications for it, discuss the consequences if we don't adopt it and the potential benefits of being among the early adopters. Sometimes it might not be tangible to see the purchasing decision and consciousness of customers".*

Regarding the budget and proper plans for employee training and sustainable awareness, he claimed that:

> *"There is no budget or training in place, but if any, the funding usually comes from the specific green initiative project that we are going to be engaged in".*

4.2.2 Company B: Sustainability Influence on NPD Success

Original equipment manufacturers (OEMs) as Company B's main customers have a key role in the success of NPD projects:

> *"We have different channels to sell our products to end-users. OEMs (original equipment manufacturers) are our main customers, and they sell to end-users in testing laboratories. We also supply end-users directly. We also have distribution partners in over a hundred countries. There are also some catalogue houses that supply distributors and end-users. Accordingly, we have different approaches to NPD projects. Based on market research and market needs gained from our distribution or supply chain partners, OEMs or even directly from end-users, we start to justify the NPD projects. We also look at changes in regulations, specific to different regions (EU, US). If there is a new regulation, it means there is new testing to do, and therefore new instruments are needed. So, we have to provide with reference materials and standards to verify their measurements. So, we would investigate all the potential projects to see which ones are going to generate revenues, what are the risks and market penetration points. Then we use a scoring system to find the potential ones to initiate and minimise the risks and failures of NPD. But generally, there is already a need for our products, because everyone tries to measure something at some point especially in consumer and pharmaceutical products and they need a way to verify their measurements, and this is what we supply to them".*

The importance of sustainability in NPD projects and the way the company implements it can help the researcher understand the influence of sustainability when considering new products:

> *"In procurement and raw material point, we do not consider that [sustainability dimensions]. We need final products to meet the specifications, and usually, we have to use specific chemicals, petroleum-based, carbon-based and mineral oils, and it is very difficult to substitute them. There is no other way around, so this is challenging to go forward. Therefore, we try to apply sustainability in other points of the NPD process such as packaging and that is where we try to benefit it".*

There are several departments involved in very NPD project, and this is an indication of the vital collaboration of all the business entities in this regard:

> *"The involved departments are management team, technical department, production department, quality department, R&D and marketing, procurement activities (which ties into technical or production departments depending on the project) as well as operations manager who looks after both procurement and IT systems".*

The gauge and measurement scale for NPD and SNPD success to record the benefits, savings and sustainable levels stated as:

> *"Measurement of success is based on the time frame (usually 18-24 months), budget and revenues generated. NPD work package is used (internally developed software), starting with a business case, budget, each departments' responsibilities, which everyone has access to it and can give feedback. At the end of the timeframe, we review it and report to stakeholders. We have, however, not yet developed a system for SNPD success measurement".*

Implementation of sustainable practices into different levels of company operations such as energy usage and waste management was explained as:

> *"All the lights in both offices and plant are replaced by low energy consumption (LEDs), PII sensors are used in certain areas to minimise the wastage. Regarding wastes, we pay for waste collection both for general wastes and recycled bins. For the wastes that we can get paid such as cardboard, we do not generate enough of those waste types, so we don't currently get paid for any waste. Regarding the disposal of products at the end-user point, with every product, we provide SDS (safety data sheet) to our customers which includes information about material disposal, hazards and safety instructions. However, we do not have any after-sales services to collect the used products and close the recycling loop".*

Sustainable logistics, as part of SSCM operations, is also explored in Company B. The nature of their products and order quantities necessitate using national couriers and therefore, it is beneficial as they do not need to use individual big trucks. However, this does not allow them to share their vehicles with any other company.

"We use normal couriers like DHL, UPS, TNT, which anyways share the products, as our products do not require specific storage conditions. All the products go in mixed parcels. It just depends on the location we are delivering to. Some of our products need to go through freight forwarder because of the nature of materials, so they will arrange the shipment, whether it is passenger flights or cargo".

With regards to the premium price and evaluation of high costs of sustainable products, he stated that:

"We cannot evaluate that until we complete our review before NPD initiation. If we can absorb the additional costs, we will do that. The costs are associated with product specifications or international environmental standards".

The company certification with EMS or workplace health and safety as initiatives towards getting more sustainable were explained as:

"Not now, but we are thinking about 14001. Understanding the environmental standards, commit resources and personnel to meet [the standards] the expectations of the standards. Then the need for management reviews. We already have the international accreditations and standards for all our products, so we know the amount of work and costs required to get approvals. There is currently no certification for workplace health and safety. Risk assessment runs by the R&D and technical director and reviewed by the management team periodically; all our tasks and processes are risk assessed. But there's no certification due to the costs and justification of benefits associated".

4.2.3 Company B: Influence of Sustainability on Demand-driven Chain Success

Considering the replacement of supply chain by demand-driven chain within the literature, the researcher sought to discover the relationship between the company, its customers and end-users as well as their customised demands, level of sustainable demands, preferences and the company potentials and willingness to be responsive for that. Company B's contact and nature of the relationship with its customers, either OEMs or end-users were explored in terms of the level of correspondence to a demand-driven chain rather than a traditional supply chain:

"We have surveys that we do with all of our customers to enable them to provide us with feedback on an ongoing basis, as well as a formal process (designer survey). On top of that, there are customer contractors who ask us to complete the supplier evaluation based on a scoring system, depending on the score there might be some areas where we need to improve such as lead-time, price, etc. The surveys are designed by the marketing and quality department in collaboration together. As per international standards, we have to make sure that we have ongoing feedback from our customers. There are different surveys. Customer surveys are annually conducted, each one with a different type of survey based on the products and services we provide. There are separate surveys for distribution partners, market research and product development side (annually)".

The way they respond to customer preferences and demands, considering their feedbacks and requirements were explained as:

> *"At the moment, there is nothing in this regard to making differences. But we are beginning to see some results from supplier surveys from customers. We know that for example accreditation to ISO 14001, quality or health and safety standards is going to become a criterion at some point in the future. Based on the scores, for example, as we don't have ISO 14001, we could be scored down as a supplier, lose our business and someone else could win the competition. Our preference is to be first in terms of our competition and to be the primary source of our customers, therefore, thinking about EMS accreditations such as ISO 14001. On the supply side, with every packaging partner we have at the moment, at the surveys, we ask what the goods are made from, are they made from recycled materials, sustainable materials, are they recyclable? So, they could start designing their packaging around those areas. Going forward, what we have agreed is about a strategic plan that would be a prerequisite for us to deal with suppliers, they must be able to supply with this type of material. From our supply chain side regarding packaging, a lot of our suppliers do not even consider the quality standards, so we don't think they are will be going to get 14001, so from our side, it wouldn't be a pre-requisite for them to be accredited to some sorts of standards. As we go through this process, the plan is we want to come out with the change in packaging and provide marketing materials with the packaging to explain to the customer what we have developed. This is also applicable and useful to the product as we do some testing internally to make sure it fits and works well".*

Company B's respondent stated that all the departments within the company are responsible and involved in the adoption of sustainable practices and also claimed it is a target to be fulfilled by the whole business:

> *"Sustainable strategies involve every department and all the business. Talking about ISO 14001 for instance, it will impact the whole business, so we have to get all the business entities involved in that process, making sure we are complied with the standards and making sure that we have a companywide strategy".*

The identification of barriers towards the adoption of sustainability can help us address them as the first step within this journey:

> *"Except for the financial investment, another barrier could be that there would be more work for employees to do, so if they don't buy in to this culture and min-set, it can be a potential barrier. But the way we approach is to educate them in the early stages and make them aware about the plan, its advantages not only to our business but also our customers and partners as well as ethical benefits for our business. So, it would be easier for us to get our people on board regarding what's going outside regarding environmental changes and climate emergency. Another real barrier, sustainable strategies are new processes and procedures that people need to adopt. There is a high probability in the next few years, that we get more sustainable demand and become more demand-driven from our customers, especially from bigger organisations".*

Regarding tools and practices that the company uses towards after-sales, Company B stated that:

> *"We have strategic aims, and we try to get them scored up to five. These include the speed of delivery, speed of service, response time and lead time using excel files. The way the survey is designed for feedback is depending on the score they give, and that then be calculated based on the score on each of these areas. So, we do it scientifically basically. For gaining feedback [general feedback] we use web-based software such as SurveyMonkey, we design the survey we get all the results and then export all the data to CSV (common separated value) files to manipulate them for all the weighting. We need to see how we performed in each area and where we need to improve in terms of customer service. At the moment, the surveys including environmental aspects are only conducted from customers to suppliers, not from suppliers to customers, but moving forward, as we put green initiatives together, that will be one of the areas that we will start to ask for feedback from customers, this is also because we have not yet implemented sustainable strategies, but in the future, as we start with sustainable development, we will need to see what value it brings to the customers and us. It's a supply chain issue".*

4.2.4 Company B: IT Influence on NPD and Customer Relationships

To facilitate the coordination of NPD projects within the company as well as all the entities of the supply chain using IT systems, Company B asserted that:

> *"For NPD, we have the enterprise resource planning system (ERP) with project management function on there. We also use various excel files as part of that. So, it's a combination of pieces of software that we use. NPD packages go through each department, and they populate excel files and ERP systems. From there, when we do procurement, we can tie it into projects, so we have feasibility and all of our costs against NPD. The same ERP and a portal for customers and suppliers, which is a new system to put our input and information sharing purposes".*

Increasing transparency and smoother information sharing with customers is a determinant towards demand-driven chains. Therefore, as Company B stated:

> *"We try to engage in technology where possible. We have IT projects at the moment where we can share information more easily with customers. When we supply our products, it comes with SDS that we put in the box. It also provides with the specifications of calibration that goes into the product box. We are trying to facilitate this information online and send them automatically. Also, they could Log on to the system to download that info. We are always thinking about how to improve on the exchange of information, where we know they need the information".*

The departments involved in the management of IT operations claimed to be none in Company B:

> *"We don't have an IT department; we have an operations manager with a background in ERP systems. I myself have a background in IT as well, so we are quite well placed on IT projects, also a third-party supplier who manages and maintains all of our IT infrastructures. [Regarding the IT software development], ERP is external. For internal use, there is bespoke software we already have in the house, and we have developed ourselves. ERPs are the most expensive, web-based system (£12000-£14000), survey (each time a few hundreds of pounds), that is also expensive. The way we choose our IT systems is that we set out a score carding system in different criteria such as cost, support, functionality and reliability. Then we look at the availability in the market, see whether the systems fit our needs, then we do a gap analysis (what we need against what the system offers), if they can fill the gaps, then we narrow it down, shortlist, invite them so that they can demonstrate their systems, asking more detailed questions on costs of ownership and lifecycle of the systems. Then we also speak to their customers directly to ask their feedback about the system operation and then we decide the most suitable one for our needs".*

The attitude of Company B regarding the applications of Industry 4.0 such as AM into their product development projects was stated as:

> *"Considering the volume we produce; they [3D printers] don't seem practical. I am interested in these approaches and regularly monitor their industrial development. We have been proactive to see if there is anything we could do in terms of digitisations of our manufacturing systems, there is nothing we could do yet because we are scored pretty well on the areas where there were possible gaps. So, there is nothing we can do at the moment in terms of 3D printing. Some of our processes are suitable for some automation, but some others are very custom, they change a lot and are not so repetitive all the time, as we use different sizes and packaging, or different types of branding. So, it is difficult to automate these productions, we can only do the semi-automation, and we have done some cost-benefit studies with third parties, but that hasn't also been successful. So, this would be more useful for mass-produced goods rather than custom made ones".*

4.2.5 Company B: Marketing Influence on Linkage on NPD and Customers

The approach of Company B towards marketing practices is:

> *"We are trying to make the process as easy as possible for end-users, for instance, in packaging design and informing them about its benefits (cost, usability)".*

The way Company B employs marketing within its product development projects is:

> *"From the very beginning to the end of an NPD project, marketing, R&D and quality collaborate, and all of them should finally agree on how the product will look like. Throughout the whole lifecycle, all of them are again involved. Tradeshows, conferences (depending on the product), might be academic or industrial, mainly in the EU, Dubai and North America. Then brochures, we have introduced the small flyers (in the packaging boxes), so when they open*

the package, that's the first thing they take out so they can see how the product is developed. We also use email marketing to end-users and distributors".

It is important to understand the barriers within the marketing approaches, especially on the international scale:

"Not for the products. There are some language barriers depending on which place the products are going to be delivered, that's why we use distribution partners, so they are able to translate with those documents, marketing materials and speaking the language of local end-users, that why our distribution channels are so important to us".

The degree that Company B employs marketing practices such as postponement, mass customisation and collective customer commitment were also answered:

"We calibrate on demand; we do custom requests which is beyond demand. It could be co-designed with customers depending on the product or calibration type. With one of our customers, we have a number of products that we manufacture, but we work with them in terms of specifications. We manufacture the supply to them, and then they supply to their end-users. Sometimes the customers contact us to say they want a specific type of material, and then we start custom manufacturing scientification for them. The lead time can be quite long. Depending on the request, we have to do some lab research to see if we can do it, time and cost are important here. It has to go to manufacturing and has to fit with our plans and norms of our operations".

Regarding collective customer commitment:

"If there is research involved, we explain to them at the start about the costs associated. We have had situations where we have done the research, and then it failed, due to all the time and resource investments".

Again, the company approach towards gaining a competitive advantage and winning the attraction of customers in the target markets was described as:

"The biggest thing is that customers should be confident with the materials we offering to them. So, we characterise materials in our labs, produce and certify them, and we say when you test it with your instruments, this is the result. We have international accreditation for our calibration laboratory, manufacturing reference materials, key USPs [Unique Selling Proposition] for us in terms of marketing to our customers. On top of that, it is underpinned by technical support that we provide, know-how, help them resolve any problems. To speed the lead times and delivery time, we know some of our competitors offer around six weeks (based in the US). Quality is also another key factor".

4.2.6 Company B: Economic Aspects of Sustainability, DCM and NPD Practices

Company B sees sustainability and its profitability opportunities from an international perspective being driven by the rising demand of consumers as end-users of the supply chains. When there is a demand for sustainability, there should be a reasonable response and supply to that as well. Company B stated that:

> *"We feel that the customer is going to demand that we meet international standards for environmental sustainability, so we need to be well-placed and prepared for that eventuality. We believe that it's going to be market opportunities for us going forward to be able to justify the costs for all these activities. It is important to think about it in terms of the product we use considering the increased awareness and purchasing decisions (consciously or subconsciously) there are some considerations about sustainability".*

He was asked if he imagines any specific harm in the adoption of sustainable practices due to necessary investments for infrastructure, employee awareness and raising sustainable culture through the whole supply chain. He asserted that:

> *"In the bigger picture, there wouldn't be harmful, I think. In the short term, it might be seen as costly, but in the medium, to long term, everyone will go that way, so it's better to be among the early adopters of this culture. Environmental impacts seem to be a big question, everyone thinking and asking about it. There are price sensitivities in different territories we supply, so we have to manage to satisfy the customer needs in those areas".*

Reducing the costs and gaining the economies of scale as a result of the adoption of the demand-driven chain was evaluated by Company B as:

> "*From a cost point of view, we make one product in stock and different batches. The cost of one product or batches of products for us is almost the same. One of our strategic aims is to be fast and responsive, short lead-times to characterise the products. So, moving towards the demand-based chain it would be very costly for the customers and wouldn't be practical for us".*

4.2.7 Summary of Case Study B

The representative of this company was knowledgeable regarding the environmental standards as well as new relevant technologies. As mentioned, he has already proposed some strategic plans for green projects. Substitution of raw materials with green ones are evaluated as being challenging for this company, since there are limited resources, and the final product needs to meet the required specifications. Though, they are working with their suppliers on the recyclable packaging by demanding them within customer surveys. This is in the situation where environmental standards such as ISO 14001 are not required in the evaluation of their suppliers. As the representative stated, the growing level of climate emergency will automatically move them towards thinking about sustainability, and this can be beneficial in the long run.

Company B is mainly a manufacturer of calibration standards and laboratory testing equipment. Their industry seems to be a touchy one since it deals with calibration systems with high sensitivity and therefore, their customers (OEMs) which are usually large organisations need to be highly confident about buying from them. Their products are used in calibration laboratories; hence they need to function as accurate as possible. Their relationships with customers are mostly based on different surveys facilitated by web-based platforms. Customer survey does not include sustainable dimensions as they have not yet adopted such practices to a great extent. Surveys are only conducted from customers to suppliers and not from suppliers to the customers, and this supply chain issue makes the flow of sustainable developments slower. This company believes that demand-driven chains are costly for customers and needs longer lead times which is opposite to the company strategy being customer responsiveness. Their customised products are usually produced in different sizes and specifications and therefore, digitisation of manufacturing lines and using 3D printing is evaluated as unpractical for them. Semi-automation manufacturing towards cost savings has also been considered by them with no results yet.

4.3 Case Study C

- **Demographics:**
  - Company C is an SME based in Kent, UK with 30 employees. It is established in 1979 as a family business. The company is formed by current directors and shareholders who started with the production of air-handling units (AHU). They gradually progressed and moved into a 20,000ft^2 factory. Afterwards, they moved to a 45,000ft^2 in Rochester.

- **Solution – Developed Products:**

  - Their products range from air handling units to air conditioning and intelligent energy controls. Modern computer-aided design and construction techniques helped them manufacture precision components and streamline production. They have claimed that the immaculate detail and finish of the AHUs, inside and out, can be achieved by skill and dedication. The company is legally obligated to ensure that the AHUs meet the government standards.

  - ECE UK Limited supported the efforts of frontline national health service (NHS) workers by providing a compliant Supply and Extract Air Handling Unit and a fully integrated COVID-19 isolation system in partnership with Atlas Maintenance Services Limited and Royal Marsden NHS Foundation Trust. The project was finished in 14 days from the order placed to the time the system was installed and fully commissioned.

- The company launched a system called BIM in 2017. This web-based portal enhances the customer experience by providing them with all the BIM Level 2 files for their job-specific, customised AHU that was specified during the design stage. Using virtual reality or augmented/mixed reality, this portal enables clients to visualise the unit exactly where they want it and walk around it in real-time.

- **Supply Chain and Competitors:**
  - Many corporate customers, including Tesco, the AA, Safeway, and BUPA, had their air handling unit needs met during the initial years of company establishment. They soon started to work on valuable projects such as the Elisabeth Fry project at the University of Anglia award-winning building, the £700k order for AHU installation on the Knightsbridge apartments project and Ikea's flagship store at Tottenham. They have also handled an order of £450k for all the low energy AHUs that were installed on the renovation of the Savoy Hotel in 2008. In addition, they have secured a £486k contract for low-energy AHUs for the Luton 6th Form College project.
  - As a significant part of their work, they provide technical support for the pre-sales to meet the specifications and budget constraints of customers as well as aftersales services.

- **Business Statistics – Performance and Revenues:**
  - This firm was operated as a family business and also mostly pursued a personal approach in its work with customers throughout its history. Many customers have worked with ECE from the very beginning, and the continued growth of the company is based on the ability to retain customers and to provide quality goods, services and value within the long run.
  - The company revenues have been $7.8m for the first half of 2021. This business is shown to be successful in its sector with 42 years of experience.

4.3.1 Company C: Respondents' Background and Sustainability Interpretation

The respondent from Company C was the production manager who has been working there for 30 years and therefore, is acquainted with all the operations of the company. His main duty is overseeing the production and production drawings. He has been a dominant company member working closely with the shareholders and managing directors of the company. Through the years, they have been working to adjust the specifications and operations to deliver quicker service and products. Their focus has been to make the same products more cost-effective. To start with, regarding sustainability interpretation, the respondent stated that:

"Carbon footprint is the first thing that comes to my mind, as we have started dealing with this factor during recent years. There are some manuals and documents that we have to hand out to the customers to show how green the products are. Our first step towards sustainability is that we are trying to make things efficient. This is usually conducted at the customer service point, such as providing them with advice about the disposal of the filters or replacing them. I guess it's a law to meet certain standards acting as a driving force behind that, so it's purely what we are told to do".

He estimated that the government is somewhat supportive of their sustainable performance:

"The government tells us what to do with deadlines that we should meet. We, however, try to exceed that and put things in place beforehand, be linear and meet all these guidelines before they even come in. Specifically, in terms of energy usage, we became more detailed in checking energy as per the government rules and regulations. So, I can say we have become greener. We have less leakage than before. We used to oversize the products to compensate the amount of leakage, but now this is changed, they (government) asked us to stop leakage and then undersize stuff in order not to use as much energy".

Similarly, the top managers/shareholders drive the company towards sustainable practices as it is a common law nowadays:

"They obviously drive that. The owners of the company somehow take the back seat now due to their age, but any operations or decisions that need to be driven, must come from the top and then it would be handed out to the top managers to sort them out along the lines".

As stated, the company does not allocate any budget for sustainable employee training:

"It has not yet gone into that point as we have not allocated any direct budget for staff training, and their performance is only based on day to day experience and practices".

4.3.2 Company C: Sustainability Influence on NPD Success

The company seems to be always in the process of introducing new products to the market based on its product nature and customer needs. Despite no allocation of a specific budget for NPD, this is a routine and ongoing process for Company C. Regarding NPD risks, it is stated that:

"We are always trying new things with the support of R&D. Always trying new components, products and units to see if they are working better, we run tests and a lot of times it works. We, however, don't get a budget for NPD projects. We get introduced by sources and told by the owners to take a look at new components, but there are no specific guidelines. We have done some projects in the past which didn't work, so we had to scrap it and start again. Financial risks are the most important ones for NPD projects. We need to fully test the products before launching them into the market. There was a time that our RG units have not been fully tested before going to the market, because of some limitations and enough time for that. Therefore, over the last few years, we had to go for random repairs to rectify them. We had to go on the site, take the parts and re-do it which was quite costly for us".

Regarding the adoption of sustainability within NPD projects and the existing motivations towards that, he surprisingly claimed that:

> *"The only reasons for us to adopt sustainability are to increase efficiency and reduce costs. For example, we are currently working on hinges and door tapes to stop the leakage of the units, to make the units more efficient. So, we don't have to use such a big motor, which saves on electricity costs for the customer. So, this automatically reduces costs while it is in line with environmental sustainability principles".*

Towards the adoption of sustainability within NPD projects, the customers are the main entities that can cause risks and threats which result in final failures for the companies, therefore:

> *"We basically try to hear the voice of customers, take notice of them and respond to their feedback as much as possible. When we get a review of customer feedback, we try to develop it in a way to satisfy their needs. We, however, need to make sure to satisfy the business. If their demands are too costly, there would be a bit of compromise. Our industries are price-driven, even if the new product is the best one in the market, if the final price is high compared to the competitors, no one will buy".*

The involved departments within the NPD process are:

> *"Procurement departments are managing the purchasing as well as looking into taking the products with the best price. The production and design departments are merged. We don't have a specific marketing department, but a sales department which is doing marketing brochures. We design the products in production, and then we send it to manufacturing (factory) as well as the R&D. We also have the managing directors in the daily move when regulations change, we ask for help. We do not have any specific tool or software to measure NPD or SNPD, and I am not sure where we stand on that".*

Regarding the sustainable design of buildings and eco-friendly products, Company C stated that:

> *"We have spoken about that a long time ago, but it's never been driven because it has been expensive at that time. But it may be now practical considering our budget for us to introduce that".*

Regarding sustainable manufacturing and minimising waste within the manufacturing stage, he reflected that:

> *"We have purchased new machinery to cut down the wastes. We have now put everything on the software programme. So, instead of relying on a person, we are now more relied on the programmes".*

In terms of selecting green suppliers:

> *"We probably wouldn't [green suppliers]. But it has been done by chance if it comes up. If we have two options of the same product with green and non-green supplier, our decision to choose one depends on other factors such as delivery time, product efficiency etc".*

To eliminate the CO2 emissions by sustainable logistics or sharing transportation between companies, Company C stated that:

> *"A lot of our suppliers deliver other companies' products in their lorries rather than dedicated lorries. There is an Italian supplier that used to have a dedicated transport, but now the transportation costs have gone down because they are sharing their deliveries with other companies. The volume of our products is not enough for us to be able to share the deliveries. However, we try to use the whole size of the vehicles, to fill them up and not to ship them with a huge amount of empty space. There used to be a company with identical products nearby (joint forces), but they are competitors, and therefore, we couldn't share with them about our sales, for example, to say that we got delivery to London next week! If we ask them to share the lorry with us and put their items in, highly probable, they will reject. They may think that we have a naughty motive, and our purpose is to reverse engineering their products. I think it just doesn't work with the other manufacturers of our products".*

Regarding the management of environmental impacts and health and safety regulations, Company C representative went on to say that:

> *"We separate our wastage to carbon, wood, metal and general rubbish, but there is no actual certification of EMS in place. There are no rules and regulations by the government, and it is purely for its own benefit. We are being paid for some of them like cardboard. We sell metal by scrap. We have to pay for general waste, and the wood is free. For workplace health and safety, we have got a guide manual and risk assessments with a contractor".*

4.3.3 Company C: Sustainability Influence on Demand-driven Chain Success

Regarding the dimensions of demand-driven chain and customer responsiveness; Company C stated that:

> *"We always try to feed our customers back and to take them on board. If their preferences are related to design issues, we try to work with them through our production department to provide them with the specific design they want and also to make them aware that their desired design is not going to work. Sometimes they demand something that we know won't work or will be an issue in the long run, so we suggest them. We have 40 years of experience, and in fact 150 years of experience in terms of our overall manager's age, so we suggest them to consider something else. We listen to their preferences and customisations needs. For instance, if they want customised colours for units, we can produce them other than our typical grey colour. Preferences can be specifications that they give us, and we try to stick to that as much as possible. It can also be suggestions on top of that, for instance, to change the position of units to be more beneficial considering their space. The thing is we don't move ahead without them being happy, so once they see the improvements and results, they are happy with that".*

The way each company manages the premium price of eco-friendly products within the market launch phase is important to be able to evaluate if the advantages of doing so outweigh its disadvantages. Likewise, he declared that:

> *"Sometimes, they ask for energy-efficient [products] despite their premium price as they will have cost saving in the future. We can offer them alternative cheaper options which might not be as green as the others. We can build and deliver products based on the energy specifications that they give us. In terms of sustainable packages, there is sometimes some eco-friendly related questionnaire before delivery regarding the source of our packaging, whether the packaging is recyclable or the ways they can dispose of the packaging. Many other demands are on-site relating to our after-sales department who need to fill a questionnaire regarding health and safety issues, and we have to supply with that information. We have never been asked to use lightweight packaging, but they have asked us to ensure the usage of euro panels in case we used palletised packaging depending on the size they are dealing with (FCS branded panels) because of their recyclable features. However, it is very occasional that we get this sort of requests".*

Regarding the management of customer variable demands, he asserted that:

> *"This is a fixed and manageable set of tasks as it is what we are doing anyway, considering the possibility of our products/services towards customisation or becoming greener. Time and resources are important in this regard. We definitely need enough time to facilitate their demands through our relevant departments. Resources are other factors as there is usually a minimum order quantity for ordering the raw materials with our suppliers. For instance, if a customer orders a specified colour for the air-handling unit, we need to find its source first, if we don't have it available. There is also a minimum order quantity to order with our suppliers, so in some cases, it might not be practical to order them considering the number of items our customer requires (Matching supply and demand). For some suppliers, the minimum order quantity is 10 tonnes while 12 tonnes for others, we then have to work around not to waste time and not to lose the customers. The lead-time is another issue in this regard since if we have a wide range of customised products, we would have to look for best prices from different suppliers, look for matching volumes and this takes more time to deal with such orders and postpones the product deliveries".*

Similarly, the departments involved in sustainability issues and the motivation to become a more sustainable company for customers are explained as:

> *"We don't have any specific departments dealing with sustainable/ecological issues. The motivation to become sustainable is to reach customer satisfaction. What customer wants; the customer gets normally. The more customers are happy with us, the more likely we will continue the business. Gaining competitive advantage is another strong motivation".*

In parallel with the principles of a demand-driven chain, the CSM and CRM are explored in Company C:

> *"Sales and after-sales departments look after the customer complaints or customer service. Sometimes if the customers don't get satisfied with after-sales, they go back to sales departments. I think we are all involved in customer care services to assist customers with their queries. After-sales department mainly facilitates our connection to the customers, but after all the production comes in, probably due to their detailed knowledge about product features".*

4.3.4 Company C: IT Influence on NPD and Customer Relationships

Technology and IT applications are vital in the facilitation of NPD projects as well as supply chain administrations and customer relationships of each company. In this regard, he declared that:

> *"We got an IT department which is involved in all technology-related and IT tasks in the company. We used to use the CCSI engineering programme to organise everything from quoting, accountancy and drawings to the delivery point, but it was more efficient for us to design our own one. We have recently started using a programme called SolidWorks, which run tests and simulations on materials for panel production. AutoCAD is another one".*

The IT systems that are being used to coordinate various supply chain entities are internally developed by the company:

> *"There is a central database system called EC force (developed by our own company) which facilitates the connection with our suppliers and customers containing the ordering and accounting details, stocks, delivery dates and JIT manufacturing. The whole idea is to share the information with our stakeholders as quickly as possible. Our stakeholders use different systems, but there are no issues in this regard".*

The toughest barriers to IT applications within the company are explained as:

> *"They [IT systems] are always under constant development and do not get finished. When you buy a package, it is constantly being updated, and things are always changing. Internal IT developments are very costly as well since they need to be put all together, requiring massive expenditures, and we are talking about approximately a million pound here".*

AM as an emerging technology in the manufacturing world is considered by Company C as:

> *"We have looked into additive manufacturing for certain components, but it is a slower process for what we could afford and what we need, meaning that we use the raw materials quicker than we produce the products by our own machinery. They are also expensive and slow in producing the volumes we need and requiring specific health and safety regulations. The printers need to be on 24/7, and that impacts the level of energy usage needed to produce our components. [The question is] Would it be sustainable to use them or buying the whole product from our suppliers? Yes, using them, we will be making our own products, but we couldn't be convinced of its feasibility to warrant the costs against buying from someone else. We can buy in volume,*

and we don't need to deal with its (3D printer) costs and implications. Implementation of 3D printers needs to establish a separate department, introduce and employ someone and provide with know-how. It is completely a new, big and challenging area to enter. I have done the investigations and found out and reported all the pitfalls, pros and cons to the owners. So, it is available on the table if they decide to implement it. I think if we were bigger if there was a need for it and if we could afford that, we could have definitely done it due to its long-term benefits, but I don't see it practical on the small scale".

4.3.5 Company C: Marketing Influence on Linkage of NPD and Customers

The main tools that facilitate marketing strategies are stated as:

"We mainly use IT or social platforms such as mailshots, LinkedIn, Twitter, Facebook and Instagram towards our advertising practices. We usually employ a project/account manager to handle the exports and dealing with the customers. We don't have direct customers from outside the UK, but there are international companies based in the UK with different offices in Doha, Dubai, Ghana, Japan and the US that order products from us and we ship them to their destinations in case it is feasible for them".

As part of the NPD process and customer involvement within the design stages, the collaboration between company representatives, especially through the marketing department with customers, were explored. Company C asserted that:

"Sometimes, we work with certain companies for some sort of machinery with the right software that they need. For some bespoke items, we work with customers, they come to us to discuss what they want, they get involved to see if their specifications can fit our items, or the items can be custom-made for them in terms of dimensions, specific fuels to be used, etc. There have also been times that we worked with customers who didn't know what they wanted. We provided them with suggestions, they agreed, we consequently made a prototype, and then we started the main production".

All the marketing strategies are being practised where appropriate in the company, based on the product specifications and customer needs:

"*Most of our products are being marketed by postponement anyways, as we buy-in, cut it into sizes and then when we get the order come through, we assemble and manufacture it into the main components we need, so automatically we practice this".*

For some sort of products, customers get involved in product development from early stages to eliminate the risks of product failure as well as committing them to buy the products:

"They [customers] normally give us an order; we produce a certified drawing. They review the drawing, and they make the desired changes with comments. We revise, talk to them, revise again, and we get the approval at the end, payment side of things come afterwards".

Thinking about the business rivals and gaining competitive advantage necessitate each company thinking about the value it offers to customers. Companies need to create specific attractions and desires for customers and offer additional values to convince them for further collaborations. He claimed that the manner Company C creates value propositions is as follows::

> *"We normally sell the differences (upselling). We point out and justify where we are better. We ask customers if they have asked another company. We would then ask to look at their specifications (taking their prices off), explaining to them that the reason we are dearer is that we are offering these advantages. In this industry, a lot of people give you something, but they won't necessarily tell you what you don't gain. There are some cases that our competitors offer an item for a cheap price, customer purchase it, they win, and then customer notices that the package is not complete, and they need to buy another component as well. However, we do the upselling practice, and in case our prices are higher than the competitors, we clarify to them in advance about the exact components and detailed prices".*

4.3.6 Company C: Economic Aspects of Sustainability, DCM and NPD Practices

This company believes that the main economical benefits of sustainability adoption belong to end-users:

> *"Our payoff and results for sustainability adoption will belong to the end-user points in terms of energy usage, rather than any pay-off for us in manufacturing, procurement or logistics point. If we use efficient motoring instead of normal motoring, it will pay off end-users as they will be using less electricity. However, it makes us more competitive. So, we always analyse energy savings and show them how much they are saving in a unit over a year compared to what they are currently paying. So, we provide those pros to the customers to help them with their decision to buy new units. We say the differences again between both options, they could go with the normal products with no benefit, and they could go with more efficient products costing a bit more but more savings in 5 years".*

Customer desires for cheaper products act as a barrier that makes Company C somewhat neutral regarding sustainability applications and also causes them to keep the costs as low as possible:

> *"Regarding the sustainable design of buildings or electric cars, it couldn't have any benefits to us in cost-savings. If it was take-off and we had to keep up in the market, we had to supply it anyways. Regarding solar panels, for example, I see it as more expensive than beneficial, and because no other company is doing that, it wouldn't be viable for us to do that at the moment. We would have to be forced to use them to be a viable option for us. Even, customers are price-driven, they want cheap products which will suffer the green element. However, if the authorities ask all the identical manufacturers to install solar panels and offer suppliers with cheap solar panel options, we will see a force to do that, However I believe, the costs wouldn't change very much".*

In Company C, sustainability adoption is not the priority within NPD projects or customer-responsive actions. However, as he mentioned, product efficiency is the key element they always consider and try to fulfil. Again, as an emerging concept, sustainability is getting viral and being practised gradually. This seems to be a natural process that is also inevitable to be avoided in the long run:

> *"We would actually adopt it, but I don't see sustainability as a forefront. We always try to make the products greener anyways, so it would be a natural process, but I think first and foremost is to design the best products. I don't see the sustainability costs as a barrier, because we will ultimately sell the differences to customers elaborating their savings in the long term compared to the normal products and that will make us winners, but our focus is mainly introducing correct products according to the market demand and a natural process for becoming greener, rather than a specific sustainable strategy or mindset. We have become almost paperless in offices trying not to print unnecessary documents. Some employees need 2 or 3 monitors to compare different documents, instead of printing. We are saving paper, but again this increases the use of electricity and produces a footprint at the end of the day. Does it cancel itself out along the line? I don't know".*

4.3.7 Summary of Case Study C

Company C has got lots of experience in its industry. Any sustainable activity such as providing sustainable panels or lightweight packaging is being initiated and demanded from the customer side through the conduct of surveys. Their attitudes regarding the application of sustainability in the organisation are mostly indicated by the energy efficiency of the products at the end-user's point. Thus, they think that the economic benefits of sustainable products will be mostly gained by customers and not the company.

This company has got regular contact with its customers in its NPD stages and takes into account their preferences as much as possible. According to the representative, their industry is price-driven and even if they produce the highest quality and sustainable product, the customers may still choose the normal ones. However, using upselling marketing strategy is a good idea to make the customers conscious about different angles and advantages of the products they are buying. In this way, even if the final price is a bit higher compared to the competitors, customers gain knowledge about the differences and therefore may get interested and convinced to buy greener options with slightly higher prices.

An interesting point that the Company C respondent mentioned was the challenge of using shared vehicles with their competitors. They used to have a competitor in the same area with whom they are not willing to share their sales due to confidentiality reasons. A problem can be the pessimistic attitude of the competitor thinking about reverse engineering or the bad

intentions of Company C if proposing for shared vehicles. This seems to be a cultural problem when they think about proposing transportation sharing.

The use of 3D printers is assessed as a slow and high energy consumption process, whereas the company can simply buy the whole component from its suppliers. They also believe that AM requires addressing health and safety regulations as well as technical know-how. However, the representative has presented the AM idea to the shareholders for them to evaluate it further.

4.4 Case Study D

- **Demographics:**
  - Company D, with approximately 4000 employees and numerous facilities in various regions of the nation, is a chemical and rubber industrial holding headquartered in the Middle East. First established in 1978, the mother company originally manufactured adhesives and their by-products. According to statistics, there are presently around 640 employees at the adhesive manufacturing company, with 370 working at the plant and 270 in the corporate offices. According to a company report, the Chairman of the Board of Directors stated that "The chemical industry and in particular the manufacturing of adhesives is of great significance; because the glue is widely used in a wide range of industries, including automotive, construction, printing and packaging, wood and furniture, and bags and shoes".

  - The business then developed new production facilities with broader products, such as tyres, carbon and laminate tubes. In this study, some documented evidence has become accessible regarding the developed bioinsecticide, its environmental dimensions and NPD context.

  - This company is a family-owned business, with a team of three owners who hold the core and ultimate authority within the organisation, as well as the responsibility for carrying out main managerial duties. Upon reviewing the recruitment strategies of business owners, it was discovered that the criteria for hiring senior managers are not strictly based on professional qualifications, but on the traditional model of selecting employees from within the family or through links, regardless of their capabilities, environmental awareness or the latest management techniques. This phenomenon is referred to as "cronyism" in literature, being viewed as a corrupt practice that stands in contrast to meritocracy, which is characterised by appointments based only on qualifications (Hudson and Claasen, 2017).

- **Problem:**
  - The depletion of non-renewable resources, the widespread use of fossil-fuel-derived energy, and pollution, including greenhouse gas emissions, are all linked with the environmental sustainability issue at the technical level. For many years, adhesive technology has harmed all of these sectors. For instance, it is now acknowledged that the release of any volatile organic compound to the atmosphere is undesirable since it contributes to photochemical smog production, and many are involved in developing respiratory illnesses like asthma (Packham, 2008). In this case, adhesives and coatings are important sources of organic volatility. Organic vapours absorb infrared radiation and therefore function as greenhouse gases.

  - Moreover, there is evidence that residues of certain polymer technology-related chemicals are xenoestrogens and may affect the human endocrine system, lowering human sperm count and occasionally resulting in male genital malformation. For many years, the term endocrine disruptor (ED) has been the topic of heated discussion, drawing the attention of politicians, industry, the media, the general public, and other stakeholders. The chemical industries association (CIA) of the UK embraces this constantly changing discussion as a chance to examine the scientific evidence. This is while many of these chemicals are utilised as additives in adhesives and composites and are likely to be released into the environment due to their inherent incompatibility with the polymer phase. This is a critical issue, with considerable disagreement regarding the effects of low quantities of such substances in the environment on people, as contrasted to their effects on test animals under laboratory settings. In the past, the EU "REACH" (Registration, Evaluation, Authorisation, and Restriction of Chemicals) regulations have frequently attempted to compel this industry to substitute endocrine disruptors with safer options. Ultimately, the European Commission conducted a fitness check on EDs under EU legislation, with the findings published in a Staff Working Document to complement the newly released EU chemicals strategy for sustainability (CIA, 2020).

- **Solution – Developed Products:**
  - The adhesive manufacturing company produces industrial and household adhesives, industrial resins, polyvinyl acetate, aluminium and plastic tubes, anti-adhesives and other subsidiary products.

- In response to the ongoing controversy around EDs, the adhesive manufacturer has started working on some of its products to minimise environmental and safety implications by using new alternative technologies. Alternatives for all the company's adhesive products, whether in financial or technological terms, are currently not feasible. However, the business has been working with a Swiss partner for the development of an eco-friendly insecticide, an important step towards the long-term sustainability efforts of the company.
- This product is labelled "The Safe Alternative" and ensures safety for all people, plants and domestic animals. This product will be referred to as "Product X" in this section and it has got three versions with slightly different features developed (Table 4.2).
- Product X's unique composition has led to it being a product based on 99.75% water also being biodegradable and environment friendly. It is thus non-flammable, odourless and does not lead to irritation of the skin or eye and does not require protection before application. It is harmful to a minimum and may also be used in children's rooms or the vicinity of food or pets.

Table 4.1 Toxicity and Safety Measures of Product X Developed by Company D

Active Ingredient:
00.25% Permethrin long-lasting activity 2 - 4 weeks

Solvents: 99.75% Water
Application: Pump-spray (ready-to-use dilution 1:100)
Packaging: Environmentally sound HDPE

Product X	Concentrate	Ready to use
Acute oral toxicity, on rats (LD 0)	> 5'000 mg/kg	not measurable
Acute dermal toxicity, rats (LD 0)	> 5'000 mg/kg	not measurable
Acute inhalation toxicity, rats (4h LC 0)	>4'000 mg/m³	not measurable
Primary skin irritation	no effect	no effect
Primary eye irritation	no effect	no effect
SPECIAL INVESTIGATIONS		
Skin irritation human		no irritation (24 h)
Repeated wetting, dog		no toxic effects
Repeated wetting, hen		no toxic effects
Swimming test, rats		no toxic effects

- The USP of Product X is defined as:
    - Lowest possible toxicity versus best possible efficacy
    - Broad application spectrum
    - Unique formulation (does not stain, no odour)
    - Biodegradable, environmentally sound
    - Economic in use as it is long-lasting
    - Preventive as well as acute applicable
    - Covers all aspects of insect prevention
    - Easy to use and apply
    - Suitable for both in and outdoors
    - The ecological and economic solution

- The strengths of Product X include lightweight packaging, minimal absorption in humidity, high density and high-temperature tolerance up to 110°C. Moreover, a linear polymer called high-density polyethylene (HDPE) is chosen for its packaging. The bottles are reusable and made of eco-friendly materials, with a dependable pump spray that can be reused. This insecticide is a greener option compared to the later chemical insecticide of this company, which has been produced in the plant for the last 20 years. Below are some of the safety features, the product features and USPs. Accordingly, Table 4.1 indicates the toxicity and safety measures of this product.

- There are also disadvantages to Product X. For instance, Product X classic has a longer killing time than many conventional insecticides. It normally takes five to ten minutes, when speed is necessary, to exterminate cockroaches. Moreover, due to additional production expenses, Product X classic version costs a premium of about $1.68 for a bottle of 375ml. Its Extra GT version costs $4.84 for the same size, whereas a competitor’s classic 375ml bottle costs about $1.52.

Table 4.2 Different Positioning of Similar Insecticides within the Marketplace

Features	Product X Classic	Product X Extra GT	Aerosol
Knockdown	Slow	Faster, but still slower than aerosol rather quick	Rather quick
Efficacy outdoors – Long-lasting effect	Good, but in case of application on dirty, organic, absorbing surfaces or hot conditions, high humidity or extreme climate (heavy rainfall, high sun exposure, etc.), it will be quickly degraded (within a few days).	Excellent, due to the microcapsules, active ingredients will be released over a long period even under extreme conditions. This makes Product X Extra GT the first choice for travelling, camping, terraces and gardens and of course, for all countries, where extreme climate conditions are usual.	Limited to the initial knockdown and kill effect.
Efficacy – Toxicity indoors	Excellent, can be used even close to food, in children's rooms and close to pets. It will not stain, there will not be any bad smell. There is no danger when applying the product. However, in cellars and storage rooms, where similar conditions as outdoors occur, the efficacy is (dust, humidity, temperature, etc.) will be rather quickly degraded.	Product X Extra GT works fine indoors. It should not be applied close to food, in children's rooms or on pets (which is true for aerosols). It works excellent in cellars and storage rooms (up to 4 months). It will not stain; the smell level is low and acceptable.	Aerosols should be used carefully indoors, as exposure to the spray mist. They work a bit longer than outdoors. Aerosols claiming to have a long-lasting effect are usually very toxic.
Environment	Environmentally sound	Toxicity data comparable to Product X Classic and biodegradable	Usually hazardous
Control of pests	Due to resistance problems, there can be difficulties in controlling pests, but under normal conditions, Product X works fine	Excellent in controlling pests, Product X Extra will overcome all resistance problems and due to the long-lasting effect control pests perfectly.	Aerosols are not capable of controlling pests.
Intention of use	Very save prevention, short term protection.	Save, long-lasting prevention, flexible use outside from home	The acute killing of single insects
Where to apply	Perfect to be used indoors in the kitchen, bad bedrooms on cloth, curtains and on surfaces even close to food or food utensils.	The ultimate product for dirty wet and warm areas. In the cellar attics and around the house to lay barriers against ants and all other creepy crawlies trying to enter the house or apartment. Also, the hobby room, garden house and balcony are perfect areas where it can be applied.	Only indoors in areas where no people are staying.
Market Positioning	Universal Household product	Heavy Duty professional indoors and outdoor product.	Indoors only
Technology	Single active ingredient unprotected	Two component insecticide applying latest and patented encapsulation technology.	NA

- The other manufacturing plant produces a wide range of tyres for light trucks, commercial trucks, SUVs and TBR in both Bias and Radial types under the license of a well-known Dutch tyre manufacturer. By application of up-to-date technology and state-of-the-art machinery, it has succeeded to promote its brand image in both local and foreign markets within the Middle East region.

- **Supply Chain and Competitors:**
  - The enterprise specifically the adhesive company has gained a competitive advantage by producing a diverse range of products, bulk production and economical prices. This business has a near duopolistic status in the nation and controls a significant portion of the nation as well as Middle East's total market share. According to one of the company reports, "The main success factors of the company include, robust research and development, strong communication with customers, innovation and creativity, and availability of goods".

- Their main customers of the tyre company are the large car manufacturers within the country as well as several countries within the region. As per the company's mission statement, they believe that "Fine products, customer orientation and providing premium after-sales services to customers" are the only pathways towards the survival of industrial organisations.

- **Business Statistics – Performance and Revenues:**
  - Approximately 18,000 tonnes of adhesives are produced by this company each year.
  - It has also succeeded to obtain ISO 9001:2008 from QS Swiss Company and also ISO 10668:2010 for brand valuation from the Canadian ICS Group certification. The foundation for Company D success is its ability to supply high-quality products on time as well as providing after-sales services.

4.4.1 Company D: Respondents' Background and Sustainability Interpretation

- Respondent 1 (R1): The project manager has been working as a commercial deputy for both of the companies for around 20 years and recently switched her role to project manager. Due to her regular contact and collaboration with all the departments and executives, she is knowledgeable about most of the company operations. Her educational background is a Bachelors in electronics engineering.

- Respondent 2 (R2): The technical manager who oversees client relationships, market monitoring for potential product development, and ensuring that the firm is on pace to reach its financial targets. A master's degree in industrial engineering is among his qualifications and he has 13 years of work experience in the adhesive industry.

As usual, we first started with general discussions about sustainability:

> *R1: "Sustainability reminds me of green and high-quality manufacturing of products. I think keeping the momentum in the tyre market and maintaining our competitive advantage and brand image in a constant manner are the best motivators".*
>
> *R2: "Frankly, the economic benefits of sustainability are more vital for us over the environmental aspects. Right now, the economic challenges we face create barriers to the adoption of sustainability. Moreover, we do not see enough drive from the government side, so in my view, this is kind of self-motivated attempt that every corporation may act for separately".*

Regarding government incentives, they stated that:

> *R1: "Government has got some hands in controlling the energy savings, reduction of noise pollutions and workplace. But if I say more than that, it is only a show-off. Occasionally, they come for inspections requiring for the adoption of different environmental related standards such as ISOs".*

> *R2: "The only thing from the government side is a set of guidelines regarding appropriate methods of waste disposal, and enterprises who fail to follow these requirements face fines".*

Regarding managers' attitudes and influences on the adoption of sustainable activities, she asserted that:

> *R1: "The highest drivers and influences come from the shareholders/owners since they believe that the continuous production of high-quality products leads to more profitability and popularity of our products. However, we cannot deny the top managers share as motivators in this regard".*

A specific budget is annually allocated for employee training purposes:

> *R1: "0.5% of the total annual sales are allocated to employee training, not merely for sustainability training, but also for product developments, marketing etc. The company also send the senior managers to different exhibitions and industry events across the world, and I always ask them to send a newly started employee or intern as well. We have had workshops regarding different ISOs for relevant staff as well. There are also large billboards installed on walls regarding different stages of health and safety instructions".*

4.4.2 Company D: Sustainability influence on NPD Success

As per our research studies into the company website, product development has been among their crucial activities, especially after a few years of the establishment of the holding:

> *R1: "Development and production of new products are always accompanied by risks and fears. However, with market studies, cost estimation and feasibility, we can minimise these risks. Starting with innovation is always risky, but in most cases, it ends with success especially in the tyre market in our region, where the market conditions and competitor prices are vital in NPD success. R&D, technical, technology and procurement departments are involved in NPD projects. Most of the NPD projects initiate according to the market needs, so both are closely related to each other. These are the customers who tell us regarding a need for a new product or development of a current product. Firstly, the R&D department conducts all the studies on new product design. Then with the help of the technical department, we investigate the need for new equipment and machinery. Then they collaborate with the technical knowledge unit to decide on either getting the know-how or the technology updates. The relevant request will be then sent to the procurement department to contact the machinery and technology providers. Finally, all the mentioned departments start collaborations and meetings to find the best suitable strategies".*

NPD success and measurement are elaborated as:

> *R1: "Some of the most crucial NPD success factors is the constant quality and continual improvement processes. These are also important to maintain our customers and increase the orders not to lose them. Most of our customers are long-term and loyal ones, so we need to fulfil their needs, for instance, for TBR tyres. It is not hard to measure NPD success in our industry. The simplest way is to compare our sales with our competitors' sales, and the customer willingness to the new products".*

Supplier selection and evaluation seem to be tough tasks for Company D considering the existing limitations regarding economic sanctions and also lack of raw materials which can sometimes be only supplied by specific companies in the world:

> *R1: "Suppliers are not being evaluated directly; however, we are trying to replace some oils, for instance, with the eco-friendly ones. We are also collaborating with the technical knowledge unit to work on purchasing the green machinery. Most of the raw materials are being purchased from China and European countries, and most of the suppliers have stopped producing chemical materials and changed their strategies to set environmental policies for their organisations and produce greener products. This is a result of moving the industrial world towards saving the earth, minimising the investment and increasing international rules; and provides the opportunity for the company to purchase green raw material unconsciously".*

Nevertheless, they have tried (especially in the adhesive sector) to develop new eco-friendly products and packaging to minimise the environmental impacts:

> *R1: "Recently, in the last two years, we have been working on the replacement of raw materials with eco-friendly ones. We have also been looking for machinery that use less electricity and fuels to have a less environmental impact. It has also been tried to replace carbon black with Silica which is a greener material [for tyre production]. Silica is being used by developed countries for many years. To be able to use Silica, we had to modify our Banbury mixers (tyre production machinery). So, there are associated investments towards producing greener products. In addition to minimising environmental impacts, we also need to work on tyre noises on roads. So, it's not only the use of raw materials but also the final products need to be sustainable in every term".*

They have also developed an eco-friendly production line in the adhesive company:

> *R1: "Moreover, the adhesive company has launched a new sustainable production line producing insecticides based on 99.75% water, totally biodegradable, safe and eco-friendly for all the humans, plants and domestic animals. It is non-flammable, odourless and does not result in skin or eye irritation. It has also got the minimum toxicity and can be applied even close to vulnerable people or foods or pets. This is definitely greener and more economical than our previous chemical insecticide, which has been produced for over 20 years. Also, we have used HDPE, as a lightweight package with low moisture absorption, high density. It's also quite cheap and recyclable".*

They reflected on sustainable logistics as:

> *R1: "The practicality of transportation sharing has not yet been investigated and therefore, impossible for the meantime. However, we more or less share the vehicles between the companies in our holding".*

> *R2: "I don't see how transporting adhesives and tyres on the same vehicle is feasible. Also, since we employ several distribution networks, sharing the vehicles appear to be impractical for now".*

They have established a recycling company as well, besides all their activities:

> *R1: "In our holding, we have developed a recycling company that transform the tyres into reclaiming. However, recycling seems to be currently impossible on a larger scale".*

The use of solar energy or other green energies has not been still possible. They claimed that*:*

> *R1: "Unfortunately, we still don't use solar energy in our plants, but we have tried to minimise the use of fossil fuels by adding larger windows allowing more sunlight to come in".*

> *R2: "Solar panels have now become fashionable, and many firms provide them. They are mostly used for household use. We currently use wind energy for the lighting of some of our buildings but also looking for companies for utilising solar panels as well".*

4.4.3 Company D: Influence of Sustainability on Demand-driven Chain Success

Customer relationship is the key function of this company, as they produce in high volumes and their customers are mainly car manufacturers. Hence, they deal with high-profile customers on a national scale. In this regard, she stated that:

> *R1: "We value our customer relationships a lot, so we monthly organise various meetings to identify our weaknesses and strengths. Customer preference is one of the factors in our negotiations with them. Every once in a while, we evaluate our customers based on some factors such as their purchasing patterns, and the regularity and quality of their contact with us. Based on the monthly meetings, especially with OEMs, we get informed of their values and preferences, or they ask us through sales and marketing departments. Close collaboration with customers and reaching an agreement with them in terms of facilitation of better products and services is a motivation itself when thinking about their sustainability preferences. If the existing problems are impossible to be solved by senior managers, they get referred to the CEO and shareholders".*

Variable customer demand was discussed as:

> *R1: "Well, frankly speaking, no one has a good relationship with changes, however in case we are obliged to make changes in the lead-time, quality or anything else, before the execution of any activity, we organise meetings with them to reach a win-win result".*

After-sales services help Company D towards customer responsiveness:

> *R1: "We have an after-sales department which provides services during the guarantee period and, in case any technical problems exist, they refer it to the technical department. As I said, customer values and consumption patterns are important factors in keeping our customers loyal. Supply chain redesign towards a demand-driven one has been initiated with the aid of industrial engineers and IT departments".*

4.4.4 Company D: IT influence on NPD and Customer Relationships

IT platforms and use of technology for NPD projects and collaboration of supply chain entities are evaluated as:

> *R1: "Technical department is dealing with technical know-how, and the IT shares the information. Most of the IT problems are due to non-correspondence to the company goals and software bugs and faults. We always try to make transparency within the inventory levels, delivery track and updates. Without automation, the whole system is faulty. Therefore, we try to make a close tie between our company and all its stakeholders. IT systems for internal company communications are usually bought within IT packages and sometimes are developed by our own. For SC coordination, we only use normal tools like Emails, Skype or face-to-face meetings".*

The usage of AM is presently not in use in Company D, although respondents indicated adequate awareness of developments in this sector that can help them move forward if adequate funds and resources are provided:

> *R1: "As a new manufacturing technique, I have had some explorations into 3D manufacturing, but still haven't presented any business plan to the CEO and shareholders".*

> *R2: "Small parts such as moulds and specific machine parts that aren't readily available in the market appear to be a good fit for 3D printing. Of course, the alloy and heat treatment conditions need to be examined in this regard. Beyond that, I have heard of a 3D printed tyre prototype that is developed by the collaboration of a French and American tyre company. Although it will take time for it to be validated, this would be a significant breakthrough in this industry that has got a high potential to change the competitive nature gradually. The 3D printed tyre is airless and fully biodegradable which means it is made of renewable materials and is also recyclable. If we think about imitating products like this, the final price will raise a question. Also, in this case, 3D printing facilities are required on the roadways and mechanic shops which necessitate high additional funds and access to this technology. Large firms are always at the forefront of technological advancements, but I suppose they can also push us as smaller firms to think about further innovative and sustainable alternatives".*

4.4.5 Company D: Marketing Influence on Linkage on NPD and Customers

Regarding the marketing of green products specifically, they provided an example regarding the green insecticide:

> *R1: "Yes, we have different marketing strategies for different products and territories. For the marketing of mentioned green insecticide, for instance, the Swiss company [which the product is licensed under] advised us to start marketing with advertising on billboards and selling to the drugstores and luxury supermarkets in the wealthier and more cultured part of the city. This is because there are more educated housewives there who are more conscious about buying green and non-harmful products (insecticides), especially for their children care. In contrast, in other parts of the city, people might be more sensitive to prices and prefer the cheapest option available, instead of caring about buying green products. This product is more expensive compared to the previous ones, but people need to gradually accept that they need to pay more to get safer products. When their knowledge level increases, they will understand what to buy. We also offer them (supermarkets and drugstores) some discounts to get motivated. As I mentioned before, we also allocate an annual budget for attending international exhibitions and we also occasionally use advertisements on media channels or large billboards".*

> *R2: "Sustainability has a symbolic form for most people. People get more interested in sustainable products when manufacturers explain and promote the product's ecological advantages. So, their willingness to spend for such can rise gradually. As a result, greater justification and consumer awareness are required for the success of the green insecticide we produce. The main difference between this product with similar market products is its impact and durability. The detailed launching and marketing plan was the first stage towards the success of this product. Marketing tools such as transit, media and digital ads are the easiest way to introduce such a product".*

Company D's existing marketing barriers and threats were explained as follows:

> *R2: "Seasonal insecticide usage has posed a threat to the development of this product. Of course, what can be highlighted about this product, in particular, is the occasional restrictions on the import of its raw materials and the interruption in market nutrition and the lack of extensive market coverage. As stated in our company reports, the sales amount of this product in recent years has been a maximum of 55 tons per year and this is a very small share in the product portfolio of our company. Considering the aforementioned circumstances and outcomes, I believe this product has not yet achieved sufficient commercial success. Another critical point and prevalent problem at the firm level is the low attention to the marketing plan. In fact, most of the focus is on advertising tools, and there is no consistency in this issue either. The noteworthy issue is the existence of advertising contracts with significant budgets but low efficiency. Given that marketing is a piece of specialised and comprehensive knowledge, it is strongly recommended to create new marketing strategies using expertise, and to analyse and get unbiased market feedback once plans are implemented".*

Almost all of their products are mass-customised, since the OEMs are in close collaboration with Company D, requiring different sizes and types for the production of the cars:

> *R1: "Every product development is initiated and mass-customised based on the customer requirements received by the customers directly or through their representatives. Therefore, the value proposition is automatically there".*

OEMs (Automakers) are not engaged in NPD, but they have representatives in the company, supervising the product development and discussing their requirements:

> *R1: "Our customers are both normal distributors and OEMs. Each of the car manufacturers has a representative in our company with full supervision on the products and their development. They are not actually engaged in NPD projects, but every once in a while, they discuss their requirements and demands".*

4.4.6 Company D: Economic Aspects of Sustainability, DCM and NPD Practices

Economic payoffs of sustainability activities are detailed as follows:

> *R1: "Pay-off on investments can be usually seen within 3-4 years. Regarding the production of eco-friendly products, we feel forced to move towards them either we want them or not. This force is due to market competition with other products [sustainable products produced by competitors], as well as dealing with environmental issues such as air pollution. The high amount of investments act as barriers towards sustainability, but in these cases, we try to execute the projects in two phases, so, we could reach our economic goals but maybe a bit later. There are also some economic barriers for the adoption of sustainability, such as fluctuation of exchange rates and economic sanctions imposed on our country".*

4.4.7 Summary of Case Study D

Compared to the previous three companies, Company D is a large enterprise with various factories and products as well as a high experience level. Sustainability is viewed as a need for international accreditation by their government, and as a result, this firm has achieved various international standards. However, this cannot fully guarantee the company commitment towards minimising environmental impacts. As a starting point, they have developed eco-friendly and harmless insecticide sprays that are sold in a niche market. However, in comparison to traditional insecticides, Product X's performance is hampered by a lack of marketing expertise, restrictions on raw material imports, and a lack of end-users' awareness about green products. The company has also started replacing some raw ingredients in the tyre manufacturing process, which is currently ongoing. Economic hurdles cannot be taken lightly in this circumstance, given the region's exceptional instability in the exchange rate, as well as enforced economic penalties that can isolate enterprises from global manufacturing technologies and prevent them from adopting further improvements within green technology.

Company D devotes 0.5% of its total sales income to staff training, and this is a remarkable job considering the amount of culture and knowledge required for NPD, sustainability, new technologies and new marketing approaches. The roles of owners and top managers regarding sustainable practices are notable, and their perceptions about sustainability are associated with high-quality products, continuous process improvement and profitability as a result. Company D claims that it values loyal customers as the ones who have indicated their commitment and support to the nationally manufactured products, which contributes to a decrease in the unemployment rate as well. They host a representative of each of their OEM customers in their company. This implies that they obtain a solid awareness of their consumers' needs and preferences. OEMs, on the other hand, are not involved in any step of NPD initiatives and just serve as controllers and supervisors.

4.5 Chapter Four Summary

This chapter provided background information and interview transcripts from four businesses, three of which were headquartered in the UK and one in the Middle East. The interview recordings are transcribed in a verbatim way to ensure that the exact words said are captured. In the next chapter, the interview data from this chapter will be coded using NVivo 12© software followed by content analysis and cross-case analysis to analyse data and explore the similarities and differences among the case studies.

CHAPTER FIVE: DATA ANALYSIS

The last chapter presented the gathered case study data from four companies. This chapter mainly consists of "Content Analysis" and "Cross-Case Analysis" of the data. It follows the first and second phases of content analysis, including preparation and organising initial codes. In parallel with data interpretations based on categories and codes, cross-case analysis will identify the similarities and differences across the cases. Finally, after each interview question, critical discussions and the literature relevance will be presented.

Figure 5.1 Flow of Data Analysis Chapter

5.1 Case Study Features

Before starting with cross-case analysis, some background data needs to be supplied to gain a general understanding of the case studies' main characteristics as well as respondents' background data. Table 5.1 indicates a classification of case study backgrounds based on firm size, type of products and job functions. The cases were selected among different sizes and territories, which may make the cross-case analysis more challenging. However, given the world's current interconnections, especially within the manufacturing sectors, it can be beneficial to explore the research concepts on a multi-national scale.

Table 5.1 Case Study Features

Company	Company Size	Supply Chain Position	Type of Products	Position of Respondent
Company A	SME < 30 employees	Focal Company	Devices to extract plastic pollution from water eco-systems	Chief Executive Officer Chief Operating Officer Chief Technical Officer Advisory Board Member
Company B	SME < 30 employees	Tier-1 Supplier/Focal Company	Calibrate measuring instruments, lab testing equipment etc.	Managing Director
Company C	SME < 40 employees	Focal Company	Air-handling units	Production Manager
Company D	Large Enterprise	Tier-1 Supplier/Focal Company	Tyres and adhesives	Project Manager Technical Manager

Figure 5.2, named word-cloud is generated by NVivo 12© based on the 100 most frequent words mentioned in each company interview. This can assist us in gaining a general understanding of the numerous existing insights to comprehend, as well as determining which elements were most relevant in each scenario.

Case Study A

Case Study B

Case Study C

Case Study D

Figure 5.2 Word-Cloud of Case Study Interview Data

5.2 Codes and Categories

To start with the content analysis, the written interview data (manuscripts) were transferred into NVivo 12© software, get labelled and broken down into different codes (known as nodes in the software). Descriptive coding is deployed to review and summarise the statements in a word or short phrase. At the end of the coding process, the codes are entirely reviewed to find out possible duplications or wrong labelling. There are *110 initial codes,* as shown in Figure 5.3. The initial codes are then classified into different categories based on their relevance to the

developed topics, as indicated in colour-codes in Figure 5.4. As obvious, some of the initial codes created sub-themes and were categorised into categories, while others developed independent categories since they did not fit into any of the wider categories or any of the other categories. Based on the category searches and classification of the initial codes into different categories, an initial map is illustrated in Figure 5.5 for further analysis. In total, *101 sub-themes (codes)* and *35 categories* are identified at this stage. Subsequently, the cross-case analysis will firstly identify the comparison between case studies, secondly, help to sense the significance of different categories with regards to the research. The initial categories and sub-themes are investigated based on their position in the main interview questions. The interview questions are included below as a reminder:

Q1: Sustainability background **–** This section examines the initial attitudes of respondents regarding sustainability, as well as the support they receive from their governments and owners. The cultural and educational dimensions of employees regarding sustainability will be also considered in this section.

Q2: NPD and the influence of sustainability **–** This section delves into the company's product development practices, including expenses, NPD success, and measurement, as well as time and resource limitations. It also explores NPD through a sustainable lens considering its costs, motivators, drivers, and success factors.

Q3: Demand chain and the influence of sustainability **–** This section includes the factors related to demand-driven chains such as customer responsiveness, customer preferences, variable demand and value propositions. Hence, it looks at the downstream view of customers as end-users of the supply chains.

Q4: Technology and information technology **–** This section discusses the technology and IT tools being deployed for NPD and coordination of the company within the supply chain, as well as the associated costs and barriers.

Q5: Marketing **–** This section looks into the firm's marketing strategy, which acts as a borderline between the corporation and its customers in order to develop its brand image.

Q6: Economics **–** This section examines the relevance of a company's investment and profitability in relation to sustainable practices.

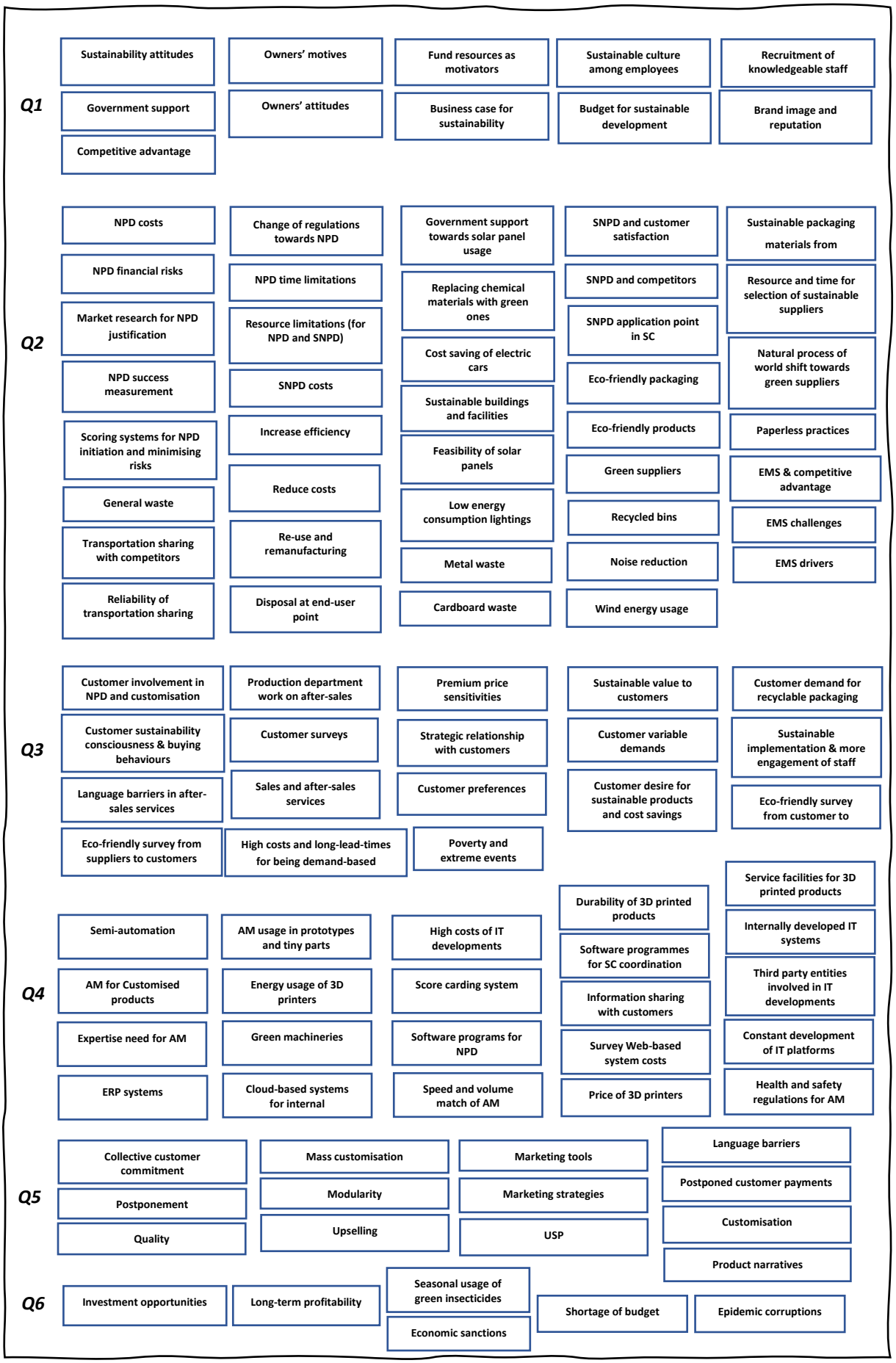

Figure 5.3 Initial Codes

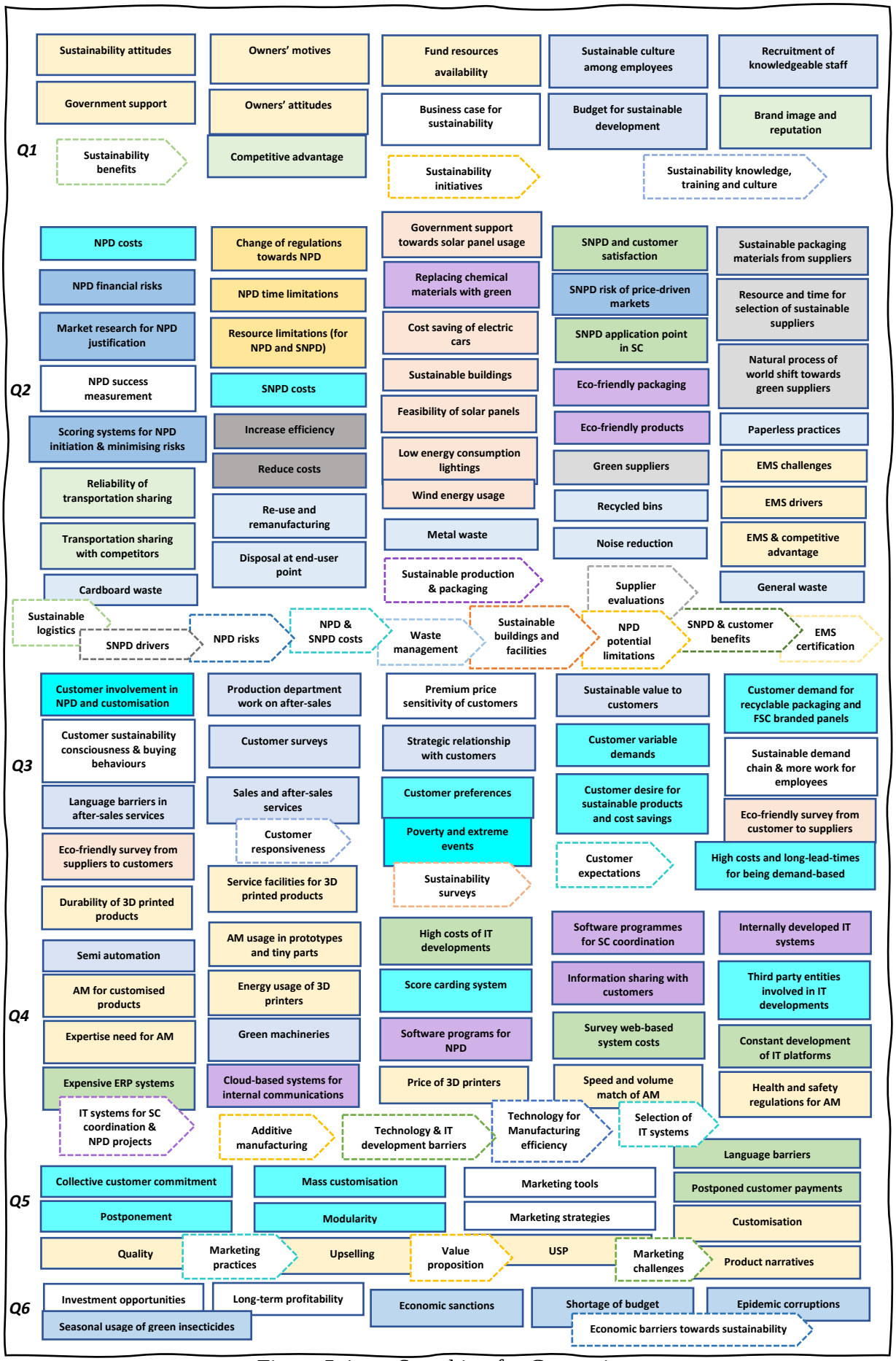

Figure 5.4 Searching for Categories

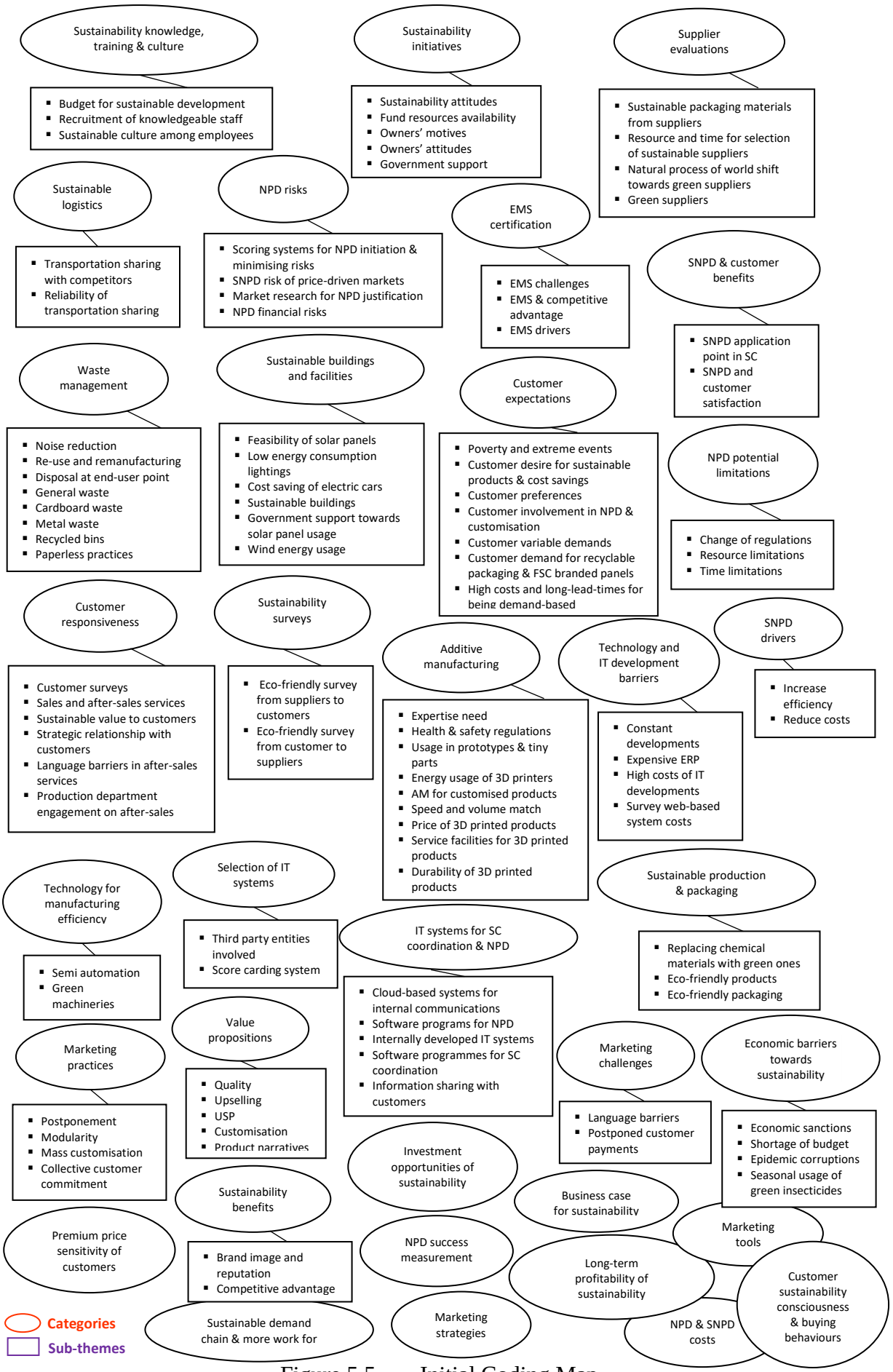

Figure 5.5 Initial Coding Map

5.3 Cross-Case Analysis

Tables 5.2-5.7 show the interview questions as well as the relevant initial codes, categories and their occurrences among the four case studies. The positive and negative aspects of the codes are identified with +ve and -ve, respectively. The six main interview questions from Table 3.7 (except the respondent background of the first question in Table 5.1) and the relevant coding will be investigated through cross-case analysis. The participant responses are explained in more detail considering the nature of each industry, the respondents' attitudes, their challenges and opportunities according to the interview data. The differences and similarities among all case studies will also be studied and compared as the cross-case analysis suggests. The relevance of the data to the literature, as well as the researcher's perspective on all issues, will be discussed.

5.3.1 Q1: Sustainability Background

5.3.1.1 Sustainability Initiatives

The initial question after the background of respondents was about the attitudes and interpretations regarding sustainability. This has been mostly positive among all the companies, being more mixed for Company B mentioning the newness of these practices that need more time to be digested and planned towards. With five positive responses for sustainability initiatives, Company A recorded the most positive responses. This indicates that Company A has taken a proactive approach from its early establishment, where government, owners and fund resources play huge roles in driving through sustainable business. Company A's sustainability attitudes take into account the environmental and social impacts within product design. Company B thinks about sustainability more in terms of business profitability as well as environmental impacts of its business, products and activities. They stated, *"This [sustainability] is fairly new to be honest, in terms of every decision we make in this regard".* For Company C, the carbon footprint is the first thing when thinking about sustainability, and they believe that the first step towards it is to make efficient products. They, however, believe that "*This is usually conducted at the customer service point such as providing them with advice about the disposal of the filters or replacing them".* Sustainability reminds Company D of green and high-quality product manufacturing, where maintaining the competitive advantage, brand image and economic benefits are among the best motivators for them to do so.

Surprisingly, government support demonstrated both benefits and drawbacks for most companies. As Company A mentioned, "*The decision of the UK government for boosting these entrepreneurial activities allow companies like us to grow, so in a way, we become conscious*

about where the opportunities are to access the funding to develop things. So, because the UK government, in this case, has funding for that, it drives companies towards that. The Ecuadorian government is not caring much, and there is too much defence from us". This clearly shows the differences between government policies in different regions of the world. In this instance, R4 of Company A stressed that the newest science and technology can be the game changers and have the capacity to urge the government to adopt sustainable practices, despite the governments generally remain five years behind technological developments.

Table 5.2 Coding Results of Sustainability Background

Interview Questions	Company A		Company B		Company C		Company D		Total
Q1: Sustainability Background	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	
Sustainability initiatives									
▪ Sustainability attitudes	1		1	1	1		1	1	
▪ Government support	1	1	1	1	1		1	1	
▪ Owners' motives	1			1	1	1	1		16
▪ Owners' attitudes	1		1	1	1	1	1		
▪ Fund resources availability	1		0		0		0		
Sustainability knowledge, training and culture									
▪ Budget for staff training	0		1	1		1	1		5
▪ The sustainable culture among employees	1		1	1	0		0		
▪ Recruitment of knowledgeable staff	1		0		0			1	
Sustainability benefits									
▪ Brand image and reputation	1	1	0		1		1		6
▪ Competitive advantage	0		1		1		1		
Business case for sustainability	1		1	1	0		0		2

As Company B highlighted, *"I am not aware of any policies, and we have not received any notifications or funding from government or any other organisations about any funding or available support towards sustainability… There might be some support and initiatives available from the government, but we are not aware of it to be able to utilise them".* This is an indication of the uncertainty of government policies and regulations and the failure in making the businesses aware of the support, funding and existing opportunities towards sustainable initiatives. Company C seems to be in a better situation as it stated, "*The government tells us what to do with deadlines that we should meet. Specifically, in terms of energy usage, we became more detailed in checking energy as per the government rules and regulations".* Company D did not see any contribution from the government within sustainable approaches and believed that the government efforts are not realistic and sufficient, "*Government has got*

some hands in controlling the energy savings, reduction of noise pollutions and workplace. But if I say more than that, it is an only show-off". They also feel that the government's only contribution is a set of rules for proper waste disposal, with fines imposed on businesses that fail to comply.

Company A is the sole company that highlighted the positive influence of societal drivers towards sustainability efforts. According to the R4 of this company, "*In the communities I interact with, there is a significant proportion of people who want a cleaner environment, who want a better community. I think there is a huge worldwide societal driver for more environmentally responsible actions. I don't know what the proportions are, but I would estimate that 70%-80% of people would like things to be more environmentally benign".* This is a great sign for environmental sustainability, given end-users' current dominance and the massive impacts of their activities on the globe in the long term. This is consistent with the findings by Pinheiro et al. (2019) which indicated that consumers and society are one of the primary hurdles to NPD adoption in CE.

Owners' motives and attitudes from Company A and D were mostly positive, while in the other two companies, there were little or no direction and some level of sustainable uncertainty from the owners/shareholders. Company A is fully focused on sustainable practices; therefore, it is normal to have the strong support of its owners. Company D is a large enterprise having lots of responsibilities regarding sustainable practices as well as a huge concern regarding its brand image and CSR. However, they are within their infancy stages of sustainability adoption, having the owners' support and emerging green concepts have helped them to move towards it by, for instance, establishing a recycling company and developing eco-friendly products. As evidence for the uncertainty of the other two companies, Company B mentioned that "*I have no idea if the owner/shareholders see the bigger picture of long-term profitability, so I think we need to make a business case and justifications for it, discuss the consequences if we don't adopt it and the potential benefits of being among the early adopters".* Similarly, Company C stressed that "*They [the owners] obviously drive that. [However], they somehow take the back seat now due to their age, but any operations or decisions that need to be driven, must come from the top and then it would be handed out to the top managers to sort them out along the lines".*

5.3.1.2 Sustainability Knowledge, Training and Culture

Staff knowledge, training and culture were discussed with the companies as vital factors related to organisational awareness and culture. With two positive responses, Company A has two positive responses in terms of sustainability culture and staff recruitment. This company recruits

knowledgeable and sustainability passionate staff from the beginning. As the respondent mentioned, they tend to hire people who are willing to contribute to the environment. The company also pays half of the training costs; in case any member of staff intends to attend a sustainable-related course voluntarily. Again, with two positive responses, Company B recorded a mixed response in this regard and guessed that it would be more work for the employees to do, if the company adopts more sustainability activities, according to this statement, "*Except for the financial investment, another barrier could be that there would be more work for employees to do, so if they don't buy-in to this culture and min-set, it can be a potential barrier. But the way we approach is to educate them in early stages and make them aware about the plan, its advantages not only to our business but also our customers and partners, the ethical benefits for our business".* Company B has not yet devoted any budget for staff training purposes, but they think that the funding will be allocated in parallel with any green initiative projects in the future. Company C has not allocated any budget as well, and the training is only based on routine activities and experiences.

The bold challenge about Company D is the cronyism that penetrates its recruiting practices. Historically, this business has lacked a recruiting criterion based on individual qualifications. To be as courteous as possible, they recruit employees especially senior managers from amongst close or personal connections. This can have a number of consequences in the long run, such as corruption, but also has an effect on the company's vision and grand strategies for environmental policies. This manner, a critical sustainable driver will be removed automatically from top management to downstream employees, and environmental activities may be minimised. Company D, however, assigns 0.5% of its total annual sales to staff training, product developments and marketing. This seems remarkable comparing to other companies; however, the size of the company should also be considered.

5.3.1.3 Sustainability Benefits

Company A, C and D are highly emphasising their brand image and reputation when it comes to product development success. According to Company A, *"For us is so important to perceive and take care of these details. Because being a company doing environmental services, if we don't consider these tiny details, the image of the company will be affected. So, I suppose this is harder for us, as we need to take care of every detail about the environment".* Likewise, Company D mentioned that *"I think keeping the momentum in the tyre market and maintaining our competitive advantage and brand image in a constant manner are the best motivators".*

Competitive advantage has also been among the factors that Company B, C and D highlighted as a positive outcome of sustainability adoption. As stated by C, *"The more customers are happy with us, the more likely we will continue the business. Gaining competitive advantage is another strong motivation".* Also, Company D asserted that *"I think keeping the momentum in the tyre market and maintaining our competitive advantage and brand image in a constant manner are the best motivators [towards sustainability]".*

5.3.1.4 Business Case for Sustainability

Regarding defining business cases for sustainability, Company A takes its core mission from sustainability and therefore automatically has a sustainable business plan itself. Company B's managing director is ready to present a sustainable business case to the CEO and owners to be further investigated by them, and this can be the starting point. However, there is still no sustainability plan in place. As it is highlighted, "*At the moment no clear direction and decision are confirming that we are going to adopt these practices to be able to define a business case together to justify the expenditures, gaining a good position in the marketplace compared to our competitors, considering the consciousness from buyers regarding sustainable products".* Despite having EMS certification and some green products, Company D does not yet provide a sustainable business case nor has a sustainability department considering its size and the major concern regarding its environmental impacts. This company has taken some initial steps towards environmental conservation but does not currently have any specific business plan for it. Therefore, sustainable approaches are being practised traditionally and not based on a defined perspective.

5.3.1.5 Discussion of Sustainability Background

As obvious from the data analysis, the most positive category of this question was sustainability initiatives with sixteen positive points. As highlighted by the Brundtland Commission (WCED) (1987), sustainable development is a result of collaborative work between governments, industry and academia. Also, the CE approach is impossible to be reached without the support of governments. However, government support has mostly recorded mixed responses, and this is a challenging issue when considering sustainability initiatives. The uncertain responses include statements such as "*Government is not caring much and too much defence from us; no notifications or funding from the government; government having some hands in controlling the energy savings, but it is only a show-off".* This indirectly refers to the greenwashing concept about inserting false-positive influence on customers that can also harm companies. This imposes a warning to the world governments to utilise their powers and unify together to address environmental impacts. Although, the Paris Agreement has been a good start; it has not

been a reliable solution from the business viewpoint. Moreover, as seen in the literature, top management, owners' attitudes and responsibility regarding sustainability is the key to sustainable implementations (e.g., Gavronski et al., 2011). The negative points of this category were less for Company A and D. The reason behind the incentives from the owners of Company A is the sustainable nature of their business and the necessity of their support towards prosperity. This is while Company D does not aim for a fully sustainable business and the support of owners merely seem to exist for gaining competitive advantage and brand reputation considering the large scale of their business and wide range of products. Competitive advantage is also highlighted among the four strategic approaches towards the SCOR model (Bernon, 2010) (Figure 2.19). Therefore, this can act as a proper foundation for this Company D towards adopting sustainability.

The second category (sustainability knowledge, training and culture) is responded mostly positive by Company A and B. Budget for staff training and sustainable culture of employees are the highest-ranked codes in this category, each with two positive points. Sustainable knowledge, staff training and organisational culture are essential for the implementation of eco-friendly strategies as highlighted in the literature (e.g., Walker and Jones, 2012; Carter and Rogers, 2008). Company A is proactive in this category and considers sustainable motivated staff from the beginning. Hence, it can be said that it acts very cautious and attentive in its recruitment practices with full consideration of sustainable goals. Company B and C showed a kind of uncertainty for this category, and this can be due to their small size. They both do not devote any budget for staff training and believe that the training will be naturally and automatically gained in any sustainable project that is going to be initiated in the future. The fact that there would be more work for employees to do if the company adopts sustainability, and they may not be corresponding to this effort and culture, can act as a barrier and speed bump in the journey of the company towards sustainable approaches. However, this can also be minimised by increasing sustainable awareness and providing training facilities across the whole organisation, surely incentivised by business leaders/owners. According to Meixell and Luoma (2015), this also depends upon the stakeholder pressures and their focused sustainability factors aiming to increase sustainability awareness among employees. Company D allocates 0.5% of its sales to staff training as well as attending exhibitions and industry events, and that is a huge figure that can be used as an opportunity towards increased staff knowledge and culture.

Company A, C and D emphasise their band reputation. The reason is that Company A's strategic customer is the Ecuadorian government and therefore, its survival depends on the

success of this partnership. In fact, Company A is more sensitive to its brand image, as it believes that the small details of unsustainable practices can have major impacts on its reputation. Company D is also a large enterprise with a wide range of products having its main customers from OEMs and automakers. Moreover, the adhesive company acts as almost a monopoly within the country and is one of the oldest ones in its industry. This makes it an important player in the market, and its reputation can be very vulnerable and depending on even small actions. As seen in Figure 2.16 model by Machado et al. (2014), brand image and reputation are among the values that effective NPD brings for the company, and this can even act as a motivation for them when thinking about sustainable initiatives. Moreover, competitive advantage has been mentioned as one of the positive outcomes of sustainability adoption by Company B, C and D. Company A has not mentioned competitive advantage among its sustainability benefits and this can be due to the niche products, niche market and its strategic partnership with government as its main customer. This can be interpreted that the competitive advantage of Company A automatically exists. These results indicate the importance of competitive advantage and brand reputation in sustainability adoption; hence it corresponds to the literature findings presented by Machado et al (2014) and Kalish et al. (2018).

The business case for sustainability is highlighted by companies A and B only, again with a mixed response from Company B. Regarding the arrangement of sustainability business case; companies need to first investigate the operational and strategic risks and opportunities of sustainability in their organisational context. This means they should think about their brand reputation in terms of sustainability, how sustainability is currently integrated into their business model, the factors that could disrupt their operations by sustainable adoption, how sustainability is currently positioned internally in their organisations and their business model, as well as the market forces and the economic factors affecting price, demand and availability of the products. After these evaluations, they would be able to argue the business case for incorporating sustainability into the strategy of their companies. In this regard, the senior manager who tends to lead the issue and present the sustainability business case to the executive committee (owners) could prepare a sustainable briefing. The briefing should argue the adoption of sustainability that can result in operational and strategic benefits for the company by elaborating all the risks and opportunities. The senior executives/owners also need to be provided with some practical examples accompanied by statistics, images and diagrams to be convinced that the business case is advantageous and appropriate to be adopted by the company. The sustainability business case would act as a key initiative in turning on the ignition of the

company towards sustainable practices. This would be only the beginning, but there is a need for continuous effort on the ongoing journey of sustainability.

5.3.2 Q2: NPD and the Influence of Sustainability

NPD procedures of each company were asked to understand the departments involved and their level of involvement in these practices. Company A mentioned that "*Half of our company is focused on NPD, as we develop technology and we commercialise".* This is since this company is basically dealing with an innovative and novel kind of sustainable product, and therefore, most of its operations are focused on that. Company B mentioned that "*The involved departments are management team, technical department, production department, quality department, R&D, marketing and procurement activities (which ties into technical or production departments depending on the project). Operations manager who looks after both procurement and IT systems".* These are most of the departments within their organisation, and this shows the need for engagement of almost all the companies in NPD. Likewise, Company C stated that "*Procurement departments are managing the purchasing as well as looking into taking the products with the best price. The production and design departments are merged. We don't have a specific marketing department, but a sales department which is doing marketing brochures. We design the products in production, and then we send it to manufacturing (factory) as well as the R&D. We also have the managing directors in the daily move when regulations change, we ask for help".* Company D highlighted that "*R&D, technical, technology and procurement departments are involved in NPD projects. Most of the NPD projects initiate according to the market needs, so both are closely related to each other. These are the customers who tell us regarding a need for a new product or development of a current product".* Comparing the four companies together, procurement, R&D, production and marketing departments are common across all which show the fundamental role of them as also mentioned in the literature (Figure 2.13, Vinayak and Kodali, 2014). The relationship of NPD with most of the departments within an organisation is also in parallel with what Nafisi et al. (2016) highlighted in the literature.

5.3.2.1 NPD and SNPD Costs

Company B and D both recorded mixed responses regarding the cost aspects of NPD and SNPD. Company D believes that there are costs associated with the development of green products, but this does not stop them from moving towards these practices. As stated by them, "*Development and production of new products are always accompanied by risks and fears. However, with market studies, cost estimation and feasibility, we can minimise these risks".* The reason is the huge impact of this holding on the environment within different cities, and a

natural shift towards becoming greener, either due to brand reputation, reducing costs or the spread of social responsibilities. This is while Company C evaluated these costs as a kind of barrier since their main motivation for sustainable adoption is to increase efficiency and reduce costs.

Table 5.3 Coding Results of NPD and the Influence of Sustainability

Interview Questions	Company A		Company B		Company C		Company D		Total
Q2: NPD and the influence of sustainability	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	
NPD & SNPD costs									
▪ NPD costs	0		1	1	0		0		2
▪ SNPD costs	0		0			1	1	1	
NPD & SNPD risks									
▪ NPD financial risks	0		0			1	0		
▪ Market research for NPD justification	0		1		0		1		
▪ Scoring systems for NPD initiation and minimising risks	1		1		0		0		4
▪ SNPD risks of price-driven market	0		0			1	0		
NPD & SNPD potential limitations									
▪ Change of regulations towards NPD	0		1	1	0		0		2
▪ NPD time limitations	0		0			1	0		
▪ Resource limitations (for NPD and SNPD)	1	1		1		1		1	
SNPD & customer benefits									
▪ SNPD and customer satisfaction	0		1		0		0		3
▪ SNPD application point in SC	0		1	1	1	1	0		
Supplier Evaluations									
▪ Selection of green suppliers	1	1	1	1	1	1	1	1	
▪ Sustainable packaging materials from suppliers	0		1		0		0		
▪ Resource and time for selection of sustainable suppliers	1		0		0		0		8
▪ Natural process of world shift towards green suppliers	0		1		0		1		

5.3.2.2 NPD and SNPD Risks

With two positive responses, Company B has the highest level of positive responses regarding minimising the risks of NPD. Company A and B are utilising the scoring models for their product development planning. The former uses TRL to identify the level of development of technology starting from zero (design stage), and the latter uses a specific scoring system to find the potential products to be further developed and introduced to the market. As Company

B mentioned, "*Based on market research and market needs gained from our distribution or supply chain partners, OEMs or even directly from end-users, we start to justify the NPD projects… Then we use a scoring system to find the potential ones to initiate and minimise the risks and failures of NPD".* Records of Company C show that the final price is significant in their industry, and therefore, the customer purchases are hugely dependent upon the final prices, even if the product offers a particular feature. As highlighted in this regard, "*Our industries are price-driven, even if the new product is the best one in the market, if the final price is high compared to the competitors, no one will buy".*

5.3.2.3 NPD and SNPD Potential Limitations

Company A and B stay at the same level regarding positive responses for this category, both having one positive response. Company A takes over the remaining three companies regarding SNPD projects, as its main products are the eco-friendly devices, while the others may find it more difficult to acquire new resources to become greener. However, as this company mentioned, the resources are the main limitations within NPD projects *"For our small company, one of the challenges is always to operate as effectively as possible, because we have fewer resources. We do a lot of research beforehand to get information from potential customers and we make decisions based on that. Because the main constraint is resources and that's the main aspect… So, if we are able to find information about customers and develop products with limited resources, we have more chances for succeeding".* Likewise, the other cases have also reported challenges around resource limitations when dealing with NPD projects. This is also true within the SNPD projects. In addition to market research and normal NPD procedures, Company B also monitors the change of regulations for different regions (EU, US). So, sometimes they start their product development, in case there is a new regulation, new testing and instruments are needed. As mentioned by this company, *"If there is a new regulation, it means there is new testing to do, and therefore new instruments are needed. So, we would investigate all the potential projects to see which ones are going to generate revenues, what are the risks, market penetrations point".* This consciousness can be beneficial for this company and enables it to adapt to the development procedures more promptly.

5.3.2.4 SNPD and Customer Benefits

With two positive responses, Company B recorded the most positive ones regarding SNPD and customer benefits. Company B and C claim that sustainability is currently impossible to be applied to their procurement, manufacturing or logistic entities. Therefore, they see sustainable applications more at the recycling stage of the product lifecycle or at the end-user point where customers benefit from the low energy consumption and high efficiency of the products. As

Company B mentioned, "*In procurement and raw material point, we do not consider that… Therefore, we try to apply sustainability in other points of the NPD process such as packaging and that is where we try to benefit it".* Regarding customer satisfaction and the role of SNPD, it was also stated that "*When we get a review of customer feedback, we try to develop it in a way to satisfy their needs".* Also, all the companies showed a proper level of using sustainable packaging, and this can be due to the lack of sophistication and extra works in the procurement of recyclable packaging as well as the global shift towards the use of recyclable packaging. Company D has gone further and developed its packaging production line for the eco-friendly insecticides in the adhesive company. Therefore, they have applied green practices in both the manufacturing and packaging stages.

5.3.2.5 Supplier Evaluations

The highest interaction in the evaluation of suppliers in terms of green practices is recorded by Company B, with three positive responses. The future path of the supply chain in terms of sustainability and the dependency of each customer upon its suppliers seem to be clear for this company. They are knowledgeable about the supplier-customer surveys and believe that the more they get adapted to sustainable practices, the more feedback they receive from their customers. This means that currently, there is a pull-based system regarding sustainable demand between this company and its customers. Despite producing sustainable products, Company A finds it challenging to find and select green suppliers due to time and resource limitations. In addition to the purpose of their devices which is to extract plastic pieces from the oceans and protect the environment, the sustainable features of the product such as using green energy and the reuse or remanufacturing are also considered. Company C is not too firm about selecting green suppliers, and their supplier selection merely depends upon delivery time and product efficiency. According to them, "*We probably wouldn't [evaluate the sustainability level of suppliers]. But it has been done by chance if it comes up".*

Table 5.3 Continued

Interview Questions	Company A		Company B		Company C		Company D		Total
Q2: NPD and the influence of sustainability	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	
Waste management									
▪ General waste	1			1		1		0	
▪ Cardboard waste		0	1		1			0	
▪ Metal waste		0		0	1			0	
▪ Recycled bins		0	1			0		0	
▪ Re-use and remanufacturing	1			0		0	1		11
▪ Disposal at end-user point	1		1			0		0	
▪ Reduction of noise pollutions		0		0		0	1		
▪ Paperless practices		0		0	1			0	
EMS certification									
▪ EMS challenges		0	1			0		0	
▪ EMS drivers		0	1			0	1		4
▪ EMS & competitive advantage		0	1			0		0	
Sustainable buildings and facilities									
▪ Government support towards solar panel usage		0		0	1	1		0	
▪ Cost-saving of electric cars		0		0		1		0	4
▪ Sustainable buildings		0		0		1	1		
▪ Feasibility of solar panels		0		0		1		0	
▪ Low energy consumption lightings		0	1			0		0	
▪ Wind energy		0		0		0	1		
Sustainable production & packaging									
▪ Replacing chemical materials with green ones		0	1	1		0	1	1	7
▪ Eco-friendly products	1			1		0	1		
▪ Eco-friendly packaging		0	1		1		1		
Sustainable logistics									
▪ Reliability of transportation sharing	1			0	1			0	2
▪ Transportation sharing with competitors		0		0		1		0	
NPD success measurement	1		1			1	1		3
SNPD drivers									
▪ Increase efficiency		0		0	1			0	2
▪ Reduce costs		0		0	1			0	

5.3.2.6 Waste Management

Company A, B, and C had three positive responses regarding waste management and Company D recorded two. Company A considers waste management at a broad level of reuse and remanufacturing, which helps in resource conservation and CE. As highlighted, "*Normally, the devices get reused, reprocessed and re-manufactured. When we design our products, we think about how to make something which is able to be re-used somewhere else. So, after their operation time of a device which is usually 3-5 years or after the contract gets finished, we take*

the machine from the ocean/river". Company B pays for general waste and recycled waste and only gets paid for cardboard and provides information on disposal to the end-users. "*Regarding the disposal of products at the end-user point, with every product, we provide SDS (safety data sheet) to our customers which includes the information about material disposal, hazards and safety instructions. However, we do not have any after-sales services to collect the used products and close the recycling loop".* Company C also sells cardboard and metal. Despite having ISO 14001 certificate, Company D is working on recycling, reuse, remanufacturing of the tyres and noise pollution, while there is no information available regarding the metal, cardboard or general wastes. This can be due to the different policies be adopted by the government. Moreover, this company is a large holding consisting of many smaller companies and therefore, having a tyre recycling line can increase its profitability by remanufacturing the used tyres.

5.3.2.7 EMS Certification

EMS certifications are mostly recorded positive by Company B with three positive responses. Company B has clarity about its environmental-related operations and elaborated the adoption of EMS accreditations comprehensively. As mentioned, "*Understanding the environmental standards, commit resources and personnel to meet [the standards] the expectations of the standards. Then the need for management reviews… Risk assessment runs by the R&D and technical director and reviewed by the management team periodically; all our tasks and processes are risk assessed. But there's no certification due to the costs and justification of benefits associated".* Company D was the only company among all with the ISO 14001 in place, as it is an obligatory regulation of its government. As they stated, "*Government has got some hands in controlling the energy savings, reduction of noise pollutions and workplace. But if I say more than that, it is an only show-off. Occasionally, they come for inspections requiring for the adoption of different environmental related standards such as ISOs".*

5.3.2.8 Sustainable Buildings and Facilities

Sustainable design, buildings and facilities were recorded as one positive response for Company B and two for Company D. Company A had nothing to say about this aspect, as it is using external manufacturing plants in other companies. Therefore, it only has got offices and labs and not dealing with the manufacturing aspects. Regarding sustainable buildings, Company B said that "*All the lights in both offices and plant are replaced by low energy consumption (LEDs), PII sensors are used in certain areas to minimise the wastage".* Company C mostly recorded negative points in this regard and mentioned that "*Regarding the sustainable design of buildings or electric cars, it couldn't have cost-saving benefits to us. If it was take-off and*

we had to keep up in the market, we had to supply it anyways… Regarding solar panels, for example, I see it as more expensive than beneficial, and because no other company is doing that, it wouldn't be viable for us to do that at the moment. We would have to be forced to use them to be a viable option for us… However, if the authorities ask all the identical manufacturers to install solar panels and offer suppliers with cheap solar panel options, we will see a force to do that, However I believe, the costs wouldn't change very much". As evident, Company C evaluates this category from the competitive advantage perspective and does not see any other incentives in doing that. Also, Company D highlighted that "*Unfortunately, we still don't use solar energy, but we have tried to minimise the use of fossil fuels by adding larger windows allowing more sunlight coming in".* They believe that solar panels have grown increasingly popular for usage in the region, and they can assess the possibilities. However, they use wind energy to power part of their buildings' lighting, which is a bonus.

5.3.2.9 Sustainable Production and Packaging

Company B and D recorded the most positive responses regarding sustainable production and packaging, with two and three positive points, respectively. Company A's main product is already the sustainable devices to separate plastic pollutions from rivers and oceans, and this is a bonus for them in this regard. However, in procurement, raw material and packaging point, this cannot be considered. Company B mentioned that *"We need final products to meet the specifications and usually, we have to use specific chemicals, petroleum-based, carbon-based and mineral oils, and it is very difficult to substitute them, and there is no other way around, so this is challenging to go forward. Therefore, we try to apply sustainability in other points of the NPD process such as packaging and that is where we try to benefit it".* Company C asserted that sustainable practices drive them to develop efficient products with lower energy usage, "*The only reasons for us to adopt sustainability are to increase efficiency and reduce costs. For example, we are currently working on hinges and door tapes to stop the leakage of the units, to make the units more efficient. So, we don't have to use such a big motor, which saves on electricity costs for the customer".* Company D highlighted that *"The adhesive company has launched a new sustainable production line producing insecticides based on 99.75% water, totally biodegradable, safe and eco-friendly for all the humans, plants and domestic animals. It is non-flammable, odourless and does not result in skin or eye irritation. Also, we have used (high-density polyethylene) HDPE, as a lightweight package with low moisture absorption, high density. It's also quite cheap and recyclable".*

Despite overall positive responses within the cases, the substitution of raw materials with the green ones is a hard task with mixed responses for Company B and D. As Company B stated,

"In procurement and raw material point, we do not consider that. We need final products to meet the specifications, and usually, we have to use specific chemicals, petroleum-based, carbon-based and mineral oils, and it is very difficult to substitute them, and there is no other way around, so this is challenging to go forward". This is due to the chemical nature of their raw materials and products, and hence, there is a resource limitation when it comes to procurement of eco-friendly raw materials instead of chemical ones". Likewise, Company D mentioned that *"Recently, in the last two years, we have been working on the replacement of raw materials with the eco-friendly ones. It has also been tried to replace carbon black with Silica which is a greener material [for tyre production]. To be able to use Silica, we had to modify our Banbury mixers (tyre production machinery)".*

5.3.2.10 Sustainable Logistics

Sustainable logistics through transportation sharing with competitors is not being practised within any of the four companies. However, it is evaluated mostly positive by Company A and C with one positive response for each. Company A highlighted that *"We are assessing that. We are now looking for a company that is capable to partner with us (with electric trucks) to minimise the impact. For us, it is so important to perceive and take care of these details".* It is evaluated as being tricky for Company C when it comes to transportation sharing with its business competitors. As highlighted by them, "*There used to be a company with identical products nearby (joint forces), but they are competitors, and therefore, we couldn't share with them about our sales our that we got delivery to London next week! If we ask them to share the lorry with us and put their items in, highly probable, they will reject. They may think that we have a naughty motive, and our purpose is to reverse engineering their products. I think it just doesn't work with the other manufacturers of our products".* As mentioned by Company C, if they propose their competitors to share the delivery vehicles, the competitors may think of bad intentions of Company C such as reverse engineering. Moreover, they deliver the fully packed vehicles to be more efficient as mentioned, "*The volume of our products is not enough for us to be able to share the deliveries. However, we try to use the whole size of the vehicles, to fill them up and not to ship them with a huge amount of space".* Company D stated that "*The practicality of transportation sharing has not yet investigated and therefore impossible for the meantime. However, we more or less share the vehicles between the companies in our holding".*

5.3.2.11 NPD Success Measurement

The way companies measure their NPD success is important to monitor their performance in this regard. NPD success is measurable by all companies except Company C as they are not sure where they stand on this. Company A's R3 stated that *"We use a stage-gate process and*

TRL method [to measure the NPD success]. As long as you pass in each stage, it is moving on, but obviously, as the company grows, those processes become a bit more complex. For certain projects, you need to understand the feasibility of projects in more detail. The stage-gate process is useful if you need to get different stakeholders to sign off things and to showcase the project". Regarding LCA tools, Company A's R4 highlighted that *"The tools such as LCA can only give you polling decisions because they are just looking at one thing. But we need to look at the other aspects as well. LCA is not the answer to everything".* Company B uses a different approach, "*Measurement of success is based on the time frame (usually 18-24 months), budget and revenues generated. NPD work package is used (internally developed software), starting with a business case, budget, each departments' responsibilities which everyone has access to and can give the feedback".* There is uncertainty for Company C in this regard as stated, "*We do not have any specific tool or software to measure NPD or SNPD, and I am not sure where we stand on that".* Company D highlighted that "*Some of the most crucial NPD success factors is the constant quality and continual improvement processes. These are also important to maintain our customers and increase the orders not to lose them. It is not hard to measure NPD success in our industry. The simplest way is to compare our sales with our competitors' sales, and the customer willingness to the new products".* The above shows that different companies have different approaches to monitoring and measuring their NPD performance. However, it is mostly based on ROI within two years of the product launch and there is no scientific measurement or LCA in place.

5.3.2.12 SNPD Drivers

Motivations towards adopting sustainable NPD is only highlighted by Company C as, *"The only reasons for us to adopt sustainability is to increase efficiency and reduce costs".* This acts as a vital role for the companies, especially SMEs, due to their limited budget and sustainability costs. By increasing efficiency and reducing costs in the long run, they can be more motivated to adopt such practices.

5.3.2.13 Discussion of NPD and the Influence of Sustainability

This interview question responds to RQ1, *"What is the driving role of sustainability towards NPD".* Based on the research findings, environmental sustainability and NPD are linked together through categories such as supplier evaluations, marketing aspects, increasing product efficiency, NPD and SNPD costs, risks and potential limitations, and IT systems as technology facilitators, all of which play significant roles. Therefore, in order to implement SNPD at the strategic level of sustainability, these variables must be taken into account within the risk management and business planning procedures.

The potential limitations of NPD are mostly highlighted as the change of regulations, time and resource limitations. Change of regulations is in parallel with the uncertainty factors within the NPD process elaborated by Martinich (2015). Also, the time and fund limitations are mentioned which is in parallel with the study by Sharifi et al. (2006). Besides, as research studies suggest, companies need to transform from machinery companies to innovative companies and also consider intangible assets such as customer satisfaction and integrated NPD rather than fiscal outcomes and equipment (Mintzberg, 1989). This can be related to Company A as it tends to achieve profits and besides competitive advantage gained by fast and efficient growth of the sustainably designed products. These are the parameters this company considers measuring the product success while entering to market, and it seems to be a great approach due to the multi-dimensional factors they consider. It shows not only their natural tendency for profit generation like any other business but also their sustainability responsible approach and high product innovation levels in a developing economy with a high demand for eco-friendly products such as Ecuador. In this regard, Company C asserted that its price-driven market forces it to keep final prices low to satisfy customers. Customer satisfaction is, of course, an intangible asset that can lead to continuous success. By contrast, there can be a mismatch between sustainable products (eco-friendly products) and the final prices. So, if the company develops a sustainable product with a pretty higher price compared to its competitors, it may face failure by the market, despite its environmentally sustainable approach. This can be interpreted that the NPD success may not always be gained by sustainable products and the SNPD product success depends on the competitive advantage, the final price of the product and the level that the market is willing to pay for (WTP).

As case study results indicate, the suppliers are not usually thoroughly evaluated in terms of all environmental dimensions, and this is the reason for mixed responses and that each company has different shortcomings in this regard. Moreover, there is a pull from customers (not always), while there is no push from suppliers. In other words, looking at the supply chain stakeholders, there is a sustainable demand, while not necessarily a proper supply. Being pull-based and demand-driven is beneficial; however, looking at the supply chain structures, all the entities need to assign obligatory criteria for each other to make a sustainable supply chain. This means that it needs to be a mutual demand and supply when it comes to addressing sustainability.

As obvious from the SDCM framework developed by Vural (2015), at the supply side of the framework, each member of the supply chain needs to evaluate its suppliers in terms of sustainability to fulfil the sustainable value propositions co-created with customers within the demand chain concept. In other words, every company (regardless of its position within the

supply chain) needs to make a full sustainable evaluation of its upstream suppliers to be able to compete within the market and define its value propositions. Moreover, as per the NPD framework by (Tan and Tracey, 2007), manufacturing, supplier and customer involvement create an integrated NPD and lead to customer satisfaction.

Among the supplier evaluation category, the selection of green suppliers is the most positive recorded code with four positive points. Each of the case study companies is located in different points of their supply chains, and if we consider Company A as a tier-1 supplier/focal company, Company B as a tier-1 supplier, Company C as a focal company and Company D as a tier-1 supplier/focal company, we could better investigate the patterns of supplier evaluations among them. However, due to different sizes of cases, different cultures, market positions and business missions, we investigate them individually. Company A evaluates its suppliers more in terms of values and attitudes rather than specific environmental measures. Company B believes there are currently some challenges associated with upstream suppliers in terms of their SO. According to this company, sustainable surveys are only conducted from their customers to them and not vice versa or from their suppliers to them. This is while Company B itself does not include sustainable dimensions (such as EMS accreditation) as a pre-requisite for its suppliers. They only ask their packaging suppliers if these products are recyclable. Company C mentioned that the selection between green or non-green suppliers merely depends on the delivery time and product efficiency. Company D stated that the supplier evaluations are done indirectly, and the only thing that is being considered is to replace some specific raw materials with green ones.

Within all the codes of waste management category, cardboard waste, re-use and re-manufacturing, and disposal at the end-user point were ranked the highest, each with two positive points. As seen from the cases, some companies believe that sustainable benefits can be gained at the recycling stage of NPD or the end-user point. This may be due to the small scale of these enterprises and the impossibility of implementing sustainable practices in the early phases of NPD, such as raw material substitution, green machinery, or even transportation sharing. It can be true that companies might not see the tangible benefits associated with the use of sustainable practices in NPD, especially in the short-term, but the recyclable packaging or high-efficient products can anyways benefit end-users by cost savings and conserving the environment, finally closing the loop in the CE concept (from cradle to cradle). As Badurdeen et al. (2009) highlighted, the definition of SSCM involves sustainable consideration during pre-manufacturing, manufacturing, use and post-use stages through the life-cycle stages. This is again related to the CE approach, and the case study results show that re-use and re-

manufacturing are being positively considered by the companies. Undoubtedly, SSCM needs the implementation of sustainability in all the entities, but starting from one point can be gradually expanded to all.

Moreover, eco-friendly packaging recorded the most positive code (three positive points) within the sustainable production and packaging category. Using recyclable packaging is becoming a norm in the world industries which makes it easier and more accessible for the companies to be adopted compared to sustainable raw materials for instance; which is not always available due to shortage of resources and also the need to meet the final product features and applications. Given the situation, the findings of this study are not fully consistent with the previous research by Pujari et al. (2003), where the focus of British manufacturers was mostly reduction of environmental impacts of conventional products instead of creating sustainable, eco-friendly products and cleantech concepts. As seen from the case studies, Company A is offering devices to extract plastic pollution and conserve the water eco-systems. Company B is working on eco-friendly packaging. Company C values the production of energy-efficient air-handling units, and Company D makes several efforts within sustainable manufacturing such as the development of green insecticides, recyclable HDPE packaging and replacing carbon black with Silica in tyre production. This means that both British and Middle Eastern industries are slightly moving with the flow of eco-friendly products, and not merely reducing the environmental impacts of conventional products.

NPD/SNPD success measurement are currently not being conducted by using special tools, except Company B, which utilises an internally developed NPD package. The monitoring and success measurement become more vital for SNPD, and hence, the use of different tools such as NPD checklists, LCA tools, material screening tools, the Eco-design Strategy Wheel and supplier scorecards can be recommended to the companies as also suggested by Kalish et al. (2018).

Sustainable logistics through transportation sharing is not yet being practised by any of the companies. This is in contrast to the situation described by Bernon (2010) and Nestlé (NA), in which British United Biscuits and Nestlé share their vehicles while being fierce competitors. The reason for this paradox could be that larger companies have more opportunities for strategic partnerships, whereas SMEs may be wary of collaborations with competitors, even for environmental purposes (as mentioned by Company C) about delivery vehicle sharing and the naughty motive of reverse engineering with one of its competitors in the region.

5.3.3 Q3: Demand Chain and the Influence of Sustainability

5.3.3.1 Customer Responsiveness

With two positive points, Company B and C recorded the most positive responses for customer responsiveness. Customer surveys are only being conducted by Company B as highlighted, "*We have surveys that we do with all of our customers to enable them to provide us feedback on an ongoing basis. Customer surveys are annually conducted, each one with a different type of survey based on the products and services we provide".* There is no evidence of other companies using formal customer surveys. Customer responsiveness related to sales and after-sales service have generally been positive within all companies, except Company B that needs to tackle the language variations of different territories. Also, Company C lacks a marketing department, and only a sales department manages the marketing tasks.

Company A and D both claimed to have a strategic relationship with their customers. The former mentioned that "*…Our customer is the government; we need to understand what they want. Because they want good public opinions, so we need to attract them. Once you understand what product you need to have, you need to build the strategy of selling, because it's not a mass-market product… You need to work with lawyers, financial teams and do continuous work with them to develop the business model".* The latter stated that *"Our customers are both normal distributors and OEMs. Each of the car manufacturers has a representative in our company with full supervision on the products and their development. Based on the monthly meetings, especially with OEMs, we get informed of their values and preferences, or they ask us thorough sales and marketing departments".* This shows the high level of the partnership of Company D as tyre manufacturers and its customers being car manufacturers, while it can create a high sensitivity both regarding the products and customer satisfaction as well as financial relationships.

Table 5.4 Coding Results of Demand Chain and the Influence of Sustainability

Interview Questions	Company A		Company B		Company C		Company D		Total
Q3: Demand Chain and the influence of sustainability	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	
Customer responsiveness									
▪ Customer surveys	0		1		0		0		
▪ Sales and after-sales services	0		0		1		0		
▪ Sustainable value to customers	0		1		1		0		
▪ Strategic relationship with customers		1	0		0		1	1	6
▪ Language barriers in after-sales services	0			1	0		0		
▪ Production department engagement on after-sales	1		0		0			1	
Customer expectations									
▪ Poverty and extreme events		1	0		0		0		
▪ Customer preferences	0		1		1		1		
▪ Customer variable demands	0		0			1		1	
▪ Customer involvement in NPD and customisation	1	1	1		1		1		
▪ Customer desire for sustainable products and cost savings	0		0		1		0		9
▪ Customer demand for recyclable packaging and FSC branded panels	0		0		1		0		
▪ High costs and long lead-times for being demand-based	0			1	0		0		
Sustainability surveys									
▪ Eco-friendly survey from customers to suppliers	0		1		1		0		2
▪ Eco-friendly survey from suppliers to customers	0			1	0		0		
Customer sustainability consciousness & buying behaviour	1	1	1		0		1	1	3
Premium price sensitivities	1	1	1		1	1		1	3
Sustainable demand chain & more work of employees	0		1		0		0		1

5.3.3.2 Customer Expectations

The customer expectation theme is mostly recorded positive by Company C with four positive responses. Regarding this, Company A highlighted that "*Right now, I don't think they have any expectations yet. This has been difficult because talking about sustainability and environmental impact is difficult in Ecuador since we have loads of other problems to deal with. We have extreme poverty, COVID-19, etc. The politicians don't talk a lot about sustainability in general".* This implies that economic difficulties and extreme events such as COVID are among

the barriers towards innovative practices such as environmental sustainability that also impacts the end-users' demand and expectations around this vital issue. Undoubtedly, an individual's physiological needs must be fulfilled before they can consider crucial world concerns such as environmental conservation. When this cannot be satisfied and consumer demand for environmental effort does not exist, an important stakeholder within the supply chain is eliminated, consumer demand is eliminated and therefore, the circular economy is disrupted.

Regarding customer expectations, Company A asserted that "*Based on my experience, our customers have mostly got technical, cost and timing requirements. However, their expectations need to be realistic either from private customers or the government".* Company B highlighted that that "*…We are beginning to see some results from supplier surveys from customers, we know that for example accreditation to ISO 14001, quality or health and safety standards are going to become a criterion at some point in the future".* Company C stated that reaching customer satisfaction motivated them to fulfil customer preferences. In other words, *"What customer wants, the customer gets normally. The more customers are happy with us, the more likely we will continue the business".* This company also mentioned that most of the customer sustainable requirements are related to energy-efficient AHUs, euro branded panels and sometimes lightweight packages. Regarding sustainable preferences of customers, it was stated that *"Customers are price-driven, they want cheap products which will suffer the green element".* Company D gets informed of the sustainable preferences through sales and marketing channels or the regular monthly meetings with their strategic customers.

Customer variable demands are associated with time, resource and lead-time limitations and are sometimes tricky for companies to be able to satisfy. This is recorded by Company C, and D. Company C highlighted that "*We need enough time to facilitate their demands through our relevant departments. Resources are other factors as there is usually a minimum order quantity for ordering the raw materials with our suppliers. The lead-time is another issue in this regard since if we have a wide range of customised products, we will have to look for best prices from different suppliers, look for matching volumes and this takes more time to deal with such orders and postpones the product deliveries".* Moreover, this company's customers are sometimes willing to pay a premium price for getting energy-efficient products to enjoy cost savings in the future. There are occasionally some sustainable preferences on packaging as stated, *"We have never been asked to use lightweight packaging, but they have asked us to ensure the usage of euro panels in case we used palletised packaging depending on the size they are dealing with (FCS branded panels) because of their recyclable features. However, this is very occasional that we get this sort of request".* Company D mentioned that *"Frankly speaking, no one has a*

good relationship with changes, however in case we are obliged to make changes in the lead-time, quality or anything else, before the execution of any activity, we organise meetings with them reach a win-win result". For this organisation, variable customer demands and difficulty in the procurement of resources are due to the economic sanctions followed by import problems and currency collapses imposed on the manufacturing industries. This shows the level of challenges and significant factors of time and resources that companies can be faced with due to the various needs of customers.

Among the four companies, only Company A's customers are not involved in the NPD process, since this company is based in the UK and the government (customers) is based in Ecuador. Hence, the company works on design, prototype, feedback, refine and main product launch to fulfil their design specification and needs. The other three companies all collaborate with their customers to some extent; in case any customisation is required towards the product features or specifications. For instance, Company B mentioned that "*We calibrate on demand; we make custom requests which is beyond demand. It could be co-designed with customers depending on the product or calibration type".* Likewise, Company C stated that *"For some bespoke items, we work with customers… they get involved to see if their specifications can fit our items, or the items can be custom-made for them in terms of dimensions, specific fuels to be used, etc".* Moreover, Company D has got a representative of each OEM customer in its company available, who act as supervision entities within the NPD process. Likewise, in this company, the production department is engaged in after-sales even more than after-sale services itself, due to its knowledge about product features.

5.3.3.3 Sustainability Surveys

Sustainability surveys include eco-friendly surveys from customers to suppliers or from suppliers to customers. Company B recorded mixed responses in this regard: "*At the moment, the surveys including environmental aspects are only conducted from customers to suppliers, not from suppliers to customers, but moving forward, as we put screen initiatives together, that will be one of the areas that we will start to ask for feedback from customers".* Again, Company C stated that *"In terms of sustainable packages, there is sometimes some eco-friendly related questionnaire before delivery regarding the source of our packaging, whether the packaging is recyclable or the ways they can dispose of the packaging".*

5.3.3.4 Customer Sustainability Consciousness and Buying Behaviour

Sustainable consciousness and knowledge of customers is an important factor in the attempt of companies towards getting greener. In Company A, the main demand for the reduction of ocean plastic pollutions comes from the government (customers), and this is a bonus for the company, as they do not need to be much concerned about their product recognition within the market. Besides, to promote community awareness about environmental sustainability and the commercial opportunities that come with it, Company A's R1 has taken the initiative, *"We try to make all the local communities involved and think of developing business models within recycling or circular economy concepts".* Likewise, R4 of this company asserted that *"Buying choice is not only about how much money you've got but also how much time you've got. I do see changes in people's buying behaviours. People recognise that if they spend their money on goods not made in their locality, it's not going to help their local industry/community. I think there is awareness but whether it alters behaviour, I don't have the answer".* Hence, in his opinion, sustainability awareness does not necessarily lead to green purchasing decisions, and this requires other factors such as enough budget, time and action.

According to R3 of the same company, "*Manufacturers are telling consumers what they want, whereas consumers are not saying what they want. People are now used to convenience and cheap products, and some people cannot afford it even in developed countries. With the current consumerism, that model changes. Until the consumers change their way, I don't think that change will not happen. I think the consumer doesn't realise how much power they have to make that change".* This implies that there is still no sufficient pull for green products from the end-users point and the current supply chains are mostly based on the push-based traditional supply chain system where products are pushed into the markets (Emmett and Crocker, 2006; Hilletofth et al., 2009).

In this regard, Company B stated that "*This has been elaborated a lot in media and news during last year, so more people are becoming more conscious, and we are also thinking about what we can do improve our activities accordingly".* Company C has not recorded any information in this aspect. This can be due to the specific product of Company C and the price-driven market for its industry. Though, Company C claimed that its customers are usually looking for air-handling products with low energy consumption features. If we include energy efficiency in the category of sustainable consumption, this can be ultimately beneficial to end-users and the environment, and maybe not to the company itself. On the other side, Company D needs to follow a mix of demographic and geographic market segmentation to sell its green insecticides to overcome the shortage of knowledge and neutrality of people in less educated areas. This

company mentioned that "*For the marketing of mentioned green insecticide, for instance, the Swiss company has advised us to start marketing and selling to the drugstores and luxury supermarkets in the wealthier and more cultured part of the city. This is because there are more educated housewives there who are more conscious about buying green… In contrast, in other parts of the city, people might be more sensitive on prices and prefer the cheapest option available, instead of caring about buying green products".* This company finds some level of difficulty for the acceptance of green insecticides in the market; however, people will slightly get more familiar and understand the need to buy sustainable products. As asserted by the technical manager, *"People get more interested in sustainable products when manufacturers explain and promote the product's ecological advantages. So, their willingness to spend for such can rise gradually. As a result, greater justification and consumer awareness are required for the success of green insecticide we produce".* Nonetheless, increasing customer consciousness and awareness will take a longer period of time in developing nations resulting in a shift in their buying behaviours towards greener items.

5.3.3.5 Premium Price Sensitivities

Premium prices of eco-friendly products have been a challenge for most of the companies with mixed responses. As Company A mentioned, these sensitivities can be reduced within B2B business models rather than B2C ones. As stated by this company, *"I can say there is a possibility [to cover the costs]. I can give you an example of an agreement that we signed with a chocolate company (B2B model). The chocolate company is developing a new product, but the branding is about protecting the oceans. They want to have compostable packaging, and they want to donate some parts of the profits to our NGO as well, and there is a market for that".* The reason can be the large scale of collaborations and partnerships between businesses according to their corporate missions and having access to a large number of funds, while the end-users might have different measures as well as limited budget for selecting their essential products.

Company B evaluates this considering different regions, *"There are price sensitivities in different territories we supply, so we have to manage to satisfy the customer needs in those areas".* This is in line with the study conducted by Guyader et al. (2017) that believed retail brands may encourage consumers to choose greener items by decreasing the price difference between eco-friendly and standard products. As seen in the last sections, Company C recorded mixed responses in this regard. Their business is a price-driven one and customers are always looking for a cheaper option. However, "*Sometimes they ask for energy-efficient [products] despite their premium price as they will have cost saving in the future. We can offer them*

alternative cheaper options which might not be as green as the others. We can build and deliver products based on the energy specifications that they give us". Likewise, Company D referred to the public locals in the same region and mentioned, *"Depending upon demographics and geographical locations, the more educated and wealthy population, the more they are willing to pay for the green products to protect their families from the toxic effects of chemical ones".* According to the same business, people may be progressively convinced to buy eco-friendly products by expanding their understanding of the benefits of doing so.

5.3.3.6 Sustainable Demand Chain & more Work of Employees

This factor is only stated by Company B, as they believed, "*Except for the financial investment, another barrier could be that there would be more work for employees to do, so if they don't buy-in to this culture and mindset it can be a potential barrier".* This links the sustainable demand chain to the organisational culture and the sustainable mindset of the employees which has been missing in the model developed by Vural (2015).

5.3.3.7 Discussion of Demand Chain and the Influence of Sustainability

This interview question answers to RQ2, being *"What is the driving force for sustainability in the context of DCM?". According* to the findings, six major categories have formed as a result of the relationship between environmental sustainability and DCM, as described in the preceding sections. This means that, in order for SDCM to become a reality, firms must first study customer sustainability consciousness and purchasing behaviours, and also establish strong relationships with customers within the operational level in order to engage them in NPD initiatives that meet their expectations. In this way, companies will not only be able to produce profitable sustainable goods, but they will also be able to increase B2B/end-users' environmental awareness, which is a necessary component of a pull-based supply chain. As demonstrated by Company A, raising sustainable awareness of the community has been one of their business goals, which is constantly promoted through events, workshops, and social media.

The notions of customer relationships related to demand-driven chains are widely discussed within the case studies. According to the case studies, what motivates customers to want sustainable products/packaging is mostly to save money (low energy use, for example), rather than to consider environmental implications. This is only if people desire such environmentally friendly items and packaging. Customers (B2B) occasionally undertake eco-friendly surveys of their suppliers, although this is uncommon. Surveys may be considered important tools to

facilitate the effective relationships between the company and its customers, as well as sustainable evaluations between the two.

Moreover, regarding customer responsiveness, Company C only has got a sales department which works on all the marketing aspects too. This is also in line with the literature study by Rocca et al. (2016) which highlighted the importance of sales entities towards customer involvement in the early stages of NPD projects, especially within the B2B concept.

According to the findings, there is a growing trend of customer involvement in NPD projects and therefore more customer orientation in place (Tan and Tracey 2007; Menguc et al., 2014; Feng et al., 2016). This shows that the companies have started taking into consideration customer bespoke needs during the last decades, as we can see the increasing level of customisation opportunities (make-to-order) according to the literature. Customer involvement leads to product and process innovation which are necessary for NPD project success (Ogawa and Piller, 2006). However, these considerations are mostly true for conventional products, not the sustainable (eco-friendly) ones as well as durable goods rather than non-durable goods. The products of the case study companies investigated in this research are all durable goods (plastic extractors, calibration standards, laboratory testing equipment, air-handling units and tyres) except the CRMs and adhesives produced by Company B and D respectively. Hence, for the durable products mentioned, it is possible to think about the involvement of customers within the co-design or co-development of products. Certainly, the extended product lifespan may create additional opportunities for enterprises to cooperate with their B2B customers and end-users on NPD initiatives, as well as discussing and negotiating the sustainable options they could add to the product.

When it comes to addressing sustainable principles and consumer participation in SNPD operations, consumer consciousness is crucial (as also stated by Company D regarding the insecticide product). In fact, customer consciousness and knowledge are the keys to sustainable consumption when viewed through the SNPD lens that needs to be studied and strategised accordingly. There are also different levels of understanding and different ways of customer responses to sustainability. Some customers, for instance, may respond by emphasising recycling, eco-friendly packaging, and low-energy-consumption items, while others seek environmentally-friendly (ethically-sourced) items. Moreover, lack of public awareness and cultural dimensions is among the external barriers towards SSCM implementation according to recent research by Sajjad et al. (2020), which has been mostly positive within this study.

The premium price of eco-friendly products is currently a worldwide challenge that all businesses are facing (Drozdenko et al., 2011). As seen from the cases, there were different reasons for the premium price sensitivities and resistance of customers towards purchasing sustainable products' including B2C challenges, different territories, price-driven market, demographics and geographical locations especially regarding the level of income and education. This is contrary to the study results of Chekima et al. (2016) which identified that the premium price does not play a vital role in customer green purchasing intentions and customers are probably willing to pay 5-40% extra price for green products. The case study companies are trying to address this issue based on their conditions. For instance, Company A utilises a B2B model to gain some profits for its NGO by supplying compostable packaging to a chocolate company. Company C mentioned the upselling practice, which serves both as a value proposition and a justification for the premium price of its eco-friendly products. Likewise, Company D uses a target marketing approach to secure the market of its eco-friendly insecticides within the high-level area within the country capital. Cause marketing and eco-labelling schemes can be useful for companies to enhance green purchasing intentions (Chekima et al., 2015). The premium price of green products is a vital fact that needs to be addressed by companies, as these are customers who ultimately need to get interested and convinced to pay a premium price for sustainable products.

Whether the trade is based on B2B or B2C models, buyers' consciousness arises from their level of education, knowledge and cultural factors. However, not every educated organisation or individual might be willing to pay extra for sustainable products, and there could be still some preferences towards cheaper products in the market; but this can be an influential positive factor. Knowledge is what usually people gain from their surroundings such as schools, universities, communities, social events, mass media, books and web content. It should be noted that these sources do not always include the right, scientific and accurate information. Cultural factors very much depend upon the level of society people live in as well as their economic situation. Likewise, these measures are not fully precise, since even in developed countries with a high level of living standards, we can see that usually, only a low percentage of people go for eco-friendly/bioproduct options. These are not the factors to be taken lightly when considering the sustainable values of customers. This is where the governments with full authority and lots of capital seem to have a huge responsibility towards increasing the awareness of their nations. It is simple. Since, if the end-users do not desire and demand sustainable products, the companies will stop producing them and therefore, the climate emergency as the ultimate goal of sustainable practices cannot be fully addressed. Having said that, customer consciousness

and customer willingness to pay (WTP) for the premium price have a direct relationship together, and that is what facilitates the creation of an effective DCM sustainably. Surely, sustainable consumption necessitates a huge transformation in human behavioural changes in the long term.

Yet, the competition between conventional products and eco-friendly/bioproducts is a vital factor that needs to be considered precisely. Achieving a competitive advantage by eco-friendly companies depends upon many factors. However, it seems that developing niche markets and sustainable products with premium prices for a limited group of passionate customers cannot lead to remarkable progress towards sustainability and it requires mass production and a broad spectrum of consumption behaviours. To become a reality, the support of governments, finance organisations, NGOs and their collaborations with manufacturing companies will undoubtedly be required.

5.3.4 Q4: Technology and Information Technology

5.3.4.1 Additive Manufacturing

The use of AM techniques, particularly 3D printing, are discussed with the companies. Company A does not have any manufacturing facilities and uses an external product manufacturer. However, they are using the AM technique in producing their prototypes. As highlighted, "*That's more common now nowadays with start-up companies, so instead of you manufacturing yourself, you use new techniques such as 3D printing or laser cutting (to reduce costs) to make prototypes, and then, you partner with large companies so they can manufacture what you designed".* This seems to be a fast, practical and hassle-free operation in making prototypes comparing to the conventional manufacturing practices. On the other side, the R3 highlighted that, *"3D printings always seem nice but have never been representative enough for what we need to have for testing. If you are trying to test something and your 3D printed material doesn't have that strength, then it is not suitable, and I don't think 3D components are durable enough".* This is a challenge for this manufacturing process due to the technical constraints of 3D printed items, such as strength and durability in aquatic environments.

Company C recorded the most negative responses regarding additive manufacturing with five negative points. Company B and C believe that it would not be feasible to use the 3D printers in their manufacturing operations. Company B claims that due to their customised products, it would not be practical to use 3D printing, and they can simply buy their ready-made components from the suppliers. As stated, "*Considering the volume we produce, they don't seem practical. I am interested in these approaches and regularly monitor their industrial*

development. We have been proactive to see if there is anything we could do in terms of the digitisations of our manufacturing systems. There is nothing we could do yet because we are scored pretty well on the areas where there were possible gaps. So, there is nothing we can do at the moment in terms of 3D printing". On the other side, Company C believes that 3D printers are expensive and slow. As asserted, "…*But it is a slower process for what we could afford and what we need, meaning that we use the raw materials quicker than we produce the products by our machinery. They are also expensive and slow in producing the volumes we need and requiring specific health and safety regulations. The printers need to be on 24/7, and that impacts the level of energy usage needed to produce our components. We can buy in volume, and we don't need to deal with its costs and implications".* This company also reflects that there is an expertise need as well as establishing a separate department for the implementation of 3D printers as it is a completely new, broad and challenging area to enter. Company D's project manager has considered the use of AM technique; however, have not yet presented any business plan to the CEO and shareholders. The technical manager of Company D stated that larger firms are on the cutting edge of new solutions such as AM applications, citing one of them as having just produced a 3D printed tyre with exceptional features. However, he believed that the required service facilities, technical know-how, and the high final price of 3D printed tyres are among the disadvantages that prohibit them from doing so. This is in line with the study of Szwejczewski et al. (2015) who believe that that service requirements are routinely assessed during NPD by involving after-sales personnel and utilising field service data.

Table 5.5 Coding Results of Technology and Information Technology

Interview Questions	Company A		Company B		Company C		Company D		Total
Q4: Technology and information technology	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	
Additive manufacturing									
▪ Customised products	0			1	0		0		
▪ Expertise need	0		0			1		1	
▪ Health & safety regulations	0		0			1	0		
▪ Usage in prototypes & tiny parts	1		0		0		1		
▪ Energy usage	0		0			1	0		2
▪ Speed & volume match	0		0			1	0		
▪ Price	0		0			1		1	
▪ Service facilities for 3D printed products	0		0		0			1	
▪ Durability of 3D printed products		1	0		0		0		
Technology for Manufacturing efficiency									
▪ Semi-automation	0		1		0		0		3
▪ Green machinery	0		0		1		1		
Selection of IT systems									
▪ Score carding system	0		1		0		0		2
▪ Third party entities involved in IT developments	0		1		0		0		
IT systems for SC coordination & NPD projects									
▪ Software programmes for NPD	0		1		1		0		
▪ Software programmes for SC coordination	1	1	1		1		1		
▪ Cloud-based systems for internal communications	1		0		0		0		11
▪ Internally developed IT systems	1		0		0		1		
▪ Information sharing with customers	1		1		0		0		
Technology and IT development barriers									
▪ The constant development of IT platforms	0		0			1	0		
▪ Expensive ERP systems	0			1	0		0		1
▪ High costs of IT developments	0		0			1	0		
▪ Survey web-based system costs	0		1	1	0		0		

5.3.4.2 Technology for Manufacturing Efficiency

Apart from Company A which only uses 3D printers in its prototypes, the other three companies are looking for improving their manufacturing efficiencies by either semi-automation or sustainable (green) machinery. This will bring them more process flexibility and the opportunity for process improvement practices which is also greatly beneficial in customised and variable demand of customers. The use of efficient machinery has been considered by most of the companies either within semi-automation or green types of machinery. Company B stated

that "*Some of our processes are suitable for some automation, but some others are very custom, they change a lot and not so repetitive all the time, as we use different sizes, packaging and different types of branding. So, it is difficult to automate these productions; we can only do the semi-automation".* According to Company C, "*We have purchased new machinery to cut down the wastes".* Likewise, Company D highlighted that "*We are also collaborating with technical knowledge unit to work on purchasing the green machinery… We have been looking for machinery that use less electricity and fuels to have less environmental impacts".*

5.3.4.3 Selection of IT Systems

With two positive points, Company B has the most positive responses regarding the selection of IT systems. Among all the companies, Company A and B do not allocate any department to IT for facilitating their information management. For Company A, IT practices seem to be a general task within all the departments. This company follows a more simplified procedure compared to the other companies in this matter. For the selection of IT systems, it simply claimed that "*There is no need for us to develop an IT platform for our SC coordination. Nowadays, there are a lot of options in the market for communications".* They mostly use web-based platforms with their suppliers, Dropbox for internal communications and Email as an older style practice with their customers in Ecuador. Company B utilises the experience of a certain amount of staff for the SC communications, as stated, *"We don't have an IT department; we have an operations manager with a background on ERP systems. I myself have a background in IT as well, so we are quite well placed on IT projects, also a third-party supplier who manages and maintains all of our IT infrastructures".* This company also employs a score carding system as well as a gap analysis in the selection of IT systems in different criteria such as cost, support, functionality and reliability. Despite there is no IT department for Company B, comparing its size to the rest of the companies (especially Company D as a large enterprise), the accurate principle of IT system selection is a bonus for them in cost savings and narrowing down the wide choice of IT systems. In this way, they conduct a kind of feasibility study to select the best IT option available in the market.

5.3.4.4 IT Systems for SC Coordination & NPD Projects

Company A recorded four positive points, being the highest positive responses for this category. Company B and C both have existing IT systems for their SC coordination (ERP and EC Force) respectively, while Company A utilises a web-based platform and Company D still uses a traditional approach of Emails, Skype or face-to-face meetings. Company B complains about the expensive ERP systems while benefiting from web-based systems (£12000-£14000) as well. For the internal company communications, Company A employs a cloud-based system (usually

Dropbox), while Company B, C and D use IT packages either developed by themselves or purchased externally. The security of cloud-based systems for Company A has forced them to take extra cautions, such as using encrypted passwords and secure systems, especially for the safety of information regarding NPD projects. In parallel with this, Company B has also mentioned that it always attempts to improve and provide an easy exchange of information, either online or through the SDS included in the delivery packages.

For NPD projects, Company B uses "*ERP system as well as project management for NPD, a combination of different software and various excel files, that go through each department and they populate excel files and ERP system".* Company C stated that *"We used to use the CCSI engineering programme to organise everything from quoting, accountancy and drawings to the delivery point, but it was more efficient for us to design our own one. We have recently started using a programme called SolidWorks, which run tests and simulations on materials for panel production. AutoCAD is another one".*

As evident, the companies use different approaches and software for information sharing and coordination of NPD and supply chains. Company A with different location bases in the UK and Ecuador see it more appropriate to use the web-based platforms. Company B and C both based in the UK, use world-known software such as ERP and AutoCAD as well as more specialised and internally developed software such as CCSI and EC force respectively. This is while the only software that Company D uses, is the internal automation software (central database system) for internal communications and the rest of international contacts are facilitated through Email, Skype and face-to-face meetings. Comparing the latter approaches with software and IT platforms, security and document privacy can be a potential issue for Company D.

5.3.4.5 Technology and IT Development Barriers

The main technical challenge for Company A is obtaining adequate funding to establish external test locations with aquatic conditions that are particular to the many types of pollution found in each ecosystem, as laboratory testing and simulations are insufficient.

Company C evaluates the constant developments, updates and changes of IT systems frustrating. This company also claims that *"The toughest barrier is that they are always under contract development and do not get finished. When you buy a package, it is constantly being updated, and things are always changing. Internal IT developments are very costly as well since they need to be put all together requiring massive expenditures, and we're talking about approximately a million pound here".* The prices associated with the use of web-based

platforms for Company B are high. However, the influence of customer surveys is remarkable on both customer responsiveness and sustainable surveys; hence, worth to be invested in. As mentioned, "*Bespoke software we already have in the house, and we have developed ourselves. ERPs are the most expensive, web-based system (£12000-£14000), survey (each time a few hundreds of pounds), that is also expensive".*

5.3.4.6 Discussion of Technology and Information Technology

Companies seldom considered or commented on the usage of 3D printers. Except for Company A, which uses this approach for its prototypes, the other examples described it as a slow, costly, and energy-intensive method given their production volumes. It might also need the creation of a separate specialised department with its own set of health and safety rules. Companies' scepticism and lack of motivation about AM are reasonable given the controversial debates over AM's sustainability level, such as the recyclability of AM-produced items, strength and durability under specific conditions, high costs, and restricted machine speed and dependability, as addressed by Ford and Despeisse (2016). Despite the fact that this production approach is still in its infancy and only a few firms around the world have adopted it, the diversity of prospective benefits it offers may encourage them to do so. Reduced transportation costs and a shorter distance between producers and buyers are only a few of the benefits, as are lower waste and energy consumption throughout the product life cycle (Ford and Despeisse, 2016). Still, firms may have concerns about manufacturing speed and daily production volume (particularly for bigger items), and they may require a significant number of 3D printers to enhance their manufacturing capacity, which may not be feasible. The case study firms have several options for mitigating both the price and the speed of 3D printing. To begin with, they can employ 3D printers exclusively for prototypes or when low-volume manufacturing is required, similar to Company A. Second, they may limit 3D printing to only their tiny pieces, which saves time and eliminates the need for attachments and welding, resulting in higher-quality manufacturing. Third, AM may be used to create customised and bespoke items for specific customers, eliminating the need for multiple suppliers and the time it takes for delivery.

Due to their consumers' customised preferences, Company C may reap the maximum benefits from AM. Meanwhile, while the majority of Company B's goods are liquids and reference materials, they may employ 3D printers for the bottles and laboratory testing equipment. Company D's tyre production may have some technical difficulties regarding the tyre safety standards and high associated costs and resources with 3D printing technique, but it may be utilised for the adhesive and glue tubes because they are little parts that take less time to make and therefore a limited number of 3D printers may be adequate. In general, they may save

money and time by combining semi-automation (as used by Company B, C, and D) and 3D printing, especially for bespoke needs.

The significance of information sharing and transparency of the supply chains, especially the relationship between the company and its customers were already studied in the literature (e.g. Liao and Wen, 2009; Agrawal 2012; Budd et al., 2012). Except for Company A, which has just prototype suppliers and a single strategic customer in Ecuador, all of the other examples have various suppliers and customers all over the world, and this requires them to maintain effective communication and transparency on information sharing. There is a wide range of software and systems used by the case studies. There are mainly three IT tools for both SC and NPD coordination purposes including IT software, web-based and cloud-based platforms. This shows that every company has different convenience, budget and needs in selecting its IT platforms. As claimed, there are different bugs, costs, regular updates and technical know-how associated with these platforms. Moving the industrial sector towards customer orientation and mass customization, on the other hand, need more robust and real-time information exchange with consumers, which is heavily dependent on the sort of IT platform and capabilities it provides. Cloud-based solutions, as opposed to software and other web-based systems, are superior IT facilitators in this regard. This is due to lower costs, more user-friendly features, offline services and in general, more advanced features compared to the traditional platforms. However, to achieve a sustainable demand chain and successful NPD, the goal should be to select the most reliable IT platforms based on customer needs while minimising costs through wise selection among the market options. The use of cloud-based systems also seems to be inevitable in the long-term as most of the organisations are starting to do so, such as Company A. As the amount of data and personal devices grows globally, data management solutions, such as cloud-based ones, are becoming less expensive and more accessible.

Overall, Company A employs a diverse set of technologies and IT solutions, which is consistent with Chong and Zhou's discussion on web-based DCM integration (2014). Among the cases, using 3D printers for prototypes or simple and effective tools such as cloud-based systems for information sharing have been properly working for them to coordinate the entities in their supply chains, especially considering their multinational businesses. However, they need to be vigilant and responsive to the technological and technical challenges that may arise in the near future.

5.3.5 Q5: Marketing

Relationships of the cases with their customers are already discussed in section 5.3.3. However, marketing practices also need to be elaborated to gain competitive advantage and reputation as well as understanding its relationship with NPD success and SDCM.

5.3.5.1 Marketing Practices

All companies have been active in different marketing practices to some extent. These practices are vital for the success of NPD projects and final marketing stages. Company A highlighted that *"We don't manufacture upfront. So, either they pay upfront some of the costs, or we have a contract, so without that, we wouldn't start manufacturing. We use modularity, not mass customisation. So, we make modular systems that we can make some small tweaks to make it work in different environments, and we don't tend to completely customise them. We tempt to design the systems in different subparts, so one of the subparts can be changed depending on the customer needs (not the entire one), so you can make changes to customise some of the aspects of the product".* Company B asserted that *"We calibrate on demand; we make custom requests which is beyond demand. It could be co-designed with customers depending on the product or calibration type. The lead time can be quite long. Depending on the request, we have to do some lab research to see if we can do it, time and cost are important here. It has to go to manufacturing and has to fit with our plans and norms of our operations".* Company C stated that "*Most of our products are being marketed by postponement anyways, as we buy-in, cut it into sizes and then when we get the order come through, we assemble and manufacture it into the main components we need, so automatically we practice this".* Among all, Company D is the one that deploys almost all the approaches from collective customer commitment to mass customisation, considering both advantages and disadvantages associated with each such as postponed payments.

5.3.5.2 Marketing Tools

The cases use different marketing tools to bridge the gap among their customer relationships. Company A mainly uses public media such as television, radio, local newspapers and media channels. They also attend interviews and use the tribune on local media channels to elaborate on the environmental issues associated with water ecosystems and promote their products. This is because its customer is the Ecuadorian government and therefore, this company need to create networks to enter the local media to attract the public attention and fulfil the government reputation and besides, make a reputation for itself. Company B sends its representatives to tradeshows and conferences to collaborate and share information with potential companies and customers. This can be academic or industrial events depending on the product type. Company

C mainly utilises social media platforms such as LinkedIn, Twitter, Facebook and Instagram as well as mailshots to advertise its products. For tyre products, Company D sometimes advertises on the public media as well as large billboards. For adhesive products, this company is almost a monopoly in the country, and the brand is well-known within the nation. However, they annually attend international exhibitions and occasionally use advertisements on media channels. For some of its new products such as the green insecticides, it uses billboards which are mostly designed for target markets.

Table 5.6 Coding Results of Marketing

Interview Questions	Company A		Company B		Company C		Company D		Total
Q5: Marketing	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	
Marketing practices									
▪ Collective customer commitment	1		0		0		0		7
▪ Postponement	0		1		1		0		
▪ Mass customisation	0		1		1		1		
▪ Modularity	1		0		0		0		
Marketing tools	1		1		1		1		4
Marketing strategies	1		0		0		1	1	2
Value propositions									
▪ Quality	0		1		0		0		5
▪ Upselling	0		0		1		0		
▪ USP	0		1		0		0		
▪ Customisation	0		0		0		1		
▪ Product narratives	1		0		0		0		
Marketing challenges									
▪ Language barriers	0		1		0		0		0
▪ Postponed customer payments	0		0		0		1		

5.3.5.3 Marketing Strategies

To fulfil the 4Ps of marketing and the final goal of competitive advantage, it is necessary for the companies to make strategic planning for marketing approaches. This enables them to manage the NPD projects at the final stages. In this regard, Company A stated that *"We use targeted market strategies with the Ecuadorian government (as our customer). We need to invest a lot in marketing activities mostly in the media and press… I do a lot of interviews with local media channels so that people understand what we do, and therefore, the government wants to operate with us"*. Company B and C have not recorded any data in this regard. Company D specified that *"We have different marketing strategies for different products and territories"*. The importance of buying behaviours, customer preferences and cultural differences are obvious regarding marketing strategies. Being adopted to various customer

preferences through marketing strategies is how companies can differentiate themselves within the competitive market and win the NPD projects ultimately.

5.3.5.4 Value Propositions

Value proposition both as a marketing technique and a criterion within the SDCM framework developed by Vural (2015) was cited by all the companies. Company A is using its potential to make an attractive look for its products especially in local media channels which is belonged to its customer (government) and has a vital role in attracting the attention of the whole nation. As stated, *"It's not only about the product itself, but also about the narratives, how you make it something cool and attractive that they would like to have it".* Company B is using different options to convince its customers, such as offering technical support, know-how, short lead times and high-quality products. International accreditation of calibration laboratories is another bonus for them. Towards this, they use USP towards their marketing approaches. Company C is using the upselling approach, as it presents the features and benefits of its products to the customers while making justifications for the higher prices it offers compared to its competitors. Company D follows a more moderate approach as it believes that the value proposition is normally achieved if the company moves in parallel with the customer desires only. It mentioned, "*Every product development is initiated and mass-customised based on the customer requirements received by the customers directly or through their representatives. Therefore, the value proposition is automatically there".*

5.3.5.5 Marketing Challenges

Company B has got language differences with some of its customers as stated, *"There are some language barriers depending on which place the products are going to be delivered, that's why we use distribution partners, so they are able to translate with those documents, marketing materials and speaking the language of local end-users, that why our distribution channels are so important to us".* The marketing issue for Company D was mainly due to the postponed payments from customers (Automakers), especially within mass customisation. The root cause of this problem can be different factors such as unstable economic conditions of this region due to economic sanctions, budget shortages and epidemic corruption. Furthermore, a major marketing issue for Company D is the lack of focus and consistency in the marketing strategy. As the technical manager stated, advertising contracts with high expenditures but low efficiency are notable in this company, and hence, new marketing strategies as well as unbiased market input after plans have been implemented, are required to address this.

5.3.5.6 Discussion of Marketing

Within the case studies, mass customisation is the most commonly employed marketing strategy. In the vast majority of situations, postponement and collective customer commitment are not practised. Mass customisation appears to be a safe option for them, as it does not require them to purchase main components in advance which could be costly and needing inventory space, and also do not need to convince customers for commitment and early purchasing prior to product development and launch.

Marketing tools for Company A and D are identical in terms of using public media channels. This is probably because both of their customers are large organisations, being government and car manufacturers respectively. In other words, B2B models and having indirect end-users require solid plans and proper cautions in any terms, especially marketing which is directly relevant to the attraction of the public. Likewise, Company B attends different tradeshows and conferences which is sensible considering their product types, as laboratory and testing equipment needs to be marketed in specific events to a targeted group of companies, due to their soft features and the need for accurate introductions of product specifications. Company C merely makes the use of social media platforms considering the hard and limited features of AHUs such as energy usage, size and colour.

As obvious, the mentioned marketing strategies are relevant to the use of different marketing tools for different territories and regions. The vital point here is the cultural differences, buying behaviours and the specific market needs and preferences of diverse communities which need to be addressed. Having said that, marketing strategies may be considered as a whole as well as the appropriate use of marketing tools for different regions of the world. Company C has got a price-driven market and is using upselling marketing strategy. Being price-driven means that the sustainable characteristic of products cannot be a guarantee for it to be the priority for customers and therefore, no competitive advantage can be guaranteed in this regard unless they use proper value proposition features to prove their product dominance to the customers. The current upselling strategy they employ can be suitable if it is applied to sustainable products as well. This also necessitates them penetrating a group of sustainable-conscious customers, such as newly built sustainable hotels in natural sightseeing areas or other sustainable infrastructures.

Marketing is among the early stages of the SDCM conceptual framework developed by Vural (2015) that aimed to combine marketing perspective with SSCM and also suggested for further research studies based on this early effort. Hence, the role of marketing needs to be identified as the first perspective towards the demand chain in section 2.3.3 as well as its interrelationships

with both SDCM and NPD. This is to investigate the innovative marketing practices and their linkage to customer demand for sustainable products.

To better comprehend the interrelationships among these concepts, we assume "*Marketing, NPD and SDCM"* as three angles of a triangle. According to the cases, marketing approaches can be divided into two groups of conventional and bespoke products which can be investigated from the NPD lens. In the development of conventional products for Company B, C and D, there is no customer engagement in the co-design stage, but the marketing practices and strategies remain in place.

Moreover, for the development of sustainable products as the main focus of this study, for instance for the plastic extraction devices of Company A, there is a need for strategic relationships with customers (government) to understand their requirements, values and market penetration points. The company has sustainability in its core corporate missions, but the Ecuadorian government is the only customer of Company A. This customer seems to be pre-identified and being negotiated with as a targeted market considering that the company owner is also from that country. Public media channels act as significant marketing tools for this company to fulfil the product narratives describing the bigger picture of the novel features the product offers. Hence, we see that the presentation of the new sustainable products needs to be attractive, understandable and acceptable for both customers and the public who indirectly and ultimately benefit from the environmental conservation of rivers and oceans. In this way, the NPD risks such as replacing with other suppliers or lack of public interest will be minimised. Given the targeted market and its developing economy, making the government conscious and knowledgeable regarding the long-term ecological harms is essential but not enough. Also, it might be the case that the current product of Company A gets technologically old-fashioned or new sustainable devices being emerged from other companies. Hence, the connection between stakeholders needs to be maintained within a long-term plan by customer engagement and collaboration in product development, continuous development and the use of updated technologies. Besides, since this company works under the support of the university, this institution can act as an external consultation body to benefit the company by the updated knowledge of fresh alumni.

On the other side, the eco-friendly insecticides developed by Company D are not generated based on a potential customer/market. This product is an innovative and novel one with a premium price being marketed and sold to a limited number of drugstores and supermarkets in the rich areas of the capital. In other words, it is being presented to a niche market. Here, the

cultural aspects, customer behaviours and public knowledge about sustainability are among the determinants that can be increased by the appropriate awareness plans from the government as well as the company itself working on CSR dimensions especially environmental sustainability. Again, this is where marketing comes into work on target audiences and develop persuasive long-term value propositions and appealing commercials. This would be more effective if it is accompanied by lower premium prices and margins, because addressing the sustainable consciousness of the households and communities is tricky enough without having to incentivise them with lower prices, at least at the start of a product launch in a specific area. In this way, the product can be sold in all the local markets, instead of a niche market. After some time, when the product gains more public notice and popularity, and people grasp its importance in comparison to traditional pesticides, the corporation may be able to raise pricing to a specific level to remain competitive and earn more profits.

5.3.6 Q6: Economics

5.3.6.1 Investment Opportunities

Investments, costs and ROI are key points for all businesses when they tend to consider sustainable activities. Evidence shows that the way they look at sustainability applications and associated benefits much depends upon their future business profitability and cost savings. However, Company A was an exception in this matter and claimed that "*Being honest, we don't measure the pay-off, because it's part of what we do. I suppose when other companies do the transition, they measure their effort of sustainability, but we see that quite a lot as greenwashing, so in our case, it's not something we analyse, as it is part of the DNA of the company".* Company B asserted that "*There could be opportunities with investments on sustainability and that is how I am looking at it…We believe that it's going to be market opportunities for us going forward to be able to justify the costs for all these activities".* Company C stated that "*Our payoff and results for sustainability adoption will belong to the end-user points in terms of energy usage, rather than any pay-off for us in manufacturing, procurement or logistics point".* Company D mentioned that *"Pay-off on investments can be usually seen within 3-4 years. The high amount of investments act as barriers towards sustainability, but in these cases, we try to execute the projects in two phases, so, we could reach our economic goals but maybe a bit later".* According to the aforementioned, all the companies agree on the positive side of sustainable investments. However, there are different incentives behind that, including corporate mission, sustainable consumer awareness and enhanced competitive advantage.

5.3.6.2 Long-term Profitability

Company A claims that it does not measure the profitability/pay-off of their products, as sustainability is embedded in their company and products, and they exist due to the market need. He also stated that lots of companies make unreal announcements out of their sustainable operations, and this is referred to as "greenwashing" by Company A. This company only considers the routine cash-flow of their company and see if it is reasonable compared to other identical companies and the efforts they make. Moreover, Company A's selling strategy is based on BOT contract model having mutual benefits for both the company and the government as a public sector. By using this approach, the government can control how public funds are spent on infrastructure development, increase innovation, and bring in innovation and expertise from the private sector. As stated by R2, *"On the business model side, we tend to be really innovative… We are trying to build equipment and just charge for its operation, and this is an innovative process called build-operate-transfer (BOT) (take it as a service). We are not selling the equipment or assets, we are selling the service for stopping the plastic with our equipment and after we finish the contract, we can leave the assets with them, so we teach them how to use them as well. That's the way we have found it more scalable to reduce the environmental impacts".*

Company B is not sure if the owners and shareholders see the wider horizons of profitability as a result of sustainable adoption. However, the managing director as company representative aims to present justifications along with a business case in this matter. Company C believes that the pay-off and positive result of the sustainable adoption belong to the consumer's point, as this is they who benefit from the low energy consumption of efficient air-handling units. As mentioned before, through upselling, this company discloses the differences and advantages of products such as the long-term energy savings to their customers. In this way, even if the prices are higher compared to their rivals, customers may prefer to select them due to sustainable product features. If they prefer so, the company will gain a competitive advantage and profits, and if not, they lose the market. On the contrary, Company D believes that the support of owner/shareholders makes a big difference in the sustainable perspectives of the company, while profitability and brand image will automatically result from continuous production of high-quality products. It can be assumed that this company see product quality and process improvement as important as sustainable practices and their outcomes.

Table 5.7 Coding Results of Economics

Interview Questions	Company A		Company B		Company C		Company D		Total
Q6: Economics	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	
Investment opportunities	1		1		1	1	1	1	4
Long-term profitability	1		1	1	1	1	1		4
Economic barriers towards sustainability									
▪ Economic sanctions	0		1	1	0			1	
▪ Shortage of budget		1	0		0		0		1
▪ Epidemic corruptions	0				0			1	
▪ Seasonal usage of green insecticides	0		0		0			1	

5.3.6.3 Economic Barriers towards Sustainability

Company A does not see any economic harm resulted from the adoption of sustainability as it is embedded in their company. Company B thinks that *"In the bigger picture, there wouldn't be harmful, I think. In the short term, it might be seen costly, but in medium, to long term, everyone will go that way, so it's better to be among the early adopters of this culture".* Company C also states that sustainability is among their priorities and the natural global move towards sustainability makes it inevitable. This company has almost become paperless in their offices and instead, some of the staff need more than one PC to work with. The question is which one has got more carbon footprint, use of 2-3 PCs or printing pile of papers. Regarding sustainability costs, this company stated that "*I don't see the sustainability costs as a barrier, because we will ultimately sell the differences to customers elaborating their savings in the long term compared to the normal products and that will make us winners".*

Company D asserted that *"There are also some economic barriers for the adoption of sustainability, such as fluctuation of exchange rates and economic sanctions imposed on our country".* This brings time and resources limitations to this company. However, it is not limited to time and resources, but it also impacts on know-how and technical knowledge associated with sustainable practices. Company D believes that its developed green insecticide has not been commercially successful enough yet. The seasonal use of such goods, together with the periodic import limitations caused by economic sanctions, the disruption in market nutrition and the failure to provide broad market coverage were among the economic obstacles to this product. Moreover, towards the commercial success of the green insecticide, a comprehensive marketing strategy is also needed, and this plan must be put up and managed with the assistance of experts, as well as thorough market research and unbiased market feedback after plans have been executed.

5.3.6.4 Discussion of Economics

Financial performance is a significant measure of NPD success (Chien and Chen, 2010) as well as the main objective of SSCM practices (Carter and Euston, 2011). This becomes more vital from the SME point of view due to their limited funds and resources. Having said that, companies need to feel confident in economic pay-off when initiating sustainable practices. In this endeavour towards sustainability, governments play a crucial role as policymakers to direct and support the businesses in terms of financial aids and expert guidance. However, governments, especially those from developing countries, are not usually proactive in supporting businesses for sustainable implementation. As a result, businesses may feel vulnerable and unprotected in this regard, which is why many of them regard sustainability as a natural tendency rather than an urgent and beneficial shift.

It is true that in the DCM model, the consumers are the ones who drive the focal companies. Another minor push appears to be coming from the government to the focal company, as well as from the focal firm to upstream suppliers, implying that all push energies are coming from the end-users and the government to the firm and its suppliers. Although a pull-based approach is required rather than pushing things to market, consumer demand must be discovered, tracked, and co-worked, and this responsiveness must be a joint connection between the firm and its consumers. Among the supply chain relationships, the interconnections between the company, government and financial organisations are among the determinants to the creation of a CE. Governments and financial organisations are the backbones of every economy, and without their right support and directions towards sustainable approaches, enterprises and end-users would be powerless in their quest for sustainability.

According to Hassini et al. (2012), one of the vital SSCM objectives is to maximise the supply chain profitability. As seen from the cases, each of them has different perspectives when it comes to economic aspects of sustainability. One of them sees the sustainable profitability embedded within their business DNA. Another one perceives it as a natural trend as the world sustainable awareness rises. The other one believes that these are the end-users who ultimately benefit from sustainable products such as low costs and energy consumption, and the last company mostly thinks about maintaining their competitive advantage within the market. These results are partly consistent with the study of Ye et al. (2020) who believed that the social and environmental aspects of sustainability are usually disregarded, Undoubtedly, companies need to see a positive economic prospect for investing in environmental management, but their mindset shift towards sustainability cannot be denied. These are only four examples, and it can be interpreted that the positive nature of sustainability and the environmental harms of

unsustainable activities make it inevitable for different businesses to have a dispassionate or neutral mindset regarding sustainability. Even if they are neutral or do not believe in its wide range of benefits, there would not be any other choice rather than agreeing on its advantages and acting accordingly.

Since nearly all of the enterprises agreed, a long-term strategy is needed until they can experience the financial benefits of sustainable initiatives. Despite the expenses, investments, and required budget for SNPD and SDCM, businesses may offer consumers appropriate value propositions that allow them to sell items at a premium price even with low-profit margins. To persuade a potential customer, the value proposition must be properly developed to provide them with clear information, such as product features, the detailed costs of NPD projects and the justification of premium prices. This is important when it comes to providing transparent information with customers, whether it is with enterprises or end-users.

The costs of sustainable buildings/facilities or sustainable logistics are not things to be added to the final product's price, since they do not offer any direct benefit to customers. As a result, these expenses are solely classified as the company's private long-term effort, which will undoubtedly be fruitful in the long run.

5.4 Chapter Five Summary

This chapter generated the initial coding map based on the coding of interview transcriptions using NVivo 12© software. Based on this map, cross-case analysis and content analysis are conducted. The cross-case analysis was to investigate the similarities and differences among the four case studies. This is combined with content analysis and the input from the literature review to be able to elaborate the case studies and make critical discussions. In the next chapter, relevant themes will be allocated to different sets of categories to generate the final conceptual research framework.

CHAPTER SIX: CONCEPTUAL RESEARCH FRAMEWORK

This chapter presents the third and final phase of content analysis (reporting) as well as the final conceptual research framework. The framework will be generated using the whole input from the literature review, the four case studies, the cross-case analysis and content analysis.

Figure 6.1 Flow of Conceptual Research Framework Chapter

The main goal of the coding process of the interview findings was to classify the gathered data into codes and categories, to discover what codes and categories have arisen from the interview questions, how are these codes and categories interpreted with relate to the research questions, and finally to classify them into broader themes. Based on literature and according to the preliminary conceptual framework indicated in Figure 2.28, the triple-bottom-line of sustainability usually act as initiatives within industrial sectors. Moreover, it was comprehended that there is as alignment between NPD and DCM facilitated by marketing element. In the next step, based on the literature, IT applications and innovative marketing practices were the two factors that contribute to the outcome of the alignment between sustainability, NPD and DCM. The main question that the codes, categories, and final research framework are attempting to answer is what the effects of such alignment are, based on the case study findings.

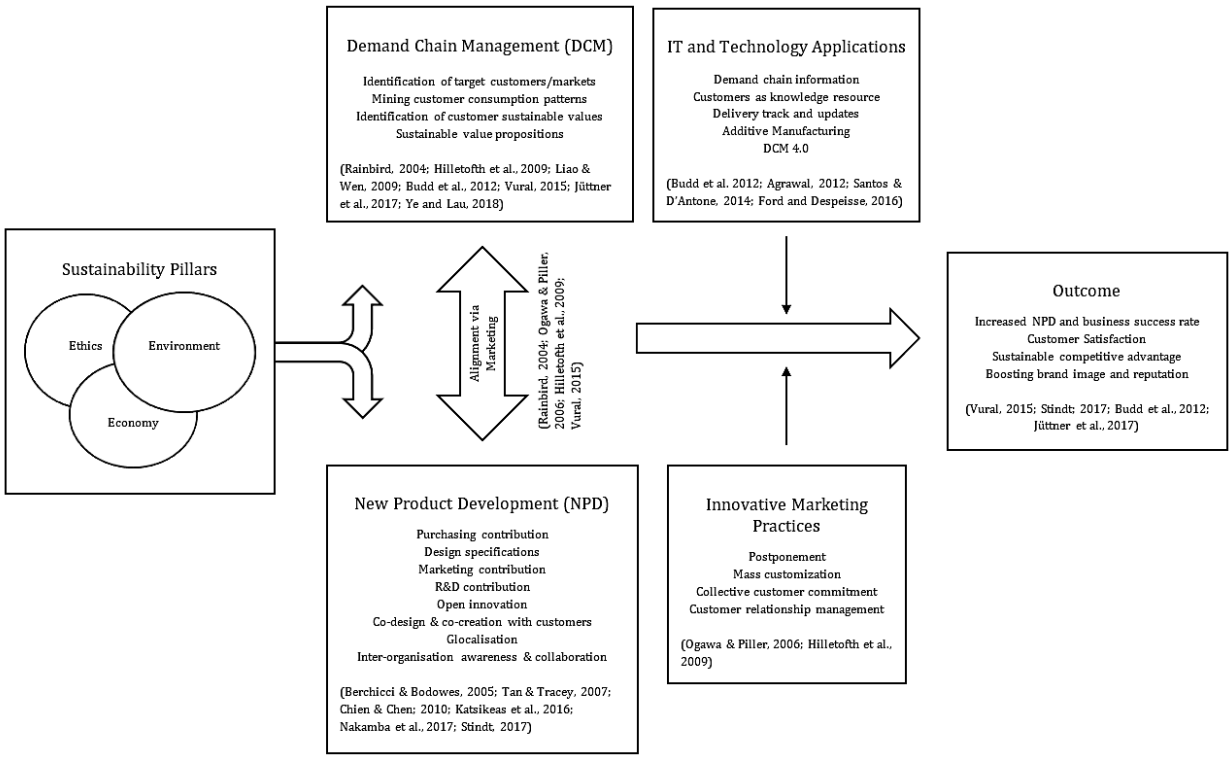

Figure 2.28 Preliminary Conceptual Framework: The Interrelationships of Sustainability, DCM and NPD

6.1 Identification of Themes

In the last chapter, the entire case study codes and 35 categories are discussed and analysed using cross-case and content analysis. In the next step, the categories need to be classified into broader themes to be able to build meaningful relationships between them and ultimately develop a conceptual research framework. Searching for themes and collating themes will be independent of the initial interview questions and will be only done based on the relevance of different categories. In total, 14 themes are shortlisted, as indicated in Table 6.1. This classification is based on the relevance of different categories, where one or more categories form a single theme as a meaningful concept towards linkages between the initial research concepts including sustainability, DCM and NPD.

Table 6.1 Identification of Themes

Codes	Categories	Themes
▪ Sustainability attitudes ▪ Government support ▪ Owners' motives ▪ Owners' attitudes ▪ Fund resources availability	Sustainability initiatives	Sustainability drivers of government and management
–	Business case for sustainability	
▪ Budget for staff training ▪ Sustainable culture among employees ▪ Recruitment of knowledgeable staff	Sustainability knowledge, training & culture	Internal and external sustainability mindsets
–	Customer sustainability consciousness and buying behaviours	
▪ Selection of green suppliers ▪ Sustainable packaging materials from suppliers ▪ Resource and time for selection of sustainable suppliers ▪ Natural process of world shift towards green suppliers	Supplier evaluations	Sustainability audits within supplier-customer relationship
▪ Eco-friendly survey from customers to suppliers ▪ Eco-friendly survey from suppliers to customers	Sustainability surveys	
▪ General waste ▪ Cardboard waste ▪ Metal waste ▪ Recycled bins ▪ Re-use and remanufacturing ▪ Disposal at end-user point ▪ Reduction of noise pollutions ▪ Paperless practices	Waste management	Environmental management
▪ EMS challenges ▪ EMS drivers ▪ EMS and competitive advantage	EMS certification	
▪ Government support towards solar panel usage ▪ Cost-saving of electric cars ▪ Sustainable buildings ▪ Feasibility of solar panels ▪ Low energy consumption lightings ▪ Wind energy usage	Sustainable buildings & facilities	
▪ Reliability of transportation sharing ▪ Transportation sharing with competitors	Sustainable logistics	
▪ NPD costs ▪ SNPD costs	NPD & SNPD costs	NPD and SNPD barriers
▪ NPD financial risks ▪ Market research for NPD justification ▪ Scoring systems for NPD initiation and minimising risks ▪ SNPD risks of price-driven market	NPD & SNPD risks	
▪ Change of regulations towards NPD ▪ NPD time limitations ▪ Resource limitations (for NPD and SNPD)	NPD & SNPD potential limitations	
–	NPD success measurement	NPD success
▪ Increase efficiency ▪ Reduce costs	SNPD drivers	SNPD drivers
–	Premium price sensitivities	The premium price of eco-friendly products
▪ Brand image and reputation ▪ Competitive advantage	Sustainability benefits	Sustainability benefits

Table 6.1 Continued

Codes	Categories	Themes
▪ Customised products ▪ Expertise need ▪ Health & safety regulations ▪ Usage in prototypes and tiny parts ▪ Energy usage ▪ Speed & volume match ▪ Price ▪ Service facilities for 3D printed products ▪ Durability of 3D printed products	Additive manufacturing	Innovative manufacturing
▪ Semi-automation ▪ Green machinery	Technology for Manufacturing efficiency	
▪ Replacing chemical materials with green ones ▪ Eco-friendly products ▪ Eco-friendly packaging	Sustainable production & packaging	
▪ Customer surveys ▪ Sales and after-sales services ▪ Sustainable value to customers ▪ Customer involvement in NPD and customisation ▪ Strategic relationship with customers ▪ Language barriers in after-sales services ▪ Production department engagement on after-sales	Customer responsiveness	Demand-driven product development
▪ Customer preferences ▪ Customer variable demands ▪ Customer desire for sustainable products and cost savings ▪ Customer demand for recyclable packaging and FSC branded panels ▪ High costs and long lead-times for being demand-based	Customer expectations	
▪ SNPD and customer satisfaction ▪ SNPD application point in SC	SNPD & customer benefits	
–	Sustainable demand chain & more work of employees	
▪ Score carding system ▪ Third party entities involved in IT developments	Selection of IT systems	IT for SC coordination and NPD project management
▪ Software programmes for NPD ▪ Software programmes for SC coordination ▪ Cloud-based systems for internal communications ▪ Internally developed IT systems ▪ Information sharing with customers	IT systems for SC coordination & NPD projects	
▪ Constant development of IT platforms ▪ Expensive ERP systems ▪ High costs of IT developments ▪ Survey web-based system costs	IT development barriers	
▪ Collective customer commitment ▪ Postponement ▪ Mass customisation ▪ Modularity	Marketing practices	Marketing plan
▪ Language barriers ▪ Postponed customer payments	Marketing challenges	
–	Marketing tools	
–	Marketing strategies	
▪ Quality ▪ Upselling ▪ USP ▪ Customisation ▪ Product narratives	Value propositions	
▪ Economic sanctions ▪ Shortage of budget ▪ Epidemic corruptions ▪ Seasonal usage of green insecticides	Economic barriers to sustainability	Financial anticipation
–	Investment opportunities	
–	Long-term profitability	

6.2 Interpretation of Proposed Conceptual Framework

By identifying the interrelationships between the final themes, the conceptual research framework is generated as indicated in Figure 6.2. This is the ultimate output of this research that obtains its data from the four case study data, cross-case analysis and content analysis. This framework consists of four main phases leading to brand image, reputation and competitive advantage as well as NPD success being initially set as the main aim of this research (manage the risks of NPD failures and business success).

The conceptual framework that has been presented may serve as a solid foundation for participatory or collaborative modelling. When different stakeholder groups develop a common language, it may allow creative planning and execution leading to long-term sustainability within different stages of SCM (SSCM) as well as adopting more sustainable elements within lifecycle analysis of products. The framework involves and incorporates input from a wide range of stakeholders, including suppliers, B2B customers or end-users, and even rivals, at different stages of development with the common aim of ensuring sustainability and success in new product development. Themes (rectangles) within the framework indicate all the key elements to be considered by companies and their stakeholders towards their endeavours in becoming demand-driven and developing a sustainable business. For example, by developing strategic plans and allocating additional budget for customer sustainability consciousness and evaluation of their purchasing behaviours, businesses and governments can work together to gradually shift sustainability mindsets, which will in turn aid in the creation of a pull-based supply chain in the future (Phase 1, Internal/external sustainability mindsets). Likewise, new negotiations can be made with market competitors for instance to collaborate sharing transportation vehicles, reducing carbon footprint and therefore serve sustainable logistics (Phase 3, environmental management). Furthermore, as stated by a few of the case responders, it is firstly the duty of all internal departments within an organisation to strive for long-term sustainability. According to the framework, several departments, including product development, production, information technology (IT), technical, marketing, and customer relations, are engaged with defined responsibilities at different stages. In the next sections, the phases of the conceptual framework will be elaborated in detail.

6.2.1 Phase One: Preliminary Planning for Sustainability

The first phase sets the initial planning to apply sustainability on product development practices and demand-driven chains. In other words, Phase one is the strategic level of this framework and elaborates how the companies need to prepare themselves and which factors are among the most significant ones at the beginning of this journey.

This phase takes its initial drivers from the government and management team of every organisation, mainly depending upon their sustainable attitudes, level of support and motivations they provide. This needs to be companied with a clear business case specifically for sustainability. Subsequently, financial anticipation is a vital factor for companies to evaluate the budget and investments associated with any sustainable practice such as IT and required technologies, sustainability audits, marketing plan, NPD and SNPD costs and environmental management. Moreover, the profitability, ROI and economic barriers they may face need to be accurately identified in this step. In the next step, companies need to evaluate, plan and build internal and external sustainability mindsets. This is also in line with the concept of SO within the conceptual framework developed by Du et al (2016) (Figure 2.26) that acts as a positive influential factor on NPD performance. Internal sustainability mindsets refer to the knowledge, culture and training opportunities for managers and employees within an organisation. External sustainability mindsets refer to customers as well as suppliers' knowledge, culture and in general sustainable consciousness regarding demand, purchasing and consumption behaviours. The first phase entirely acts as a prerequisite for the second phase, which is called demand-driven product development.

The first and the second phase provide answers to the first and second research questions (RQ1 and RQ2) according to section 1.3 of this research being *"What is the driving role of sustainability towards NPD?" and "What is the driving role of sustainability towards DCM?".* After the content analysis and categorisation of codes, categories and themes, it is now evident that sustainability drives demand-driven product development with the presence of some moderating variables.

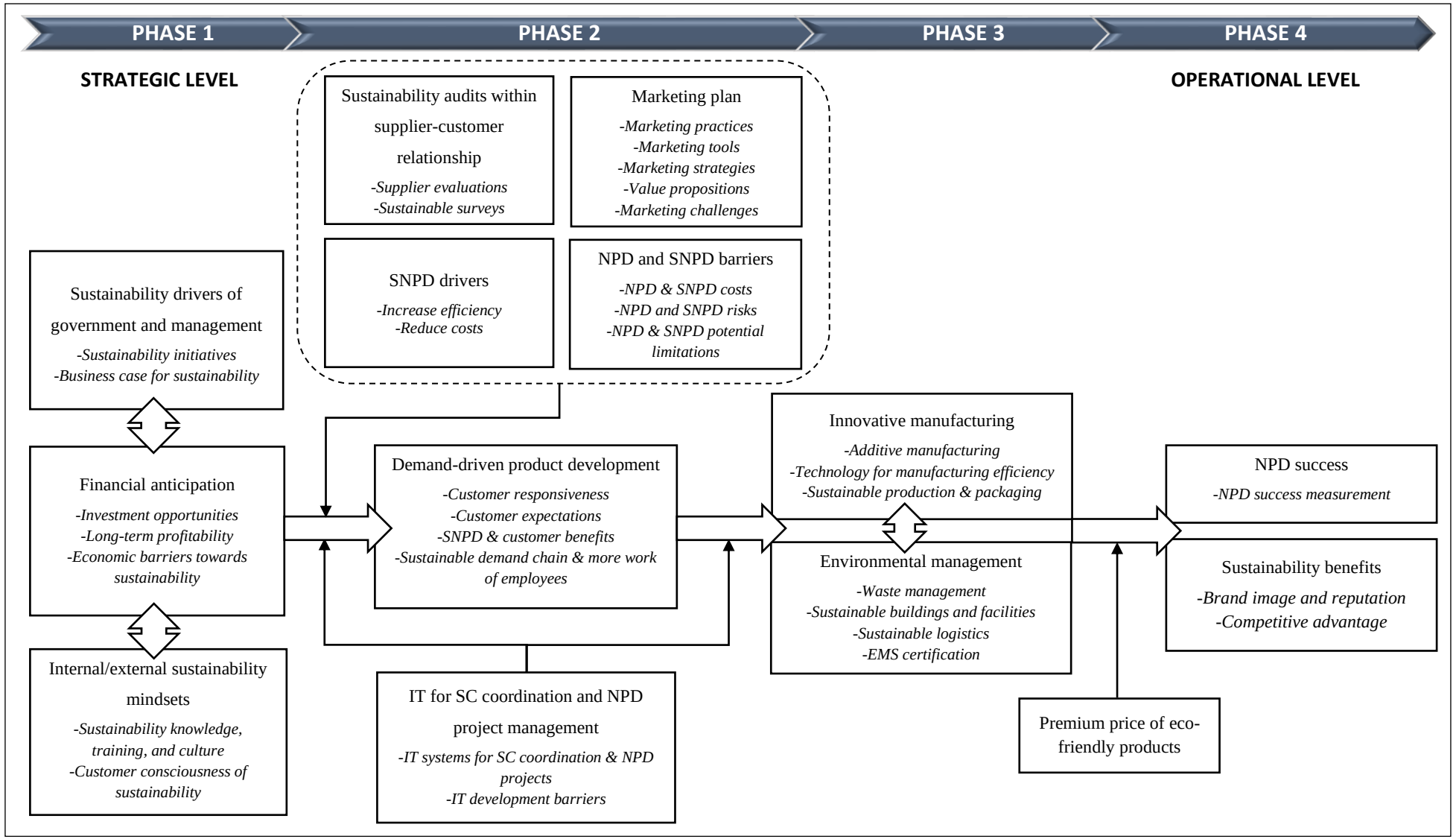

Figure 6.2 A Proposed Conceptual Framework – Sustainability Influences on DCM and NPD

6.2.2 Moderating Variables between Phase One and Two

Within the transition of Phase one into Phase two, there are some moderating variables. These variables are moderating since they alter the relationship between the two other variables while being unaffected by the independent variable. From one side, the four factors including sustainability audits, marketing plan, SNPD drivers, NPD and SNPD barriers and from another side, IT systems have proved to modify the relationships between sustainability and demand-driven product development without being directly affected by sustainability. Sustainability audits such as survey conduction with both suppliers and customers make a good record of customer/supplier requirements and enable the company to plan and fulfil those needs. Marketing has been one of the demand chain principles and the first interpretation of the demand chain within the literature. This also includes the sales and after-sales services since all the three departments organise and facilitate the relationships with customers. Marketing practices such as mass customisation, collective customer commitment, postponement of modularity can be negotiated within early marketing stages. Marketing tools facilitate and ease the communication between the company and customers. Marketing strategies imply the identification of target markets, pricing, cultural and demographical solutions. NPD and SNPD barriers include associated costs, financial risks, SNPD risks of the price-driven market, change of regulations towards NPD, time and resource limitations. On the other side, IT acts as a catalyst and facilitator for the coordination of entities across the demand-driven supply chain as well as NPD projects.

Selecting the right IT infrastructure and reliable software programmes becomes important towards increasing transparency, easy communication and customer satisfaction. Moreover, the companies need to accurately consider the advantages and disadvantages of IT software, cloud-based and web-based platforms to be able to select the one that fits their budget, requirements and supply chain style. This will enable them to benefit from the rapid information sharing and data exchange with their supply chain, especially with customers. Moreover, the constant development of IT platforms and high costs of IT developments, ERP systems and survey web-based systems need to be addressed at this point.

6.2.3 Phase Two: Demand-Driven Product Development

The rationale behind this naming is the importance of how the NPD projects are being processed when focusing on customer requirements within a demand-driven chain. It has been obvious from both literature and case studies that for a demand-driven chain to become true, there is a necessity for it to be associated with different NPD stages. Specifically, within the design stage of NPD, mass customisation, or modularity practices facilitate the communication between the

company and customers. The design stage is the initial and key stage to take into account customer needs, specifications, policies and financial limitations. Within the manufacturing stage especially for B2B contexts, business customers can have a presence in manufacturing company as a monitoring/supervisory role as seen from case study D. The marketing stage is the most typical stage within the customer relationships and most of the negotiations, and after-sales services take place in this stage. This is also in parallel with literature studies which highlights the triangle of marketing, DCM and SCM and considers marketing as a borderline between company and customers (Hilletofth et al., 2009). This means that there is a close linkage between NPD and demand-driven chain, and hence, this stage is called demand-driven product development. This exactly makes the NPD distinctive and answers the RQ3 identified in section 1.3 of this research – *"What is the relationship between a demand-driven chain and the marketing pillar of NPD?".* The demand-driven product development takes its characteristics from the demand chain with a core aspect of pull-based production systems and the creation of pull for new products instead of pushing them into the market. This necessitates customer involvement from the initial stages of NPD projects to be able to identify customer value drivers, build an SSN and fulfil customer variable demands, as also highlighted within the SDCM framework developed by Vural (2015).

6.2.4 Moderating Variable between Phase Two and Three

IT acts as a moderating variable between Phase two and three as well, due to its positive effect on making NPD projects more transparent, smoother, and safer. The use of IT platforms within NPD includes but is not limited to ERP systems for NPD project management as well as engineering programmes for NPD design and execution. This includes both the design and engineering aspects of NPD. The IT also provides more effective supply chain coordination which is required from the preliminary planning for sustainability to final production and end-user point.

6.2.5 Phase Three: Innovative Manufacturing and Environmental Management

This phase is the operational level within the conceptual framework. In other words, this is where sustainability is implemented to the products and processes through innovative manufacturing and environmental management practices. Reliable technology advancements such as AM, semi-automation, green machinery, as well as sustainable production and packaging can help innovative manufacturing to become a reality. In this journey, some barriers exist, such as the expertise need for AM as well as operating speed, volume and prices. Moreover, the shortage of green raw materials and the replacement of green machinery has been a question for case study companies. On the other side, environmental management needs

to have an alignment with innovative manufacturing to act as a full bundle towards the implementation of environmental sustainability at this level. Considering waste management; reuse, remanufacturing, and paperless practices are among the activities at this stage. Reducing energy usage, using solar panels, installation of large windows for more sunlight and usage of electric cars at the manufacturing plants are among the sustainable practices for improving buildings and facilities. Transportation sharing is another factor considering the carbon footprint of the logistic activities between factories, distribution centres, retailers and customers. In this respect, companies need to assess the availability and reliability of sustainable logistics and possibly come up with solutions to coordinate with their competitors or companies with identical products. Moreover, governments can play a huge role in motivating companies and setting rules and regulations for transportation sharing and in general environmental management practices.

6.2.6 Moderating Variable between Phase Three and Four

Towards the final stages of product development and customer satisfaction in parallel, the premium price of eco-friendly products brings some risks and uncertainties that need to be the focal point of marketing, sales and after-sales services. This is due to the niche market of eco-friendly products despite its growing industry trends and customer consciousness, especially within developing countries. Within societies less familiar with eco-friendly products, manufacturers need to conduct feasibility studies and plan in advance to identify the B2B partners, target markets or the end-users to see whether or not they have the capability to respond positively to the premium prices. They also need to minimise the costs and set the final prices with the lowest possible profit margins to be able to survive within the market. Moreover, cause marketing and eco-labelling schemes can be helpful to raise the green purchasing intentions among the end-users.

Culture, education level, buying behaviours, demographics and WTP of the customers or B2B partner are vital factors to be considered in this regard. It must be noted that buying behaviours and culture are not factors that can be changed easily within a short period. Even in the developed countries, most people look for typical items, especially non-durable ones and mostly prefer not to pay a premium price, despite the government efforts towards increasing their awareness regarding environmental impacts. Fundamentally, this is the task of governments, communities and educational institutions to enhance people's knowledge and build up a green buying culture within societies. However, manufacturing organisations also need to shift their mindsets from price-driven markets and take more responsible actions towards climate emergency.

6.2.7 Phase Four: NPD and Business Success

This phase indicates the final output of the framework as well as the main aim of this research being *"To investigate the interrelationships between sustainable practices, DCM and NPD with the intention of understanding and managing the risks associated with NPD failures and business success".* It also answers the fourth research question (RQ4) being "*Considering the driving roles of sustainability, what are the interrelationships between the three research components?".* This is where the preliminary phases and other inputs react to each other and ultimately generate the NPD success, brand image, reputation and competitive advantage. In other words, in a supply chain with sustainability initiatives, two main outputs will be generated as a result of customer engagement through a demand-driven chain within NPD projects. At this stage, the NPD success becomes important in gauging the ultimate performance of the company after linkage of sustainability, DCM and NPD. As evident from the case studies, each case study company follows different practices to evaluate and measure the NPD success. Most of them simply compare the investments and budget with total sales (profitability) within a specific timeframe, and one of them compares its products' quality and sales with its competitors. In general, as per literature suggested, process performance and financial performance are two main factors that NPD performance relies upon them (Chien and Chen, 2010), and this is also proved by the findings of this study.

Brand image, reputation, and competitive advantage are the indicating factors for business success. This is what makes the businesses win the markets and catch the attention of audiences in today's competitive markets where multiple options are available for customers. To have a successful business and gain profitability, end-users need to feel an attachment and see an added value in the brand they purchase from. This is where customer loyalty and creating shared value (CSV) become important. CSV presents a win-win strategy that can help companies to adopt sustainability not only to benefit the society and environment but also to maximise their revenues. CSV highlights a higher level than CSR, since CSR merely considers the business impact on society and the environment, whereas CSV's main aim is to enhance profitability and brand image as a result of valuing local community and environment. CSV can be beneficial for companies by making collaborations with communities where a societal gap or challenge needs to be fulfilled. In other words, they need to capture the opportunities wherever there is a shortcoming in the society either in terms of environmental conservation, health, education, culture and employment. In this way, mutual contact among companies and communities will be created and lead to the health of the community as well as the competitive advantage of the company.

6.3 Chapter Six Summary

This chapter completed the data analysis chapter by presenting the final conceptual research framework. The framework started with preliminary sustainability planning continuing with demand-driven product development, innovative manufacturing and environmental management, leading to NPD and business success. Moderating variables acted as facilitators within the transition of different variables. This framework provides answers to the research questions in the first chapter, where the associations between the main three research concepts were unknown. The next chapter concludes the key research findings as well as the limitations and future research recommendations.

CHAPTER SEVEN: CONCLUSION AND FUTURE WORKS

In earlier chapters, the requirements of the research were addressed by conducting a systematic review of literature, describing the research methodology, data collection and analysis, and finally the final conceptual framework. This chapter discusses the main research questions (RQs), aim and objectives and reviews their level of fulfilment. It also summarises the research findings and elaborates the contribution to knowledge and limitations of the study.

7.1 Fulfilment of Aim and Objectives

This research aimed to investigate the interrelationships between sustainable practices, DCM and NPD in order to better understand and manage the risks associated with NPD failures and company success. The systematic review attempted to meet part of the goal, while the second phase involved the conduct of four case studies. The main study concepts were covered in the interview questions.

The data analysis through cross-case and content analysis helped the researcher to make the categorisation out of derived codes and ultimately find the relevance and interrelationships between different themes. The conceptual research framework is the final output of this research, in which various study elements form a single map and interpret the research findings.

The objectives of this research were as follows, and according to each chapter's analysis, it is evident that this study has achieved the objectives identified at the beginning:

1. To examine the applications of sustainable practices within NPD projects of manufacturing organisations through an empirical study. *(Chapter 2)*

2. To examine the applications of sustainable practices within the context of DCM. *(Chapter 2)*

3. To evaluate the barriers associated with the applications of sustainability within both NPD and DCM, and how to minimise them. (*Chapter 2, 5 and 6)*

4. To develop a conceptual framework illustrating the interrelationships between research concepts to assist organisations towards minimising the DCM and NPD failures as a result of sustainability adoption. *(Chapter 6)*

7.2 Summary of Research Findings

Based on the case study discussions as well as the final conceptual framework, key findings of this research will be detailed in this section. To make this more organised, research findings are summarised by responding to each of the four research questions:

RQ1) What is the driving role of sustainability towards NPD?

The SDCM framework started with demand chain profiling based on the sustainable pillars, with NPD and commercialisation incorporated into the last stage of SSN (Vural, 2015). Nonetheless, the findings of this study are at odds with those of literature to some extent. The research framework within this study proposes that sustainability drivers of government and management, as well as financial anticipation and internal and external sustainability mindsets, serve as foundations for NPD projects. This study indicates a direct relationship between sustainability drivers and NPD, unlike the previous study. The following points indicate the main findings of the study addressing the associations of sustainability and NPD:

Conventional versus eco-friendly products

Despite the academic and industry efforts in the environmental context, the tight competition between conventional and eco-friendly products is still undeniable. Conventional products with competitive prices mostly gain competitive advantage within all the markets. However, as the case studies show, even firms that were solely focused on traditional products have recognised the need for minor environmental transformations in recent years. This transformation has mostly been fuelled by the sustainable mindsets of company owners and senior executives, as well as the world's natural transition towards sustainability. This is included within sustainability initiative factors, where the government support was questionable, but the owners' drives and attitudes were mainly positive.

Mutual supply and demand for sustainable NPD

In the case study analysis, environmental evaluation of suppliers has been an uncertain area. This comes as firms have experienced greater pull pressures from customers, indicating a mismatch between supply and demand for sustainable NPD. Looking at the entire supply chain generally within the four case studies, the sustainable pull and relevant enquiries were mostly from focal companies towards upstream suppliers, and by moving towards OEMs, the tier-1 and tier-2 suppliers, the sustainable demand and environmental assessments shrink. This is since the focal firms are the closest entities to the consumers and end-users, and hence market dynamics may have a direct impact on them. The more we move towards upstream suppliers,

the lighter the sustainable propositions get. The selection of green suppliers has also been most beneficial, though each firm takes a different strategy in this area. This selection is based on the supplier values, attitudes, recyclable packaging and green raw material usage.

RQ2) What is the driving role of sustainability towards DCM?

The final conceptual framework has shown that sustainability is the preliminary planning stage that may drive and promote DCM adoption. It has also been demonstrated that DCM and NPD cannot be separated for successful product development, implying that sustainability planning must play a greater role from the outset.

Although the findings of this study are essentially consistent with those of Vural (2015), they differ in significant areas. Vural (2015)'s SDCM framework initiates with demand chain profiling and continues with sustainable value propositions that lead to sustainable supply networks. The findings of this study highlight several specific criteria that influence SDCM establishment, customer behaviours, and the success level of sustainable products, particularly durable goods on the market. These factors are as follows:

Customer involvement in NPD

Since the emergence of make-to-order and customisation in the previous decades, this factor has become a trend. According to the case studies, the majority of products are conventional and durable ones, and therefore, any customer involvement is also limited to these types of products. Certainly, the long lifespan of products (whether conventional or sustainable) provides better opportunities for engaging customers at various stages of NPD as well as price negotiations.

Customer sustainability consciousness and buying behaviours

This component is included in both the internal and external sustainability mindsets. Nevertheless, the framework states that it has an indirect impact on the formation of demand-driven product development. Customer consciousness is influenced by knowledge and culture, as well as demographics and geographical areas, particularly education and income levels. Customer buying behaviours is dependent upon the premium prices, especially in regard to green products in developing nations.

Energy efficiency and cost savings

This is proved to be a vital factor for end-users when selecting sustainable products. Customer buying behaviours and their WTP for sustainable items are associated with the final price (often a premium price), cost savings and energy usage of the products as well as after-sales costs. These also serve as SNPD drivers and moderating factors between the framework's first and second phases.

RQ3) What is the relationship between a demand-driven chain and the marketing pillar of NPD?

The results of this study imply that for sustainability to be adopted in industrial contexts, DCM and NPD must be tightly linked. The logic behind this is that within a DCM, the firm needs to be associated with its customers (end-users or B2B customers) from the initial design stages to the final sales and after-sales stages. This contact and association can be in a single stage or cross-sectional, and it is an essential part of SDCM and successful NPD.

RQ4) Considering the driving roles of sustainability, what are the interrelationships between the three research components?

The conceptual research framework identifies two main outputs, including NPD success and sustainability benefits related to brand image, reputation and competitive advantage. These two features have directly emerged from innovative manufacturing and environmental management, which serves as a major pillar of TBL in terms of manufacturing efficiency and environmental sustainability.

Given the importance of sustainability in the industrial world as well as the key role of successful NPD within DCM, the necessity for understanding the associations between the three concepts can be recognised. While there have been multiple studies looking at the function of sustainability in DCM or NPD separately, there has been no academic study to date that examines the interactions of the three research components through a single lens. This association is indicated through the conceptual research framework as the main output of this study.

7.3 Contribution to Knowledge

Based on the research findings, this study makes five key contributions to knowledge as follows:

1) Conceptual research framework – The main knowledge contribution was the generation of the final conceptual framework based on case study findings. This novel model provided an understanding of the linkages between the main research concepts, including sustainability, DCM and NPD, which was previously unknown and did not exist in the literature. The framework makes visualisation of the interrelationships between study concepts from a strategic to the operational level. In fact, it illustrates how sustainability and demand-driven chains change the direction of NPD projects towards greening and customer satisfaction. The conceptual framework can help researchers and practitioners acquire fresh insights into how sustainability may be applied to every aspect of their company and supply chains. It can also assist them to plan and act more effectively in the face of climate emergency, allowing businesses to become greener and more customer-focused, resulting in enhanced profitability.

2) Categorisation – This study categorised the case study data from raw qualitative interview transcripts to codes and categories. This was accomplished using NVivo 12© software and descriptive coding. The initial coding map comprised 99 codes and 35 categories in total, allowing the researcher to examine the similarities and differences of case studies and extensively analyse the data acquired.

3) Identification of key themes – After categorisation and identifying relations across different categories, 14 themes were nominated for the second round of categorisation. The themes are unique to this study since they only comprise relevant categories drawn from the data derived from the four case studies.

4) Content analysis – By comparing the highlighted literature and interview data coding from four case studies, this study presented a comprehensive content analysis to create critical discussions. The content analysis was conducted concurrently with the cross-case study and presented the details of relationships between sustainability, DCM and NPD as a whole picture.

5) A systematic review of literature – This study conducted a systematic review to investigate relevant studies and key papers of the last 20 years. This was due to a large number of scholarly materials relevant to this study. Using the PRISMA diagram and SCOPUS as a search database, 75 publications were eventually selected for further analysis and classifications.

7.4 Limitations and Recommendations for Future Research

There have been certain limitations within the journey of this research. The following statements point out these limitations followed by relevant research proposals to guide like-minded researchers and practitioners to expand on the existing knowledge on sustainable applications, with a particular focus on end-users and NPD:

- This study was conducted through a qualitative approach and generated a conceptual framework to combine the sustainability perspective with NPD and DCM. Even though it sought to fulfil the aim and objectives, it could be beneficial in the future to employ quantitative or mixed-method approaches such as survey methods to reach a higher number of respondents/case studies with a greater statistical population. This also helps to increase the accuracy of research.

- Four manufacturing organisations and their approaches regarding research concepts were investigated in this study. However, future research might be more extensive in examining the whole supply chain stakeholders of a single organisation to explore NPD risk factors, consumer insights, and a sustainable strategy for a given product and distribution network. This may also be used to showcase solutions for a certain industry or product category.

- In this study, technology and IT applications regarding demand-driven chains were gently covered. However, the application of technology infrastructures, such as the fourth industrial revolution (Industry 4.0) is still ongoing and can be further investigated to find out how they can contribute to the sustainable practices and customer orientation of various business sectors.

- A longitudinal time horizon for study might help researchers better analyse the long-term advantages of sustainability applications in DCM and NPD. This is particularly important for SMEs that are more economically fragile. To implement sustainable practices, SMEs must anticipate long-term profitability and benefits, which may be better measured through longitudinal research.

- Further verification and validation of the framework are necessary to establish whether or not the established framework can be effectively applied in businesses. This was beyond the scope of this research and surely needs the allocation of extra time and budget.

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APPENDICES

Appendix A: List of Publications

1) Naghi Ganji, E., Shah, S., and Coutroubis, A. (2016) 'An evaluation of demand focused chain contribution to industrial sustainability', *Advances in Manufacturing Technology XXXI: Proceedings of the 15th International Conference on Manufacturing Research (ICMR),* London, UK. 6, pp.359-364.

2) Naghi Ganji, E., Shah, S. and Coutroubis, A. (2017) 'The role of sustainable new product development in demand-driven chains', *International Conference on Industrial Engineering, Management Science and Application (ICIMSA),* Seoul, South Korea. pp.1-5.

3) Naghi Ganji, E., Shah, S. and Coutroubis, A. (2017) 'Sustainable supply and demand chain integration within global manufacturing industries', *IEEE International Conference on Industrial Engineering and Engineering Management (IEEM),* Singapore. pp.1807-1811.

4) Naghi Ganji, E., Shah, S. and Coutroubis, A. (2018) 'An examination of product development approaches within demand-driven chains', *Asia Pacific Journal of Marketing and Logistics,* 30(5), pp.1183-1199.

5) Naghi Ganji, E., Shah, S. and Coutroubis, A. and Gestring, I. (2018) 'Towards a Sustainable Demand Chain Framework: Successful Product Development Integration and Drivers', *IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD),* Marrakech, Morocco, pp.166-171.

6) Naghi Ganji, E., Shah, S. and Coutroubis, A. (2020) 'Demand Chain toward Prosperity of New Product Development (NPD) Projects: A Systematic Review', *IET Collaborative Intelligent Manufacturing,* 2, pp.151-163.

Appendix B: Case Study Interview Questionnaire

Question Area	Question Description	Relevance to Literature

Q1:
General Background
	Kindly provide your background.
	➢ Relevant department of employment
	➢ Job functions within the company
	➢ Education background
	➢ Overall work experience in this organisation
	➢ Company background
	  o Year of establishment
	  o Company size
	  o Previous and current products range
	  o Total number of employees
	➢ What does sustainability mean to your organisation?
	➢ What motivates you to adopt sustainable strategies?
	➢ How much are the government regulations and policies supportive of sustainability adoption?
	➢ How much are the top managers/shareholders of the company supportive and committed towards sustainability pillars?
	➢ How much does the company make an effort towards employee training towards increasing awareness and knowledge of sustainability?
		Brundtland Commission (1987)
		Menguc et al. (2010)
		Gavronski et al. (2011)

Q2: NPD and the Influence of Sustainability	➢ What are the NPD risks, threats and success factors? ➢ Why is sustainability important within NPD? ➢ How does sustainability approaches impact on NPD process with examples of a specific product? ➢ What are the main/potential barriers, risks and threats towards SNPD adoption within your company? ➢ How do you address these barriers? ➢ Which departments are involved, and what role do they assume? ➢ How do you measure NPD success? ➢ How do you measure SNPD success?	*Berchicci & Bodowes (2005)* *Tan & Tracey (2007)* *Chien & Chen (2010)* *Vinayak & Kodali (2014)*

	➢ *To what extent is your company engaged in the implementation of following sustainable practices towards the success of NPD projects (as following)?* o Sustainable design (Constructions and eco-friendly products) o Manage the high costs and premium price of products o Sustainable marketing o Sustainable manufacturing (Environmental reduction practices such as additive manufacturing) o Suppliers environmental evaluation (green suppliers) o Sustainable logistics - raw material purchasing, product delivery and inter-organisations transportation (Zero-emission vehicles, CO2 emission calculation, sharing transportation with other companies etc.) o Reduction of environmental impacts through: • Recycling • Waste reduction • Certification of the environmental management system (EMS) • Workplace health and safety • Reduction of fossil fuel usage replacing by solar energy, geothermal energy etc.	*Machado et al. (2020)* *Katsikeas et al. (2016)* *Nakamba et al. (2017)* *Stindt (2017)*
Q3: Demand Chain and the Influence of Sustainability	➢ How do you evaluate your company's relationship with your customers/end users? ➢ How much do you consider your customer preferences and demands? ➢ How much are you familiar with your customer's sustainable values and preferences? ➢ How do you manage differences in customer variable demands? ➢ If you have made changes in customer demands, what feedback have you received? ➢ What skills have you been able to develop within your organisation due to customer demand changes? ➢ What motivates you to adopt sustainability to fulfil customer preferences? ➢ Which departments are involved, and what role do they assume? ➢ Why are these departments involved and not the others? ➢ What are the main/potential barriers, risks and threats towards SDCM adoption within your company? ➢ How do you address these barriers? ➢ *To what extent is your company engaged in the adoption of sustainable pillars towards a demand-driven chain (as following)?* o Identification of sustainable customer values	*Hilletofth et al. (2009)* *Liao & Wen (2009)* *Budd et al. (2012)* *Vural (2015)* *Jüttner et al. (2017)* *Ye and Lau (2018)*

	○ Identification of target customer/markets ○ Mining customer consumption patterns ○ Customer service management (CSM) ○ Customer relationship management (CRM) (after-sales service and maintenance, technical know-how) ○ Supply chain redesign towards a demand-driven chain ○ Supply chain redesign towards a demand-driven chain	
Q4: Technology and Information Technology	➢ To what extent do you employ IT applications towards your product development projects? ➢ Do you use IT systems to coordinate your various supply chain entities? ➢ What IT systems do you use towards smoother relationships and more transparency with your customers/end-users? ➢ Which departments are involved in IT and technology-related tasks, and what role do they assume? ➢ Do you develop the IT systems yourself or do you use external resources? ➢ How do you choose your IT systems? ➢ What are the main/potential barriers, risks and threats towards IT applications within your company? ➢ How do you address these barriers? ➢ *To what extent are applications of technology and IT important regarding both customer satisfaction and success of NPD projects (as following)?* ○ Demand chain knowledge ○ Delivery track and updates [Kanban, electronic data interchange (EDI), POS, …] ○ Transparency of demand and inventory levels across the whole chain ○ Industry 4.0 applications such as additive manufacturing ○ Close coordination of IT and SC entities ○ Automation of key SC processes	*Budd et al. (2012)* *Agrawal (2012)* *Gandhi et al. (2014)* *Santos & D'Antone (2014)* *Ford and Despeisse (2016)* *Machado et al. (2020)*
Q5: Marketing	➢ What are the main marketing strategies for your company? ➢ Do you have several marketing strategies for different countries? ➢ How do you evaluate the relationship between marketing and NPD? ➢ To what extent do your customers take part in product development processes? ➢ How is your marketing department involved in the identification of customers' sustainable desires and other customised preferences?	*Ogawa & Piller (2006)* *Hilletofth et al. (2009)* *Vural (2015)*

	➢ Do customer variable demands affect your NPD practices? ➢ What are the main/potential barriers, risks and threats towards marketing approaches within your company? ➢ How do you address these barriers? ➢ *To what extent are sales and marketing practices/innovations important regarding both customer satisfaction and success of NPD projects (as following)?* • Postponement • Mass customisation • Collective customer commitment • Value propositions	
Q6: Economics	➢ How do you evaluate the sustainability investments payoff? ➢ What are the possible economic harms you assume for the implementation of sustainability? ➢ Do you evaluate the high costs of investments are barriers to sustainability adoption within your company? ➢ How do you evaluate and measure the economic impacts of your NPD and SNPD approaches? e.g. Sustainable logistics, reduction of environmental impacts, recycling, environmental certifications, etc. ➢ How do you evaluate and measure the economic impacts of considering customer preferences?	*Walker et al. (2000)* *Hilletofth et al. (2009)* *Carter & Euston (2011)* *Hassini et al. (2012)* *Budd et al. (2012)*

Appendix C: Participant Information Sheet

UNIVERSITY *of* GREENWICH
Faculty of Business

PARTICIPANT INFORMATION SHEET
(Participants over the age of 18)

Dear participant,

My name is Elmira Naghi Ganji, and I am currently studying at the University of Greenwich for my degree in MPhil/PhD Business. As part of my studies, I am undertaking a research study entitled
"Designing a Conceptual Framework linking Sustainability into Demand Chain and New Product Development".

Invitation

I would like to invite you to take part in this research study. Before you decide to allow this, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. If anything you read is not clear or you would like more information, please do not hesitate to contact me.

What will happen if you take part?

The interview will last for around 60 minutes. The research statement explaining the purpose and application of the collected data will be made available to all potential participants when carrying out the research interview. The questions will be worded with instructions of what to do next where specific questions may not be relevant to the potential participant depending on which answer they select in the question before.

What about confidentiality?

Digital data will be anonymised wherever possible, stored on an encrypted USB and kept in a locked cupboard for the duration of the study; non-digital data will be stored in a locked box, in a locked cupboard. Data will only be accessed by the researchers, students and staff members directly involved in the study and data that can be used to identify individuals will not be made public without the express written informed consent of the individual being identified. Once the study has been completed (and any archiving responsibilities undertaken) the data will be shredded (non-digital and CD/DVD media) or deleted and overwritten (for re-writeable digital media).

Participants have the right to withdraw consent as well as not to answer specific questions if they wish. The deadline for the consent withdrawal is two weeks after the interview date, and participants have the unconditional right to do so and ask for data destruction without giving any reason. All the participants' information and data will be anonymised at the time of research publication, and no participant will be identified.

Who to reach in case of queries or concerns?

In case of any queries or concerns feel free to reach Elmira Naghi Ganji through their University email address e.naghiganji@gre.ac.uk.

Alternatively, you can do this through the research supervisor Prof. Dotun Adebanjo at the Faculty of Business who can be reached via their University email: D.Adebanjo@gre.ac.uk and University telephone number:…

Appendix D: Participant Consent Form

PARTICIPANT CONSENT FORM

To be completed by the participant. If the participant is under 18, to be completed by the parent/guardian/person acting *in loco parentis*.

- I have read the information sheet about this study
- I have had an opportunity to ask questions and discuss this study
- I have received satisfactory answers to all my questions
- I have received enough information about this study
- I understand that I am / the participant is free to withdraw from this study:
    - At any time (until such date as this will no longer be possible, which I have been told)
    - Without giving a reason for withdrawing
    - (If I am / the participant is, or intends to become, a student at the University of Greenwich) without affecting my / the participant's future with the University
- I agree to take part in this study
- We may wish to use your research data for a further project in anonymous form. If you agree to this, please tick here ☐

Signed (participant)	Date
Name in block letters	
Signed (parent / guardian / other) (if under 18)	Date
Name in block letters	
Signature of researcher Elmira Naghi Ganji	Date
This project is supervised by: Prof. Dotun Adebanjo	
Researcher's contact details (including telephone number and e-mail address): E.naghiganji@gre.ac.uk	